October, 2025

E-ISSN: 3049-3846

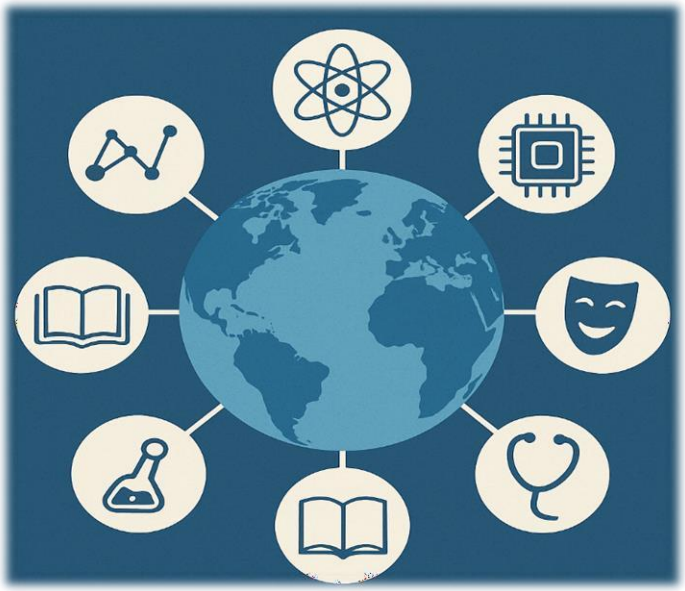
International Journal
of
Innovative Trends in Multidisciplinary Research

International E-Research Journal

Peer-Reviewed, Open-Access Journal

Volume – 1, Issue – 5

MULTIDISCIPLINARY ISSUE



Website: https://www.ijitmr.com/ Email: editor@ijitmr.com

Published by
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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

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REVIEW ON FORMULATION AND EVALUATION OF HERBAL COUGH RELEVANT CANDY

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ABSTRACT

Lozenges are a type of solid dosage form that contains drugs that are meant to dissolve gradually in the mouth for therapeutic effects. Common colds and the flu are common illnesses that typically affect the respiratory system and cause symptoms like fever, drowsiness, head and body aches, and a persistent amount of medication in the mouth or throat tissues. Lozenges frequently contain medications for cough, congestion, runny nose, analgesics, antimicrobials, antiseptics, and antitussives [1]. Various herb-based compositions are used in the traditional Indian medical system to treat various illnesses. Coughing and sore throats are unpleasant symptoms of a throat infection. Lozenges and cough syrup are examples of calming medications that can provide symptomatic relief. Despite the availability of numerous allopathic and natural medications, they are insufficient to address every ailment in a single formulation. The findings show that these herbal cough lozenges have the potential to be a safe substitute for prescription cough drugs and a natural and efficient treatment for cough and throat irritation. Lozenge is a cost-effective way to treat all cold symptoms because it is entirely herbal and has no artificial ingredients.

KEYWORDS

Lozenges, cough, Herbs, Throat infection.

INTRODUCTION

Lozenges are characterized as flavored solid dose forms that are usually intended to be retained in the mouth and hydrated by saliva until they dissolve completely [3]. They are used for both systemic (such as pain alleviation and antacid reasons) and local (such as pharyngitis or sore throat) effects. Lozenges are unit-dose, hard, solid forms that are intended to dissolve or decompose gradually in the oral cavity. Depending on their texture and composition, lozenges can be classified as chewy, caramel, compacted tablet, soft-, or hard-boiled. Hard lozenges, which first appeared around 1970, come in sugar-based and sugar-free varieties. Hard boiled lozenges (HBL), also known as hard boiled candies (HBC), are the most popular and often used product among customers. Hard-boiled lozenges come in a range of sizes,

shapes, colors, and flavors, and they typically weigh between 2 and 3 grams. These are usually made up of hydrophilic, water-soluble substances like sucrose, dextrose, or liquid glucose, or low-calorie, sugar-free components like isomalt, sorbitol, or mannitol. Lozenges are dissolved gradually in the mouth to relieve throat irritation and halt coughing. A promising method of relieving cough symptoms while reducing the usage of synthetic medications and the negative consequences they can cause is the creation of herbal cough lozenges. Additionally, adding natural substances with established therapeutic benefits could improve the lozenges' therapeutic effectiveness [5].

Cough:

Coughing, a typical symptom of respiratory infections and other respiratory disorders, often causes people to feel uncomfortable and distressed. Even though traditional cough medications are widely available, herbal remedies are becoming increasingly popular due to their perceived safety and possible efficacy in treating cough symptoms [6]. Herbal remedies have long been used in traditional medical systems due to their therapeutic benefits, which include improving respiratory health, lowering coughing, and easing sore throats. This study aims to develop and evaluate herbal cough lozenges by fusing natural ingredients with medicinal properties. The ingredients that were selected include ginger, honey, clove, Tulsi (holy basil), cinnamon, cardamom, and jaggery. Each ingredient was chosen because it has a long history of use in treating throat and cough pain and because it might complement other components. The development of herbal cough lozenges is a promising way to alleviate cough symptoms while lowering the need of synthetic drugs and the potential side effects they may have. The therapeutic efficacy of the lozenges may also be increased by using natural substances with proven therapeutic advantages [7].

Symptoms of coughing:

1. A stuffy or runny nose.
2. Postnasal drip is the feeling of liquid running down the back of your throat.
3. Frequent cleaning of the throat and sore throat
4. A hoarse voice.
5. Breathlessness and wheezing.

Advantages:

- Both young and elderly individuals can easily receive it.
- It tastes good and will prolong the amount of time a medicine is in the mouth to produce local action.
- Drugs can be absorbed systematically through the buccal cavity.
- It requires very little equipment to prepare.

- Sweeteners and flavors added to the formulation might hide the taste of the medications.

Disadvantages:

- Children could accidentally use it as candy.
- Parents should be advised to keep the product out of children's reach and to avoid associating drugs with candy.
- Benzocaine is one medication that might not work well with aldehyde confectionery bases.
- Lozenges are safe for usage by kids older than six.

Types of Lozenges:

1. Hard Candy Lozenges.
2. Soft Candy Lozenges.
3. Chewable Lozenges.

History of Lozenges:

Since the Twentieth Dynasty in Egypt, when the sweets were manufactured from pure honey and flavored with citrus fruit juices, different herbs, and certain priceless spices, candies have been used to calm the throat since 1000 BC. Some doctors in the 19th century utilized heroin and morphine, which are derived from opium and have antitussive properties. The two most widely used formulas at the time were Luden's, which was developed in 1880, and Smith Brothers Cough Drops, which was originally marketed in 1850. Later, there was worry about the possibility of opioid addiction and dependence, which prompted the creation of substitute drugs [8].

Aim: The aim of the present study is to formulate and evaluate herbal cough relevant candy.

Objective: To prepare herbal candy to eliminate and control cough.

MATERIALS AND METHODS

1. **Ginger:**

Fig: Ginger [8]

Taxonomical Information:

- Family: Zingiberaceae
- Genus: Zingiber
- Species: Zingiber officinale

Biological Source: Southeast Asia is the origin of the flowering plant known as ginger. The rhizome, or underground stem, is the portion that is utilized for its therapeutic qualities.

Organoleptic Characteristics: Typically, ginger has a spicy, slightly sweet flavor and a strong scent. Typically, the rhizome has a rough exterior texture and is light brown in color.

Chemical Constituents: The therapeutic qualities of ginger are attributed to several bioactive substances, such as gingerol, shogaol, zingerone, and paradol.

Uses: Because of its anti-inflammatory, antioxidant, and digestive qualities, ginger is frequently utilized in traditional medicine. It is frequently used to lessen inflammation, enhance digestion, and ease nausea.

Ginger Strengthens the Immune System Ginger's immune-boosting properties can help relieve coughs and sore throats and speed up your recuperation. Most sore throat coughs are brought on by viruses. This covers mononucleosis, the flu, and the common cold. These are gastrointestinal and carminative regulators [9].

2) Tulsi:

Fig: Tulsi [10]

Taxonomical Information:

- Family: Lamiaceae

- Genus: Ocimum
- Species: O.Sanctum

Biological Source: Tulsi is made up of both fresh and dried leaves from the Labiatae family plant, Ocimum sanctum Linn.

Organoleptic Characteristics: a pleasant, aromatic, and spicy odor, a mildly pungent and bitter taste, and a visually appealing green color for the leaves

Chemical Constituents: Steam distillation of Tulsi leaves, and flowering tops yield 0.1–0.9% bright yellow volatile oil, mostly composed of 70% eugenol, 20% eugenol-methyl-ether, and 3% carvacrol. Caryophyllin, fixed seed oil, alkaloids, glycosides, saponins, tannins, vitamin C, and trace amounts of citric, tartaric, and maleic acids are also present in the plant.

Uses: There are several uses for the volatile oil, juice, and fresh leaves. The oil has insecticidal and antibacterial properties. The leaves have diaphoretic, spasmolytic, fragrant, and stimulating properties. In addition to being used as an antiperiodic, the juice is a component of several remedies for skin conditions and earaches. The leaves' infusion is used as a stomach. The medication is an effective immunomodulator [11].

3) Clove:

Fig: Clove [12]

Taxonomical Information:

- Family: Myrtaceae
- Genus: Syzygium
- Species: Syzygium aromaticum

Biological Source: The clove tree, Syzygium aromaticum, produces fragrant flower buds called cloves [13].

Organoleptic Characteristics: The scent of cloves is powerful, sweet, and spicy. The dried buds have a characteristic nail-like form and are tiny and dark brown.

Chemical Constituents: Cloves contain various bioactive chemicals, including eugenol, which is the major component responsible for its scent and medicinal effects. Flavonoids, phenolic acids, and tannins are other components [14].

Uses: For millennia, cloves have been utilized in both traditional medicine and cooking. Their analgesic, antifungal, antibacterial, and anti-inflammatory qualities are well known. Cloves are used in traditional medicine to treat respiratory ailments including cough and sore throat, as well as toothaches and digestive issues.

4) Turmeric:

Fig: Turmeric [15]

Taxonomical Information:

- Family: Zingiberaceae
- Genus: Curcuma
- Species: Curcuma longa

Biological Source: The rhizomes of the Curcuma longa plant, which is indigenous to South Asia, especially India and Indonesia, are used to make turmeric [16].

Organoleptic Characteristics: The color of turmeric is a rich yellow orange. It smells warm and earthy and tastes a little spicy and harsh.

Chemical Constituents: Curcumin, the main bioactive ingredient in turmeric, is what gives it its vivid color and many of its health advantages [17].

Other significant components include several vitamins and minerals, as well as volatile oils including zingiberene and turmerone.

Uses: For centuries, traditional medicine has utilized turmeric, especially in Ayurveda and traditional Chinese medicine (TCM). It is well-known for its analgesic, antibacterial, antioxidant, and anti-inflammatory qualities. Numerous ailments, including digestive problems, inflammatory diseases like arthritis, and respiratory infections, can be treated with turmeric.

Turmeric may contribute to its therapeutic qualities, such as its anti-inflammatory and antibacterial actions, to the composition of herbal cough lozenges, which can help relieve sore throats and promote respiratory health. Turmeric curcumin components may also help reduce cough symptoms and offer antioxidant advantages. Turmeric also gives the lozenges flavor and color, which improves their allure [18].

5) Cinnamon:

Fig: Cinnamon [19]

Taxonomical Information:

- Family: Lauraceae
- Genus: Cinnamomum
- Species: Cinnamomum verum, or true cinnamon, and Cinnamomum cassia, or cassia cinnamon, are two of the species of Cinnamomum that are used to make cinnamon.

Biological Source: The inner bark of trees in the genus Cinnamomum is used to make cinnamon. While cassia cinnamon (Cinnamomum cassia) is indigenous to China and other East Asian countries, true cinnamon (Cinnamomum verum) is indigenous to Sri Lanka [20].

Organoleptic Characteristics: Cinnamon smells warm, fragrant, and woodsy, and it tastes a little peppery. Cassia cinnamon (Cinnamomum cassia) is darker and has a stronger, acrider flavor than true cinnamon (Cinnamomum verum), which is lighter in color and has a delicate, sweet taste.

Chemical Constituents: Cinnamaldehyde, the primary bioactive ingredient in cinnamon, gives it its distinct flavor and scent. Various essential oils, coumarin, and eugenol are additional ingredients [21].

Uses: For millennia, cinnamon has been utilized in both traditional medicine and cooking. It is well-known for its digestive, antibacterial, anti-inflammatory, and antioxidant qualities. Cinnamon is used in traditional medicine to help with digestion, circulation, and respiratory issues [22].

6) Cardamom:

Fig: Cardamom [23]

Taxonomical Information:

- Family: Zingiberaceae
- Genus: Elettaria (for true cardamom)
- Species: Elettaria cardamomum

Biological Source: The plant cardamom, sometimes referred to as genuine cardamom or green cardamom, is indigenous to Southeast Asia and the Indian subcontinent. It is grown for its fragrant seeds, which are used for seasoning [24].

Organoleptic Characteristics: Cardamom seeds have a little spicy, minty flavor and a powerful, sweet, and fragrant aroma. The tiny, black seeds are contained in papery pods.

Chemical Constituents: Numerous bioactive substances, such as phenolic compounds like catechins and flavonoids, and essential oils like cineole, terpinene, and limonene, are found in cardamom seeds [25].

Uses: For many years, cardamom has been utilized in both traditional medicine and cooking. It has antibacterial, digestive, and carminative qualities. Cardamom is frequently used to treat digestive problems like gas, bloating, and indigestion. Additionally, it is used to treat congestion and coughs, as well as to freshen breath.

Cardamom may offer its medical qualities, such as its capacity to relieve throat irritation, lessen coughing, and strengthen the respiratory system, to the production of herbal cough lozenges. Cardamom's aromatic chemicals may facilitate easier breathing by clearing nasal passages. Furthermore, cardamom gives the lozenges a pleasing taste and scent.

7) Honey:

Fig: Honey [26]

Biological Source: Bees use floral nectar to make honey. Within their hives, bees store this naturally occurring sweet material in honeycombs [27].

Organoleptic Characteristics: Depending on which flowers the bees get nectar from, honey can have different colors and flavors. It may be light amber to dark brown, with notes of fruit, flowers, or herbs. There are two possible textures: smooth and fluid and thick and viscous.

Chemical Constituents: Although the main carbohydrates in honey are glucose and fructose, it also contains trace amounts of antioxidants, vitamins, minerals, and amino acids. Depending on variables including the flower source and processing techniques, its composition may change [28].

Uses: For centuries, honey has been utilized for its therapeutic qualities and as a natural sweetener. Its antimicrobial, anti-inflammatory, and wound-healing qualities are well known. Honey may help relieve sore throats, reduce coughing, and add a sweet taste to cough lozenges.

Honey is used as a natural sweetener and may have therapeutic benefits, such as coating the throat, relieving irritation, and having antimicrobial properties, when used in the formulation of herbal cough lozenges. Additionally, its sweet taste makes the lozenges more palatable [29].

8) Jaggery:

Fig: Jaggery [30]

Chemical Constituents: About 5–15% glucose and fructose, 60–85% sucrose, and 0.4% protein [31].

Uses: Laxative, flavoring, and sweetening agent.

Materials for Preparation of Candy:

Sr. No.	Ingredients
1	Ginger
2	Tulsi
3	Clove
4	Turmeric
5	Cinnamon
6	Cardamom
7	Honey
8	Jaggery

Method of Preparation:

Jaggery dissolved in a small amount of water until the mixture had a suitable consistency. A small amount of water was added to another container, along with all the herbs, which were then well combined and filtered. In the beaker with the filtered herbal juice, jaggery syrup was added. They added honey. Until the mixture reached 150°C, it was heated while constantly stirring. To create lozenges of the perfect size, the mixture was then taken off the heat and placed onto a lozenge mold. At room temperature, the mold was let cool and solidify. To keep the firm lozenges from becoming sticky in the presence of moisture, they were sprinkled with powdered jaggery after chilling. The sugar powder-tossed lozenges are kept in a cool location in an airtight, wide-mouthed container. Tulsi, clove,

ginger, cinnamon, cardamom, and turmeric are among the herbs utilized in the mixture. The purpose of honey was to soothe the throat.

Evaluation Parameters:

A) Physical Parameters:

Shape	Circular
Color	Brown
Texture	Smooth
Type	Hard candy
Odour	NA

B) Physicochemical parameters:

A variety of organoleptic criteria, including color, odor, taste and touch, hardness, and weight fluctuation, have been evaluated for the made lozenges. Lozenges thickness was determined using a thickness apparatus, and a friability test was conducted using a friability test apparatus. Five lozenges were weighed separately to measure the weight variation. The average weight was then computed to estimate the percentage variance of each tablet [32].

Disintegration Time Study:

Disintegration time is the amount of time needed for a lozenge or its constituent particles to disappear completely from the tester's net. A disintegration tester was used to evaluate the manufactured lozenges for disintegration in accordance with USP30 [33].

Stability test for lozenges:

As soon as they are prepared, lozenges are put through stability testing under the specified conditions, which might be one to two months at 60 degrees RH for six to twelve months for their stability study in accordance with ICH criteria [34].

Packaging of Candy:

Since lozenges are typically hygroscopic, an involute and multiple packing technique should be employed to preserve their stability during the marketing process. The lozenge should be covered in a moisture-impermeable liner. After that, the wrapped lozenges are put inside a water-resistant or tamper-proof glass and then covered with aluminum foil.

Storage:

It is best to keep lozenges away from extremes in humidity or temperature. The product's label typically specifies whether the product should be kept in a refrigerator or at room temperature, depending on the drugs and the base used to formulate the lozenges' storage needs [35].

CONCLUSION

Herbal lozenges are small tablets that dissolve gradually in the mouth and are intended to offer a variety of health benefits. Herbal lozenges are designed to relieve a variety of conditions by delivering the active herbal constituents straight to the mouth, throat, and respiratory system.

The cough lozenge is intended to treat sore throats brought on by infections or the common cold and cough. utilized to provide short-term relief from symptoms like coughing (from a cold, for instance) or sore throats. It functions by making the mouth feel cooler and producing more saliva.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

THE ALLOSTERIC REVOLUTION: A MAJOR REVIEW OF NEW MODULATORY APPROACHES FOR THE THERAPY OF SCHIZOPHRENIA

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ABSTRACT

Schizophrenia is an illness with marked disability and chronicity that presents with a complicated array of positive, negative, and cognitive symptoms. For more than a half-century, pharmacological management has been dominated by dopamine D_2 receptor-antagonist drugs, a strategy that mainly affects positive symptoms but leaves the debilitating negative and cognitive impairments inadequately treated, at considerable cost of side effects. The fault limits of this dopaminergic model have generated a paradigm shift for research, with emphasis placed upon the central position of glutamatergic and other neurotransmitter system dysfunctions within the pathophysiology of the disease. Direct orthosteric agonism of these novel targets, especially the NMDA receptor, is fraught with risk because of possible excitotoxicity and limited therapeutic ratio. This has opened the door to a more advanced and more secure therapeutic approach: allosteric modulation. Allosteric modulators dock at topographically remote sites on a receptor, serving as "dimmer switches" to modulate the receptor's response to its natural ligand. This method maintains the physiological patterns of neurotransmission and possesses a dramatically better safety profile. This comprehensive review covers the landscape of allosteric modulation as a therapeutic approach for schizophrenia. We explore the molecular mechanisms and clinical promise of subtype-selective $GABA_a$ PAMs targeting the GABAergic system, NMDA, $mGlu_2$, and $mGlu_5$ receptor PAMs targeting the glutamatergic system, and other new targets like the α7 nicotinic acetylcholine receptor and the Trace Amine-Associated Receptor 1 (TAAR1). We critically assess the strengths of this strategy, consider the problems of clinical translation, and define the future directions that will ultimately produce treatments which cover the entire range of schizophrenia symptoms.

KEYWORDS

Schizophrenia, GABAergic system, receptor-antagonist drugs, neuropsychiatric illness.

INTRODUCTION

1.1. The Enduring Challenge of Schizophrenia

Schizophrenia is a catastrophic neuropsychiatric illness that afflicts about 1% of the world's population, characteristically appearing in late adolescence or early adulthood. Schizophrenia is not a monolithic, homogeneous disorder but a heterogeneous syndrome characterized by a triad of disabling symptom clusters:

Positive Symptoms: These are an excess or perturbation of usual functions and consist of hallucinations (usually auditory), delusions (fixed, false beliefs), disorganized speech, and grossly disorganised or catatonic behaviour.

Negative Symptoms: These describe a loss or lack of usual functioning. They involve lessened emotional expression (affective flattening), lack of talk (alogia), inability to feel pleasure (anhedonia), lack of motivation (avolition), and social withdrawal.

Cognitive Deficits: These are now thought to be one of the fundamental features of the illness and are the best predictor of long-term functional outcome. Deficits are diffuse and involve working memory, executive function, speed of processing, and attention.

Although positive symptoms are dramatic and tend to be the cause of initial hospitalization, it is the chronic negative and cognitive symptoms that are most to blame for the long-lasting and severe disability in schizophrenia, causing people to lose relationships, education, or jobs. The cost to society and the economy is huge, and the cost to patients and their families is incalculable.

1.2. A Critical Overview of the Dopamine Hypothesis

The history of schizophrenia therapy over the last 70 years has been shaped by the dopamine hypothesis. Introduced in the 1960s, it suggested that excessive activity of dopaminergic circuits in the brain, and especially in the mesolimbic circuit, was the major force behind psychosis. This theory was founded on two critical observations: first, that amphetamines, which elevate synaptic levels of dopamine, could produce a psychosis indistinguishable from paranoid schizophrenia; and second, that each of the effective antipsychotic drugs, from chlorpromazine to haloperidol, had in common one mechanism of action: blockade of the dopamine D_2 receptor.

This "first generation" of typical antipsychotics, while a titanic step forward from the horrors of institutionalization, was dearly purchased. Their powerful D_2 blockade of the nigrostriatal pathway most often induced disastrous extrapyramidal symptoms (EPS), such as parkinsonism, dystonia, and the perhaps irreparable tardive dyskinesia. The introduction of "second generation" or atypical antipsychotics (e.g., clozapine, risperidone, olanzapine) in the 1990s introduced a lower incidence of EPS, chiefly due to their simultaneous action upon the serotonin 5-HT_{2a} receptors. But they brought with them a new constellation of issues, most significantly a high risk for metabolic syndrome, such as extreme weight gain, dyslipidemia, and type 2 diabetes.

Most importantly, both generations of antipsychotics are afflicted with the same basic flaw: they are mainly effective on positive symptoms. Their efficacy on the life-destroying negative and cognitive symptoms is negligible to non-existent. This clinical phenomenon, combined with their troublesome side-effect profiles, reveals a deep-seated unmet need and serves to emphasize that the dopamine hypothesis, though not inaccurate, is inherently incomplete. It specifies a portion of the tale—a "final common pathway" for psychosis—but does not reflect the upstream, essential pathophysiology of the condition.

1.3. The Glutamate Hypothesis: A New Conceptual Framework

The quest for a more general model resulted in the development of the glutamate hypothesis of schizophrenia. According to this hypothesis, the fundamental deficit is not in an overabundance of dopamine but in the hypofunction of the N-methyl-D-aspartate (NMDA) receptor, which is a key element of the brain's major excitatory neurotransmitter system.

Support for the hypothesis is persuasive. During the 1980s, it was found that NMDA receptor antagonists such as phencyclidine (PCP) and ketamine, when they were administered to healthy volunteers, induced a transient condition that mimicked the entire gamut of schizophrenia symptoms—not just psychosis (positive symptoms), but also severe negative symptoms (apathy, withdrawal) and cognitive disorganization. As opposed to amphetamine psychosis, this drug-induced condition was a much more accurate model of the illness. In addition, these agents worsened symptoms in patients with schizophrenia. This implies that diminished NMDA receptor transmission may be a central hub in the pathophysiology of the disease, resulting in downstream dysregulation of both dopamine and GABA systems and therefore the broad range of symptoms.

1.4. The Allosteric Solution: Precision Targeting for a Complex Disorder

Identification of NMDA receptor hypofunction as a critical target immediately created a therapeutic dilemma. The simplest method—creating orthosteric, direct agonists to increase receptor activity—is risky. The glutamatergic system is tightly controlled, and overstimulation of NMDA receptors opens the floodgates for a huge calcium influx, which sets into motion a cascade of intracellular processes that culminate in excitotoxicity and neuronal death. The danger of causing seizures and brain damage with a direct agonist is too great.

This is where the idea of allosteric modulation comes as a beautiful, effective solution. Allosteric modulators do not occupy the primary (orthosteric) site where the endogenous ligand (such as glutamate) binds. Rather, they bind to an allosteric, topographically distinct site on the receptor complex. This causes a conformational shift in the receptor that will modify its response to the orthosteric ligand.

Positive Allosteric Modulators (PAMs) enhance the receptor's affinity for the ligand or its signaling efficacy, essentially magnifying the intrinsic signal.

Negative Allosteric Modulators (NAMs) reduce the receptor's affinity or efficacy, which suppresses the signal.

This mechanism has revolutionary benefits for CNS drug development:

Safety and a "Ceiling Effect": A PAM only acts when the endogenous neurotransmitter is present. Its action is thus limited by the natural, physiological dynamics of neurotransmitter release. It cannot activate the receptor independently to avoid the harmful over-stimulation associated with direct agonists.

Spatio-Temporal Precision: By augmenting the endogenous signal, PAMs maintain the precise timing and spatial characteristics of natural neurotransmission, resulting in a more physiological, fine-tuned effect.

Subtype Selectivity: Allosteric binding sites are frequently less conserved between receptor subtypes than orthosteric sites. This makes it possible to develop extremely selective drugs that can act on a specific receptor subtype (e.g., one involved in cognition) without affecting another (e.g., one which leads to sedation), thus reducing off-target side effects.

2. The GABAergic System: Rebalancing the Inhibitory Tone

While glutamate is the major excitatory drive, its action is ever counterbalanced by the brain's main inhibitory neurotransmitter, gamma-aminobutyric acid (GABA). Increasing evidence points toward GABAergic impairment, specifically within fast-spiking parvalbumin-positive interneurons, as a central aspect of schizophrenia pathophysiology. These interneurons are important for the generation of the high-frequency gamma oscillations (~40 Hz) which are believed to be critical for synchronizing neural activity and facilitating higher-order cognition such as working memory. Post-mortem examinations of schizophrenic brains uniformly reveal decreased expression of GAD67, the primary enzyme involved in GABA synthesis, in these interneurons. This GABAergic deficit can disinhibit downstream pyramidal neurons, causing chaotic or "noisy" cortical signaling and contributing to cognitive fragmentation.

2.1. Allosteric Modulation of $GABA_a$ Receptors

The favored target of GABA is the $GABA_a$ receptor, a ligand-gated chloride ion channel. Benzodiazepines are the prototypical $GABA_a$ PAMs, but application to schizophrenia is controversial. As non-selective modulators, they increase the activity of all sensitive subtypes of $GABA_a$ receptors, resulting in sedation, cognitive impairment, and dependence liability—all undesirable results in a patient group already afflicted with cognitive deficits and avolition.

GABAergic modulation in the future of schizophrenia is to be expected through subtype-selective PAMs. The properties of the $GABA_a$ receptor are defined by subunit composition, notably the alpha (α) subunit.

α1 Subunit: Extremely widespread throughout the cortex and cerebellum, this subtype is responsible for mediating mainly the sedative and amnestic actions of benzodiazepines.

α2 and α3 Subunits: Present in limbic structures such as the amygdala and hippocampus, these subtypes are believed to mediate the anxiolytic effects.

α5 Subunit: Occurring nearly exclusively in the hippocampus, this subtype is important in learning and memory.

Therapeutic hypothesis is that a well-designed PAM that has selectivity for the α2/α3 subunits might give an anxiolytic and mood-stabilizing effect, supporting the affective dysregulation and anxiety of schizophrenia, without the sedative liability of α1 activity.

Far more interesting is the prospect of α5-selective NAMs or partial inverse agonists. By reducing slightly the activity of this particular hippocampal receptor, it should be possible to augment cognitive function. Although a number of agents have been investigated in pre-clinical models, clinical translation has proved difficult. The complexity of the GABAergic system dictates that any modulation has to be exquisitely targeted not to perturb the subtle excitatory-inhibitory balance that supports normal cognition.

3. The Glutamatergic System: The Hub of Contemporary Investigation

The glutamate hypothesis has established this system as the most likely domain for therapeutic development in schizophrenia. Allosteric modulation is not only a choice in this case; it is a requirement for targeting this potent system safely.

3.1. The NMDA Receptor (NMDAR): The Target of Choice

The NMDAR is a distinctive and intricate ion channel that functions as a "coincidence detector," only opening when two things happen at the same time: (1) it is occupied by the neurotransmitter glutamate, and (2) the post-synaptic neuron is already depolarized, which pushes out a magnesium ion (Mg^{2+}) that keeps the channel pore blocked otherwise. This makes it a key substrate for synaptic plasticity, learning, and memory (a process referred to as Long-Term Potentiation, or LTP).

3.1.1. Structure, Function, and Co-Agonism

The NMDAR is a heterotetrameric receptor, normally formed of two GluN1 and two GluN2 subunits (there are four types of these, GluN2A-D). Importantly, the GluN1 subunit has a co-agonist binding site, which must be filled for the receptor to be functional. The co-agonist is either glycine or D-serine. The glycine/D-serine binding site, or glycine modulatory site, has also been the central target of

therapeutic development. The first efforts at enhancing NMDAR function were to add high doses of glycine or D-serine to existing treatment regimens, which produced some modest but limited by confounded brain penetration and pharmacokinetics.

3.1.2. Positive Allosteric Modulators (PAMs) of the NMDAR

NMDAR PAMs provide a much more elegant solution. Rather than overwhelming the system with co-agonists, these compounds interact with allosteric sites to augment receptor function upon presentation of endogenous ligands. NMDAR PAMs can be generally categorized:

Glycine-Site PAMs: These compounds do not bind at the glycine site but to an adjacent allosteric pocket that enhances the binding affinity of the GluN1 subunit for glycine or D-serine. This has the effect of increasing the potency of the present co-agonist.

Non-Glycine-Site PAMs: These modulators are independent of the glycine site. For instance, certain PAMs have been engineered that decrease the inhibition of the receptor by negative allosteric modulators such as zinc, or that bind at the interface between the subunits to stabilize the open-channel conformation.

3.1.3. NMDAR PAMs in Clinical Development

The discovery of NMDAR PAMs has been a focus of active research, albeit with their attendant challenges.

SAGE-324/BIIB124: Although primarily indicated for essential tremor, this neurosteroid PAM targets both the $GABA_a$ and NMDA receptors, positioning the opportunity for drug molecules that can connect the inhibitory-excitatory systems.

MAP4343: This is a regulator of the microtubule-associated protein that has been established to be a selective PAM for the GluN2B subunit of the NMDAR. Its mechanism is unique and seeks to restore dendritic spine density and synaptic function, which are established to be lacking in schizophrenia.

The journey to an effective NMDAR PAM has been challenging, with numerous compounds dropping out early in trials because of insufficient pharmacokinetics or insufficient efficacy. Yet the therapeutic hypothesis is still extremely compelling, as these drugs provide the most direct mechanism by which to address the hypothesized fundamental deficit of schizophrenia.

3.2. Metabotropic Glutamate Receptors (mGluRs): The Indirect Modulators

Metabotropic glutamate receptors are G-protein coupled receptors (GPCRs) that don't create ion channels per se but rather affect neuronal excitability and neurotransmitter release by intracellular signaling cascades. They are master regulators of the glutamatergic synapse and are optimal targets for allosteric modulation. Eight mGluR subtypes are divided into three groups.

3.2.1. Group II ($mGlu_2$/$mGlu_3$) Receptors: The Presynaptic Brake

$mGlu_2$ and $mGlu_3$ receptors are generally found presynaptically, where they serve as autoreceptors. Upon activation by excessive levels of glutamate in the synapse, they suppress subsequent glutamate release. This is a safety feedback, which serves as an important "brake" on the system to avoid over-excitation.

The schizophrenia hypothesis is that in some areas of the brain, like the cortex, there could be hyperrelease of chaotic glutamate that leads to psychosis. A PAM of the $mGlu_2$ receptor would increase the natural braking system, lowering synaptic glutamate levels and thus normalizing cortical function. This is believed to be an opportunity for treating the positive symptoms.

ADX71149: This is a selective $mGlu_2$ PAM that entered clinical trials. In a Phase II study, it was tested as an add-on to atypical antipsychotics. While it did not meet its primary endpoint, it showed some promising signals, particularly in patients with more prominent negative symptoms, suggesting a more complex role than initially hypothesized. The failure of this and related compounds has highlighted the complexity of targeting this system.

3.2.2. Group I ($mGlu_5$) Receptors: The Postsynaptic Amplifier

The $mGlu_5$ receptor is found postsynaptically, commonly in close functional and physical relationship with the NMDA receptor. Activation of $mGlu_5$ results in mobilization of intracellular calcium as well as increased NMDA receptor currents. The functional synergy here implies that an $mGlu_5$ PAM can indirectly enhance NMDA receptor signaling.

This offers a second strategy for the treatment of the negative and cognitive symptoms. A PAM could enhance the $mGlu_5$-NMDAR interaction, potentially to restore synaptic plasticity and enhance cognitive circuit function without directly modulating the NMDAR itself, potentially with a different efficacy and safety profile.

Basimglurant: An $mGlu_5$ NAM (not a PAM) that did not work in depression trials, demonstrating the difficulty of modulating this receptor. $mGlu_5$ PAMs for schizophrenia have been in active preclinical development but have not achieved clinical success. Because the cross-talk between $mGlu_5$ and other receptors is complex and sometimes hard to predict, modulation of this receptor can have complicated and unpredictable downstream consequences.

4. Other Novel Allosteric Targets: Expanding the Horizon

The quest for efficacious treatments has moved past the traditional GABA and glutamate systems, where other interesting allosteric targets have been found.

4.1. The Cholinergic System: Alpha-7 Nicotinic Acetylcholine Receptor (α7-nAChR)

It has been known for a very long time that more than 80% of schizophrenic patients are heavy smokers, at a rate significantly higher than that of the overall population or other psychiatric patients.

It is now generally thought to be a type of self-medication. Nicotine binds to nicotinic acetylcholine receptors, and one subtype, the α7-nAChR, is particularly implicated in cognitive function.

This receptor plays a key role in sensory gating, pre-attentive filtering out of irrelevant stimuli. A common deficit in schizophrenia is a breakdown of P50 sensory gating, which can be quantified with EEG. The α7-nAChR is also required for attention and working memory. Post-mortem analyses indicate a substantial decline of these receptors in the brains of schizophrenia patients.

Direct agonists to the α7-nAChR have been created but are plagued by rapid desensitization of the receptor. PAMs for the α7-nAChR provide a better solution. They interact with an allosteric site that will not induce desensitization but rather increase the response of the receptor to its native agonist, acetylcholine. In enhancing cholinergic transmission in important cortical and hippocampal circuits, these PAMs are predicted to directly enhance cognitive functioning and reverse sensory gating impairments.

Encenicline: A partial agonist at this receptor that initially looked promising at enhancing cognition but was subsequently discontinued because of severe gastrointestinal side effects.

Next-generation PAMs: Various companies are creating more targeted PAMs designed to circumvent problems encountered by earlier drugs, so this represents one of the most active research areas for pro-cognitive agents.

4.2. Trace Amine-Associated Receptor 1 (TAAR1): The Intracellular Rheostat

TAAR1 is an interesting and relatively new target. It is an intracellular GPCR that is not stimulated by traditional neurotransmitters but trace amines such as β-phenylethylamine and tyramine. On a functional level, it is an extremely potent intracellular rheostat or "master switch" for the dopamine, serotonin, and glutamate systems.

Upon activation, TAAR1 decreases dopamine production and release and lowers the rate of dopamine neuron firing in the VTA. This affords a previously unknown, non-D_2-receptor-mediated means of moderating the hyperdopaminergic condition of psychosis. Notably, since it will not block D_2 receptors in the nigrostriatal pathway, it should not produce EPS or tardive dyskinesia.

Ulotaront (SEP-363856): This agonist of TAAR1 (which might be thought of as functionally equivalent to a PAM in its modulation of the dopamine system) has created vast interest. In Phase II clinical trials, it was shown to have great efficacy at lowering overall schizophrenia symptoms, both negative ones and positive ones, with no side effects of D_2 blockers—no EPS, and no weight gain. It is the first genuinely new mechanism for an antipsychotic in decades. Although it encountered failures during Phase III trials, its novel mechanism has established TAAR1 as a promising and highly worthy target for upcoming drug discovery.

5. CHALLENGES AND FUTURE DIRECTIONS

Despite the very great theoretical potential of allosteric modulators, the path to clinical approval has been long and difficult. The course of schizophrenia drug development is marked by a series of promising compounds that failed in late-stage trials.

5.1. The Challenge of Clinical Translation

Several factors contribute to this high failure rate:

Patient Heterogeneity: Schizophrenia is likely not a single disease but a collection of syndromes with different underlying pathologies. A glutamatergic drug may only work in a subset of patients who have a primary glutamatergic deficit.

Lack of Biomarkers: In contrast to oncology or cardiology, no sure-fire biomarkers exist for stratification. We can't yet perform a blood test or brain scan and know whether a patient will respond to an $mGlu_2$ PAM or a TAAR1 agonist.

Challenges in the Measurement of Cognition: Cognitive improvement is notoriously hard to demonstrate in multicenter clinical trials. The assessment batteries currently available can be insensitive to small but significant changes, and placebo responses are typically large.

5.2. The Need for Biomarkers and Stratification of Patients

Future success with allosteric modulators hinges on biomarker development. This might include:

Electrophysiology: Measuring gamma oscillations or mismatch negativity using EEG may be able to detect patients with a particular interneuron or NMDA receptor loss.

Neuroimaging: Methods such as PET imaging may measure receptor density, and fMRI may be used to measure circuit activity in response to a cognitive stimulus, offering an objective quantification of a drug effect.

Genetics and Proteomics: Detection of genetic markers for certain neurotransmitter systems may pre-select patients for whom a targeted therapy has the highest likelihood of success.

5.3. The Promise of Combination Therapy and Polypharmacology

It is not likely that an allosteric modulator will be a panacea. The promise of the future may be rational combination therapy. A patient, for example, might be given a low dose of a D_2 antagonist to manage acute psychosis in conjunction with an NMDAR or α7-nAChR PAM to restore cognitive function and reduce negative symptoms. This would involve acting on various symptom domains through separate mechanisms, with potential to give a more complete and better-tolerated treatment regimen.

CONCLUSION

The treatment model of schizophrenia is undergoing a gradual but deepening revolution. The limitations of the dopamine hypothesis are now inescapable, and the discipline is being compelled to

face the underlying neurobiological dysruptions in the GABAergic, glutamatergic, and cholinergic systems that give rise to the entire range of the disorder. The blunt strategy of orthosteric blockade is being replaced by the more refined, precision-oriented tactic of allosteric modulation.

Allosteric modulators promise to safely and subtly re-tune aberrant neural circuits without overwhelming natural signals, and they hold out hope for drugs that will finally cure the crippling negative and cognitive symptoms of schizophrenia without a side-effect profile that trades one disability for another. Though the journey from preclinical potential to clinical fruition has been difficult, these targets such as the NMDA receptor, $mGlu_2$ receptor, α7-nAChR, and TAAR1 are the brightest prospects for innovation in a decade.

The holy grail is to transition away from a "one-size-fits-all" strategy toward a future of neuropsychiatry tailored to the individual, where biomarkers can be employed to determine a patient's unique neurobiological impairments, enabling clinicians to choose the appropriate allosteric modulator to rebalance the appropriate circuit. This allosteric revolution may be the key to finally transforming schizophrenia from a life-long sentence of disability into a manageable chronic condition, allowing patients to reclaim their cognitive clarity and re-engage with the world.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

HERBAL FUNGICIDES AND PESTICIDES: A REVIEW ON NEEM, CLOVE, ALOEVERA, GARLIC AND OTHER PLANT EXTRACTS

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ABSTRACT

Synthetic pesticides and fungicides are widely used in agriculture but are associated with health hazards, environmental toxicity, and pest resistance. Herbal pesticides and fungicides derived from natural plant extracts are eco-friendly, biodegradable, and safer alternatives. Plants such as neem (Azadirachta indica), clove (Syzygium aromaticum), Aloevera , and garlic (Allium sativum) contain bioactive compounds including azadirachtin, eugenol, and allicin, which have proven pesticidal and fungicidal properties. This review discusses types and methods of extraction of herbal constituents, suitable techniques for obtaining active agents, and their preparation into herbal pesticides and fungicides. Appropriate formulation with diluents, emulsifiers, viscosity modifiers, and coloring agents is highlighted, along with packaging approaches that improve stability during storage. Such innovations provide a strong basis for developing sustainable and effective plant-based alternatives to synthetic pesticides.

KEYWORDS

Herbal Fungicide, Herbal Pesticide, Neem, Clove, Aloevera, Garlic, Extraction, Formulation, Packaging

INTRODUCTION

The heavy dependence on synthetic pesticides has led to environmental pollution, soil degradation, and development of resistant pest species. Herbal pesticides and fungicides offer a promising alternative due to their natural origin, rapid degradation, and safety. Plants such as neem, clove, aloe vera, and garlic are widely known for their pesticidal and fungicidal activity.

To develop effective herbal pesticides, extraction of active phytoconstituents is the first and most crucial step. Extraction methods influence the yield, purity, and stability of bioactive compounds.

Hence, a clear understanding of different extraction techniques is essential before formulation.

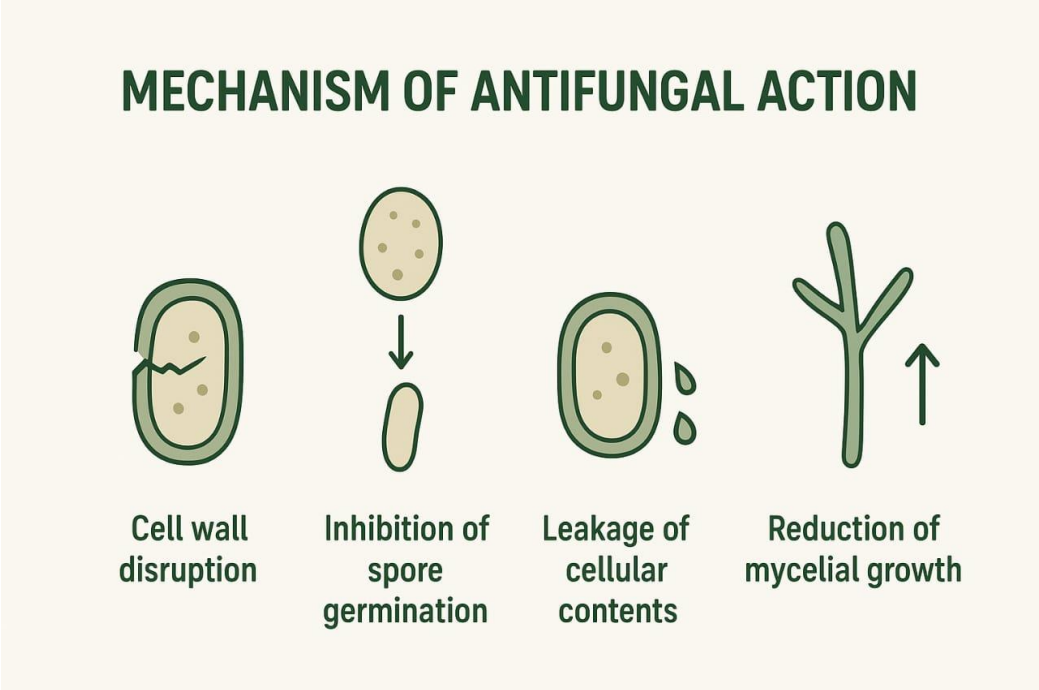

Fig No. 01

INTRODUCTION TO HERBS

1] NEEM

Neem extract has antifungal and antibacterial properties, which comes from the Meliaceae family.

This plant has antioxidant, microbial, and therapeutic properties. Its extract contains several bioactive compounds such as azadirachtin, salannin, nimbidin, margolonone, gedunin, and others, which are applied as insect mite repellents. Neem extracts are famous in India for medicinal properties and are obtained from various parts of the plants and found to contain polyphenols possessing strong antioxidant, antibacterial, as well as anti-inflammatory and immunomodulatory properties.

neem extract profile exhibits high antioxidant properties than synthetic antioxidants. There is a major shift towards natural extracts from synthetic chemicals due to their harmful effects on humanhealth and the environment.

Fig.No.02

2] CLOVE

Clove comes from the Myrtaceae family.

Clove contains a variety of bioactive compounds such as sesquiterpenes and triterpenoids . Eugenol (4-allyl-2-methoxyphenol), the

main bioactive compound of clove oil, displayed strong insecticidal and antioxidant properties.

Fig No .03

3] ALOVE VERA

Alove vera comes from the Asphodelaceae family.

Aloe vera gel exhibits antifungal properties to prevent postharvest diseases. Aloe vera gel has proven effective in reducing the spore survival of Penicillium, Botrytis and Alternaria and those of Rhizoctonia, Fusarium, and Colletotrichum . Aloe vera gel utilization in blueberries, strawberries , and avocado as antifungal coating has been proven excellent. Additionally, aloe vera has antibacterial activities against Bacillus cereus, Salmonella typhimurium, Escherichia coli, and Klebsialla pneumonia. All aforementioned benefits evidenced its selection excellent as coating material.

Aloe vera consists of active compounds in its profile such as vitamins, enzymes, minerals sugars, lignin, saponins, salicylic acid, and amino acids.

Fig No 04

4] GARLIC

Garlic comes from the Amaryllidaceae family.

Garlic (Allium sativum Linn.) has been used as medicine since ancient times and has long been known to have antibacterial, antifungal, and antiviral properties. It has been suggested that development of resistance to allicin easily than it does to certain antibiotics.

Fig No .05

5] LEMONGRASS

Lemongrass comes from the Poaceae family.

Lemongrass consists of bioactive compounds which are beneficial for health. Lemon-grass contains terpenoid compounds such as geranial, linalool, neral, pinene, myrcene, and terpinene. The terpene helps in the degradation of bacteria and causes toxic effects on cell membrane and cytoplasm. The antibacterial activity causes structural changes and cell lysis. Therefore, lemongrass assists in

preservation and shelf-life extension. Lemongrass also contains allelochemicals which affect the insects thus also known as biopesticide.

Fig No .06

6] TURMERIC

Turmeric comes from the Zingiberaceae family.

Curcuma longa L., commonly known as turmeric, stands out as a plant species abundant in natural compounds, showcasing diverse bioactivities. It holds great promise not only in the food industry, but also as a potential pharmacological agent in the cosmetic, pharmaceutical, and agriculture sectors. The primary phytochemical constituents of turmeric extracts are diarylheptanoids, including curcuminoids , along with essential oils. Acting as free radical scavengers with reducing power, these compounds serve as antimicrobials against a broad spectrum of food-borne and food-spoilage bacteria and fungi. They have also garnered attention for crop protection as natural substitutes for synthetic fungicides, insecticides, and herbicide. For instance, curcuminoids have been successfully employed to prevent fruit and vegetable.

Fig No .07

7] COW URINE

One of the recent inventions relates to new use of abundantly available cow urine distillate as an enhancer of antibiotic action on the target pathogen. The cow urine distillate helps in enhancing the absorption of antibiotics across the cell membrane in animal cells. Several literatures explaining the properties

Cow urine contains 95% water, 2.5% urea, and the remaining 2.5% a mixture of salts, hormones, enzymes, and minerals. It has been considered that cow urine is very useful in agricultural operations as a biofertilizer and biopesticide as it can kill number of pesticide and herbicide resistant bacteria, viruses, and fungi.Cow urine in combination with plant extracts is used to
prepare disinfectant which is biodegradable and ecofriendlywith good antibacterial action.

Fig No. 08

Extraction Process Of Herbal Pesticides

Types Of Extraction

Maceration – Plant material soaked in solvent at room temperature for several days, then filtered.

Percolation – Continuous flow of solvent through plant material, efficient for large-scale extraction.

Soxhlet Extraction – Plant material repeatedly washed with hot solvent; ideal for thermostable compounds.

Steam Distillation – Used for essential oils such as clove oil (eugenol) and cinnamon oil (cinnamaldehyde).

Supercritical Fluid Extraction (SFE) – Uses supercritical CO_2; efficient and solvent-free, suitable for sensitive compounds.

Aqueous Extraction – Boiling/crushing with water; suitable for garlic (allicin release).

Suitable Extraction For Herbal Pesticides

Neem: Cold pressing or solvent extraction for azadirachtin.

Clove: Steam distillation for essential oil [eugenol]

Garlic: Aqueous or ethanol extraction to preserve allicin.

Flowchart Of Extraction Process

Plant Material Collection → Drying & Powdering → Selection Of Solvent →

Extraction (Maceration/Percolation/Distillation) → Filtration →

Concentration Of Extract (Rotary Evaporation) → Standardization Of Active Constituents → Formulation

METHOD OF PREPARATION

Extraction Of Active Herbal Constituents

Neem seeds → Cold pressing → Neem oil (azadirachtin).

Clove buds → Steam distillation → Clove oil (eugenol).

Cinnamon bark → Hydrodistillation → Cinnamon oil (cinnamaldehyde).

Garlic cloves → Aqueous/ethanol extraction → Garlic extract (allicin).

Formulation Of Herbal Fungicide And Pesticide

Components:

Active Agents: Neem oil, clove oil, cinnamon oil, garlic extract.

Diluents: Water, ethanol, or vegetable oil for solubility.

Emulsifiers: Tween 80, saponins, lecithin for stability.

Viscosity Modifiers: Glycerin, xanthan gum for better spray adherence.

Preservatives: Vitamin E, citric acid as antioxidants.

Coloring Agents (optional): Chlorophyll extract for uniform appearance.

Formulation Types:

Emulsifiable Concentrates (EC): Oil extracts mixed with surfactants.

Aqueous Extracts: Water-based for organic farming.

Microencapsulation: Essential oils protected in biodegradable polymers for slow release.

Granules: Plant extracts absorbed onto carriers like bentonite/talc for soil application.

Packaging And Stability

Primary Packaging:

Amber glass bottles or HDPE plastic containers.

UV-resistant, airtight closures to protect volatile oils.

Secondary Packaging:

Laminated aluminium foil pouches or cartons to prevent moisture and oxygen entry.

Stability Enhancement:

- Incorporation of antioxidants.
- Nitrogen flushing to minimize oxidation.
- Storage under cool, dry, dark conditions.

Advantages

- Eco-friendly and biodegradable
- Safer for farmers and consumers
- Reduced risk of resistance development
- Multi-targeted action

Limitations

- Shorter shelf-life than synthetic pesticides
- Variation in bioactive content depending on source and season
- Extraction and formulation cost
- Need for large-scale validation

Benefits of Herbal Fungicides and Pesticides

- To provide an eco-friendly alternative to synthetic chemical fungicides.
- To utilize natural plant resources (e.g., neem, garlic, clove, turmeric, lemongrass) for controlling fungal diseases.
- To reduce environmental pollution and harmful effects on soil, water, and non-target organisms
- To minimize health hazards to farmers, consumers, and animals caused by chemical residues.
- To develop cost effective and enhance crop yield formulation
- To prevent the development of resistance in fungi due to repeated use of synthetic fungicides.
- To support sustainable agriculture and promote organic farming practices

CONCLUSION

Neem, clove, Aloevera, and garlic extracts represent effective sources of herbal fungicides and pesticides. Selection of suitable extraction methods, proper formulation using active agents and stabilizing excipients, and innovative packaging are essential to ensure product stability and efficacy. With further development and standardization, these natural products can reduce reliance on synthetic agrochemicals and support sustainable agriculture.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

MOLECULAR DOCKING: PRINCIPLES, ALGORITHMS, AND CURRENT APPLICATIONS IN DRUG DISCOVERY

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ABSTRACT

Molecular docking is a pivotal computational method in modern structure-based drug design (SBDD). It predicts the preferred orientation and binding affinity of a small molecule (ligand) when bound to a macromolecular target (receptor), which is typically a protein or nucleic acid. This technique computationally simulates the molecular recognition process, aiming to identify the most stable ligand-receptor complex (the "binding pose"). It achieves this by exploring the vast conformational space of the ligand within the target's binding site and then evaluating the potential of each pose using a scoring function. Docking is extensively used for virtual screening of massive compound libraries to identify novel "hit" compounds. It is also critical for "lead" optimization, where it guides the rational design of analogs with improved binding affinity and selectivity. Furthermore, it can be used to elucidate potential mechanisms of drug action or toxicity. Despite persistent challenges, particularly in the accuracy of scoring functions and the efficient handling of receptor flexibility, the field is rapidly advancing. The continuous development of more sophisticated algorithms, the deep integration of machine learning, and the combination of docking with computationally intensive methods like molecular dynamics are progressively enhancing its predictive power and cementing its role in the drug discovery pipeline.

KEYWORDS

Molecular Docking, Drug Discovery, Structure-Based Drug Design (SBDD), Virtual Screening, Scoring Functions, Docking Algorithms, Search Algorithms, Lead Optimization, Ligand-Protein Interaction, Induced Fit, Conformational Selection, Polypharmacology, In Silico.

INTRODUCTION

The process of discovering and developing a new therapeutic drug is notoriously time-consuming, expensive, and high-risk. From initial concept to market approval, the journey can easily span 10-15 years and cost over $2.5 billion, with an exceptionally high failure rate—for every 10,000 initial compounds, only a handful make it to clinical trials, and only one may be approved.

Traditionally, drug discovery relied on serendipity or mass-scale high-throughput screening (HTS), where vast, physical libraries of chemicals are experimentally tested against a target. This process is a

resource-intensive, brute-force approach. The advent of structural biology—which provided high-resolution 3D structures of biological targets via X-ray crystallography and NMR spectroscopy—combined with the exponential growth of computing power, has propelled computer-aided drug design (CADD) to the forefront of pharmaceutical research.

A cornerstone of CADD is molecular docking. This in silico (computer-based) technique provides atomic-level insights into the binding event between a ligand and its receptor. The fundamental goal is to answer two critical questions:

1. **Pose Prediction:** What is the most likely binding pose (the specific 3D conformation and orientation) of the ligand when it is in the receptor's active site?
2. **Affinity Prediction:** How strongly does it bind? (i.e., what is the binding affinity, often expressed as a binding free energy or an inhibition constant like K_i?)

By providing predictive answers to these questions, researchers can rapidly screen virtual libraries containing millions or even billions of compounds, prioritize a small and manageable number for expensive experimental testing, and rationally design novel molecules with enhanced therapeutic properties. This ability to filter and prioritize significantly accelerates the drug discovery pipeline and reduces costs.

PRINCIPLES

The core principles of molecular docking are based on simulating the complex physicochemical interactions that govern molecular recognition. The process is historically guided by two complementary theories, with a third, more modern view, gaining prominence.

1. **"Lock-and-Key" Theory:** Proposed by Emil Fischer in 1894, this is the simplest and earliest model. It considers both the ligand (key) and the receptor's binding site (lock) as rigid, static entities. Binding occurs only if the ligand has a perfectly complementary shape and chemical profile to the binding site.
2. **"Induced Fit" Theory:** A more sophisticated model proposed by Daniel Koshland in 1958, which accounts for molecular flexibility. It postulates that the binding of a ligand induces conformational changes in the receptor (and vice-versa). The active site is not rigid but malleable, and it reshapes itself to achieve an optimal, stabilized fit after the initial binding event.
3. **"Conformational Selection" Theory:** A more modern and statistically-driven view. It proposes that the receptor is not a single static structure but exists in a dynamic equilibrium of multiple conformations, even in the absence of a ligand. The ligand does not induce the

change, but rather, it selects and preferentially binds to a pre-existing, favorable conformation, thus shifting the equilibrium toward that bound state.

To simulate this complex process, all docking programs must incorporate two key components:

- **Sampling (Search Algorithm):** This component is responsible for generating a diverse set of candidate poses. It explores the ligand's degrees of freedom, which include its translation (position in x, y, z space), rotation (orientation), and conformational flexibility (torsional angles of its rotatable bonds).
- **Scoring (Scoring Function):** This component evaluates each pose generated by the sampling algorithm and assigns a numerical score. This score is an estimate of the binding affinity, ideally related to the Gibbs free energy of binding (\Delta G_{\text{bind}}). The goal is to rank all poses and identify the one with the most favorable score as the most likely binding mode.

ALGORITHMS

The search algorithm is critical for efficiently sampling the high-dimensional search space. A ligand with just 6 rotatable bonds can have millions of possible conformations. Algorithms are broadly classified as:

1. Systematic Searches:

- Incremental Construction (e.g., FlexX): The ligand is "built" piece-by-piece inside the active site. A rigid "anchor" fragment is docked first, and the rest of the molecule is added incrementally, exploring the rotational freedom of each new bond.
- **Conformational Search:** The ligand's conformational space is explored exhaustively, often by systematically rotating bonds by a set increment (e.g., 30 degrees). Each resulting conformation is then docked as a rigid body. These methods suffer from combinatorial explosion and are computationally infeasible for ligands with more than a few rotatable bonds.

2. Stochastic Algorithms: These are the most popular methods, as they introduce randomness to explore the vast search space more efficiently, avoiding the trap of combinatorial explosion.

- **Monte Carlo (MC):** The algorithm starts with a random pose. It then makes a series of small, random moves (translation, rotation, or a bond torsion). The new pose is evaluated. If its score is better, it is accepted. If it is worse, it may be accepted based on a probability (the Metropolis criterion), which allows the search to "climb" out of local energy minima and explore more of the landscape.
- **Genetic Algorithms (GA) (e.g., AutoDock, GOLD):** These methods are inspired by Darwinian evolution. They maintain a "population" of poses (e.g., 100 poses). Each pose is a

"chromosome," and its properties (coordinates, torsions) are its "genes." The population "evolves" over many generations through:

- **Crossover**: Two high-scoring "parent" poses are combined to create a new "child" pose.
- **Mutation**: A random change is introduced to a pose (e.g., flipping a torsion angle).
- **Selection**: Low-scoring poses are culled, and high-scoring poses survive to the next generation.

- **Swarm Optimization (e.g., Ant Colony Optimization):** Inspired by social insects, these methods use many "agents" (like ants) to explore the search space. The agents communicate information (like pheromone trails) to guide the collective search toward the most promising (lowest energy) regions.

3. Simulation-Based:

- **Molecular Dynamics (MD):** This is a physics-based simulation that solves Newton's equations of motion for every atom. While far too slow for full-scale docking, short-run MD simulations can be used to sample conformations or, more commonly, to refine a pose generated by a faster docking algorithm, allowing the ligand and receptor to mutually "relax" in a more physically realistic way.

DOCKING PROCESS AND FLEXIBILITY MODELS

The mechanism of a docking simulation involves balancing computational speed with physical realism, and the primary challenge is how to handle flexibility.

1. Pose Generation (Handling Flexibility)

- **Rigid Docking**: The simplest and fastest form, where both ligand and receptor are treated as rigid "lock-and-key" bodies. This is computationally cheap but only suitable if the bound conformation is already known or for specific applications like protein-protein docking where large-scale conformational changes are not expected.
- **Flexible Ligand Docking:** This is the most common approach and the default for most programs (e.t., AutoDock Vina, Glide). The ligand is treated as fully flexible, and its rotatable bonds are sampled by the search algorithm. The receptor, however, is held rigid. This provides a good balance of accuracy and computational speed, but it fails if the receptor's active site must change shape to accommodate the ligand.
- **Flexible Docking (Induced Fit / Conformational Selection):** The "gold standard" in terms of physical realism, but also the most computationally expensive.

- **Side-Chain Flexibility**: Key amino acid side chains in the active site are allowed to change their conformation (e.g., by sampling from a library of common "rotamers").
- **Backbone Flexibility:** In the most advanced methods, small movements of the protein's peptide backbone may also be allowed.
- **Ensemble Docking:** Instead of using one rigid receptor structure, the ligand is docked against an "ensemble" of different receptor conformations (e.g., from multiple crystal structures or an MD simulation). This simulates the "Conformational Selection" model.

2. Pose Evaluation (Scoring Functions)

Once a pose is generated, the scoring function calculates a score to estimate its binding strength. This is widely considered the weakest part of the docking process, as accurately modeling the complex thermodynamics of binding is extremely difficult.

- **Force-Field-Based (e.g., CHARMm, AMBER):** These functions are derived from classical physics. They sum up the energies of all pairwise interactions, primarily:
  - **van der Waals forces:** Modeled by a Lennard-Jones potential (strong repulsion at close distance, weak attraction at optimal distance).
  - **Electrostatic interactions:** Modeled by Coulomb's Law (attraction or repulsion between partial atomic charges).
  - They are physically rigorous but are computationally slow and often do not correlate well with binding affinity because they neglect the critical role of entropy and solvation.
- **Empirical (e.g., ChemScore, Glide SP/XP):** These are fast, regression-based functions. They assume the total binding free energy can be approximated by summing a set of weighted energy terms. The formula looks like: Score = w_1·(H-bonds) + w_2·(hydrophobic) + w_3·(electrostatic) + ... + w_n·(entropy loss) The weighting factors (w_1, w_2, etc.) are "trained" (regressed) using experimental binding data from a large set of known protein-ligand complexes. They are fast and popular but are only as good as the data they were trained on.
- **Knowledge-Based (e.g., PMF, DrugScore):** These functions derive statistical potentials (also called "potentials of mean force") from analyzing known protein-ligand crystal structures in a database like the PDB. They are based on the premise that interactions observed more frequently than random chance are more favorable. They calculate the probability of finding certain atom pairs (e.g., an oxygen-donor and a nitrogen-acceptor) at a specific distance and convert this probability into an energy score.

- **Consensus Scoring**: This is a meta-approach. Since all scoring functions have different strengths and weaknesses, consensus scoring runs several different scoring functions on the same pose. A pose is only considered a "hit" if it scores well across multiple, chemically distinct scoring functions, thus reducing the rate of false positives.

CURRENT APPLICATIONS

Molecular docking is an indispensable tool with diverse applications across the drug discovery pipeline:

1. **Virtual Screening (VS):** This is the most common application. Docking is used to screen massive in silico libraries (millions to billions) of virtual compounds against a target's structure. The top-scoring compounds (typically the top 0.1-1%) are selected as "hits" for subsequent experimental validation, filtering the vast chemical space to a testable number.
2. **Lead Optimization**: Once an experimental "hit" is identified, medicinal chemists synthesize analogs to improve its properties (e.g., potency, selectivity, ADMET properties). Docking is used to predict how these chemical modifications (e.g., "add a hydroxyl group here to form a new hydrogen bond with Serine-195") will affect binding, guiding the rational design of more potent and specific "lead" compounds.
3. **Drug Repurposing:** Docking can be used to screen libraries of known, approved drugs against a new target of interest. This "off-label" screening can rapidly identify existing therapeutics that may be effective for a different disease (e.g., discovering an anti-viral drug is also effective against a cancer target), saving significant time and cost as the drug's safety profile is already known.
4. **Target Fishing (Reverse Docking):** This is the inverse problem. Instead of docking many ligands to one target, reverse docking screens a single ligand (e.g., a natural product with interesting biological activity but an unknown mechanism) against a library of all known protein structures. This can help identify the biological target(s) of the molecule, which is crucial for understanding its mechanism of action.
5. **Polypharmacology & Toxicity Prediction:** Many drugs bind to more than one target. This can be unintentional, leading to side effects, or intentional, for treating complex multifactorial diseases. Docking a drug candidate against a panel of known "anti-targets" (e.g., the hERG channel, which is linked to cardiac toxicity, or CYP450 enzymes, which are involved in drug metabolism) can help predict potential adverse drug reactions (ADRs) and toxicity early in the discovery process.

FUTURE PERSPECTIVE

The field of molecular docking is continuously evolving to overcome its primary limitations: the inaccurate representation of protein flexibility and the inaccuracies of scoring functions. The future is being shaped by:

1. Machine Learning (ML) and Deep Learning (DL): This is the most significant trend.

- **AI-Scoring:** ML models, particularly deep neural networks and Graph Neural Networks (GNNs), are being trained on vast structural and affinity datasets. These models can capture complex, non-linear relationships and quantum-level effects (like polarization) that traditional scoring functions miss, leading to more accurate affinity predictions.
- **Generative Models:** AI models are also being used for de novo design, where they "grow" a new, optimized molecule directly within the binding site, rather than just screening existing ones.

2. Integration with Molecular Dynamics (MD): Combining fast docking with more rigorous (but slower) MD simulations is becoming standard. Docking provides initial poses, which are then used as starting points for full MD simulations. These simulations are then "post-processed" using methods like MM/PBSA (Molecular Mechanics/Poisson-Boltzmann Surface Area) to get a much more accurate, physically-grounded estimation of the binding free energy by accounting for solvent effects and receptor flexibility.

3. Ensemble Docking: As mentioned, this approach uses an "ensemble" of different receptor conformations to better represent the inherent flexibility of the protein ("Conformational Selection"). This is becoming standard practice as it consistently improves hit rates over single-structure docking.

4. Improved Handling of Solvation and Entropy: Accurately modeling the role of water molecules in the binding site (which can mediate key interactions) and the entropic costs of binding remains a major challenge. New methods that use explicit water molecules or more accurate implicit solvent models are in development to better capture these crucial thermodynamic contributions.

CONCLUSION

Molecular docking has transformed from a niche academic technique into a foundational, indispensable tool in modern drug discovery. Its ability to provide rapid, atom-level insights into molecular recognition allows researchers to rationalize experimental results, prioritize experiments, and make high-informed decisions that save critical time and resources. While significant challenges in accurately predicting binding affinity (the "scoring problem") and handling protein dynamics (the "flexibility problem") persist, the field is advancing at an incredible pace. The deep integration of artificial intelligence and the pragmatic combination of docking with other, more rigorous simulation

techniques are progressively enhancing its predictive power. This ensures that molecular docking will remain a central, evolving component in the quest for novel therapeutics for years to come.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

REVIEW OF ANTI-PYRETIC ACTIVITY OF HERBAL GEL

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ABSTRACT

In this research, the design and assessment of a highly acceptable polyherbal jelly from the combination of extracts of Tamarind (Tamarindus indica) and Nirgundi (Vitex negundo) for its antipyretic activity are given. Fever, an increase in body temperature usually resulting from infection or inflammation, is controlled by the hypothalamus. Standard antipyretic drugs influence this center to reduce the thermal set-point, but their administration is linked with side effects. The current study aims to create an effective, safer herbal remedy. T. indica, with its cooling effect, and V. negundo, with its anti-inflammatory and antipyretic properties, are an effective combination with a synergistic potential. A jelly as a semi-solid dose form was selected to make the formulation patient-friendly, particularly in children and the elderly, with its covering of the bitter taste of the extracts and ease of swallowing. The jelly was prepared by a standard heating process with pectin (2%) as gelling agent. The formulated sample will be analyzed for its physicochemical parameters (pH, viscosity, spreadability, stability) and organoleptic properties. In addition, its antipyretic activity will be compared with that of a standard antipyretic, e.g., paracetamol, using an appropriate in-vivo animal model, i.e., the yeast-induced pyrexia model in Wistar rats. This study hopes to establish a scientifically proven base for a new herbal remedy for the treatment of fever.

KEYWORDS

Antipyretic, Tamarindus indica, Vitex negundo, Polyherbal Formulation, Jelly, Patient Compliance, Phytochemicals, Yeast-Induced Pyrexia.

INTRODUCTION

Fever, or pyrexia, is a multifactorial physiological reaction involving an increase in the core body temperature above the standard value of 37°C (98.6°F). Fever is a major body defense mechanism against disease-causing agents and inflammatory reactions. The mechanism of fever pathophysiology is through the generation of pyrogens, either exogenous (such as lipopolysaccharides of bacteria) or endogenous (such as cytokines such as Interleukin-1β, Interleukin-6, and TNF-α). These cytokines induce the production of prostaglandin E2 (PGE2) in the hypothalamus that results in an increase in the set-point for thermoregulation, causing elevated heat production and reduced heat loss. Although fever is a healthy host response, very high or prolonged fever results in distress, dehydration, and can be harmful with attendant complications that require therapeutic treatment.

At present, the most frequently applied antipyretics are the non-steroidal anti-inflammatory drugs (NSAIDs) and such drugs as paracetamol. Their action is through inhibition of the cyclooxygenase (COX) enzymes, thus preventing the synthesis of PGE2. Yet their extended use can cause severe side effects such as gastric irritation, nephrotoxicity, and hepatotoxicity, which are mostly attributed to the non-selective inhibition of COX enzymes. This has led to a focus of scientific interest towards traditional medicine and an investigation into plant-based medicines that have a potentially safer profile by virtue of alternative mechanisms of action. Polyherbal preparations, with more than one herb, are commonly preferred in traditional practice for their possible synergism such that the combined activity is more than the sum of individual activities and for possible reduction in toxicity.

1.1 Plant Profile: Tamarind (Tamarindus indica L.)

Tamarindus indica, belonging to the Leguminosae family, is a big evergreen tree in tropical Africa but widely distributed throughout India and other tropical areas. The fruit pulp contains a high amount of tartaric acid, vitamin C, antioxidants (such as geranial and limonene), and other minerals. Pharmacologically, the plant has antioxidant, anti-inflammatory, and antimicrobial activity. Active phytochemicals like lupeol and catechins are responsible for such effects. In traditional medical systems, tamarind pulp has been prized for its cooling property and is frequently used to prepare decoctions for the reduction of fever and for digestion. Its seed contains a polysaccharide (TSP), a xyloglucan, with fine gelling qualities, which may be used as a natural alternative to pectin in food and pharmaceutical applications.

1.2 Plant Profile: Nirgundi (Vitex negundo L.)

Vitex negundo (family Lamiaceae) is a big, fragrant shrub occurring all over India. It is known as the five-leaved chaste tree. The name Nirgundi in Sanskrit is derived from the fact that "Nir" means protection and "Gundi" means body, meaning "that which protects the body from diseases." The leaves contain flavonoids (such as casticin, isoorientin), iridoid glycosides (agnuside), phenolic compounds, and alkaloids. Such compounds are accountable for its strong anti-inflammatory, analgesic (pain-stilling), and antipyretic activities that are thought to be mediated by the inhibition of prostaglandin formation and cytokine synthesis. Nirgundi is a foundation herb in Ayurveda employed for controlling fever, headache, and other inflammatory diseases.

1.3 Rationale for the Formulation

The combination of the two herbs is suggested to produce a synergistic effect. Tamarind has a soothing and cooling effect, while Nirgundi attacks the inflammatory pathways involved in fever directly. Preparating these extracts in a jelly dosage form offers a number of benefits:

Enhanced Palatability: Jellies are capable of masking the bitter or unpleasant taste of herbal extracts, which is essential for patient compliance.

- **Ease of Administration:** Being readily swallowable, this semi-solid state is particularly suitable for children, the elderly, and dysphagic patients.
- **Improved Patient Compliance:** A desirable appearance and taste can have a major influence on adherence to a treatment regimen.

- **Faster Onset of Action:** Active ingredients are pre-solubilized in the jelly matrix, so there could be quicker absorption than with solid dosage forms.

This research seeks to utilize these advantages by creating a stable, efficient, and flavorful polyherbal jelly and scientifically proving its antipyretic assertions.

AIMS AND OBJECTIVES

The main objective of this research is to prepare and test a polyherbal jelly from extracts of Tamarindus indica and Vitex negundo for their antipyretic activity.

The specific objectives are:

1. To prepare and standardize aqueous or ethanolic extracts of Tamarindus indica pulp and Vitex negundo leaves.
2. To carry out preliminary phytochemical screening of the individual extracts for the detection of the presence of major bioactive compounds.
3. To prepare a stable and acceptable polyherbal jelly with the aid of the extracts and pharmaceutically acceptable excipients.
4. To analyze the prepared jelly for its organoleptic and physicochemical characteristics, such as pH, consistency, spreadability, and stability.
5. To carry out an in-vivo investigation using an established model animal for scientifically assessing the antipyretic efficacy of the formulation.
6. To compare the activity of the polyherbal jelly with a reference, commercial antipyretic drug.

MATERIALS AND METHODS

3.1 Materials

- **Plant Material:** Locally collected fresh tamarind pulp and nirgundi leaves will be authenticated by a qualified botanist at an established institution. Voucher specimen will be lodged in the institutional herbarium for future use.
- **Chemicals & Reagents**: Citric acid, sodium benzoate, ethanol (95%), and all other chemicals shall be of analytical grade, purchased from a well-established supplier.
- **Equipment**: Soxhlet apparatus, rotary evaporator, heating mantle with magnetic stirrer, digital pH meter, Brookfield viscometer, stability chamber, glassware, and sterilization equipment (autoclave).

3.2 Preparation of Herbal Extracts

Extraction of Tamarind: The tamarind pulp shall be soaked in hot purified water (1:5 w/v) for 6 hours, pressed to free the constituents, and filtered through muslin and then Whatman No. 1 filter paper. The

aqueous extract recovered shall be evaporated to semi-solid consistency under regulated heat (maximum 60°C) to avoid thermolabile component degradation.

Extraction of Nirgundi: Freshly cleaned nirgundi leaves shall be shade-dried and coarse powder. The powder shall be subjected to 95% ethanol extraction through the Soxhlet method for 24 hours or until the completion of the extraction. The resulting extract will be filtered and reduced under low pressure using a rotary evaporator at 40-45°C to give a semi-solid mass.

3.3 Preliminary Phytochemical Screening

The extracted samples will be analyzed using routine qualitative chemical tests to check for the presence of different phytoconstituents including alkaloids (Mayer's and Dragendorff's tests), flavonoids (Shinoda test), tannins (Ferric chloride test), saponins (Froth test), glycosides (Keller-Kiliani test), and terpenoids (Salkowski test).

3.4 Formulation of the Polyherbal Jelly

Ingredient	Quantity	Role
Tamarind Extract	As required	Active Ingredient
Nirgundi Extract	As required	Active Ingredient
Pectin	~2.0% w/w	Gelling Agent
Sugar (Sucrose)	~60-70% w/w	Sweetener
Citric Acid	~0.3-0.5% w/w	Acidulant
Sodium Benzoate	~0.1% w/w	Preservative
Purified Water	q.s.	Vehicle

The jelly will be prepared using the conventional heating method based on the following formula:

Procedure:

1. Precise amounts of the tamarind and nirgundi extracts are taken.
2. Sugar is dissolved in a precalculated amount of pure water and heated until a transparent syrup results.
3. The herbal extracts are incorporated into the sugar syrup and mixed well.

4. Pectin is triturated with minimal sugar and added to the hot mixture while stirring continuously to avoid lumping.
5. The mixture is heated to about 105°C, or until the gelling point (tested by a sheet or drop test) is attained.
6. Citric acid and sodium benzoate, pre-dissolved in a small quantity of water, are added towards the end.
7. Pre-sterilized glass jars are filled with hot jelly mixture, closed, and left to cool at room temperature to set.

3.5 Evaluation Parameters of the Jelly

1. **Organoleptic Properties:** The formulation will be assessed for its color, odor, taste, clarity, and texture.
2. **Physicochemical Evaluation:**
    - pH: The pH of a 1% w/v solution of the jelly in distilled water will be measured using a calibrated digital pH meter. A target range of 3.0-3.5 is ideal for gel strength and preservation.
    - Viscosity: Viscosity of the jelly will be measured with a Brookfield viscometer and a suitable spindle at a specific RPM.
    - Spreadability: Calculated to establish the ease with which the jelly can be spread or applied. The spreadability (S) will be calculated from the formula: $S = m \times l / t$, where m is the weight attached to the upper slide, l is the length of the glass slide, and t is the time to disconnect the slides.
    - Total Soluble Solids (TSS): Assayed on a hand refractometer and in °Brix units.
    - Moisture Content: Assayed to achieve stability and to inhibit microbial activity.
    - Microbial Load: Total viable count (TVC) and certain pathogens (e.g., E. coli, Salmonella) will be tested to confirm compliance with safety standards.
    - Stability Studies: The jelly will undergo accelerated stability testing according to ICH guidelines (40°C ± 2°C / 75% RH ± 5% RH) for 3 months to establish its shelf life and check for any changes in its physical or chemical nature.

3.6 In-Vivo Antipyretic Study

Study will be performed on healthy Wistar albino rats of 150-200g after approval from the Institutional Animal Ethics Committee (IAEC).

1. **Animal Grouping:** The rats will be grouped into four (n=6):
2. **Group I (Normal Control):** Treated with vehicle only (e.g., 2% gum acacia suspension).

3. **Group II (Negative Control):** Induced pyrexia + treated with vehicle only.
4. **Group III (Standard Drug):** Induced pyrexia + treated with reference paracetamol (150 mg/kg, p.o.).
5. **Group IV (Test Group):** Pyrexia is induced + treated with the prepared polyherbal jelly (at a given dose, e.g., 200 or 400 mg/kg, p.o.).
6. **Induction of Pyrexia:** Fever will be induced in all groups (except Group I) with a subcutaneous injection of a 20% aqueous suspension of brewer's yeast (10 ml/kg).
7. **Treatment and Monitoring:** The basal rectal temperature of all the rats will be measured with a digital thermometer after 18 hours. Animals exhibiting a marked increase in temperature (>0.5°C) will be chosen. The test jelly, standard drug, and vehicle will then be dosed orally. The rectal temperature will be measured at fixed intervals (0, 1, 2, 3, and 4 hours) after dosing.
8. **Statistical Analysis:** The findings will be presented in the form of mean ± Standard Error of the Mean (SEM). The data will be subjected to one-way Analysis of Variance (ANOVA) and Dunnett's post-hoc test for finding the level of significance. A p-value of <0.05 will be used as the level of statistical significance.

FUTURE SCOPE AND LIMITATIONS

4.1 Future Aspects of the Formulation:

- **Novel Drug Delivery System (NDDS):** The formulation is an ideal platform for NDDS, especially for pediatric and geriatric patients who avail non-solid dosage forms.
- **Nutraceutical Development:** The jelly may be marketed as a functional food or nutraceutical that contributes both nutritional (from tamarind) as well as therapeutic benefits.
- **Bioavailability Enhancement:** Future research may aim at adding permeation enhancers or fine-tuning the formulation to enhance the bioavailability of the active phytoconstituents.
- **Mechanistic Studies:** Additional work can be done to define the specific mechanism of action, i.e., whether it inhibits COX enzymes or suppresses cytokines.
- **Utilization of Natural Excipients:** The studies can be extended to utilize additional natural gelling agents (e.g., agar, guar gum) and natural preservatives to prepare a complete organic product.

4.2 Shortcomes of Jelly Formulations

1. **Stability and Shelf Life:** Jellies are highly hygroscopic due to high water content, thus prone to microbial development and syneresis (water dripping out of the gel). This requires the use of preservatives and stringent control of storage conditions.

2. **Dose Standardization:** Achieving a homogenous distribution of active ingredients within the semi-solid base may be difficult, and thus accurate dose standardization may prove to be tricky as compared to tablets.
3. **Batch-to-Batch Consistency:** The phytochemical composition of herbal extracts is subject to variations depending on geographical origin, time of collection, and method of extraction, making consistency challenging.
4. **Storage Conditions:** The product may need precise storage conditions (e.g., refrigeration) to preserve the texture and stability.
5. **Regulatory Challenges:** Herbal products are challenged in being standardized and approved compared to conventional drugs.

CONCLUSION

The formulation of a polyherbal jelly from Tamarindus indica and Vitex negundo is an innovative method to manage fever. The paper provides a rational scientific approach to preparing a product that is not only likely to be effective but also highly patient-compliant and palatable. A formulation involving the use of 70% sugar and 2.0% pectin, based on initial trials and literature, can be predicted to produce a jelly with its best chemical, sensory, and stability properties. Successful fulfillment of this research and subsequent in-vivo confirmation may offer a safe, effective, and commercially acceptable herbal remedy for over-the-counter antipyretic treatment over traditional antipyretic drugs, with the synergy of Ayurvedic herbs in a new dosage form.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

A COMPREHENSIVE REVIEW OF GREEN CORROSION INHIBITORS: PRINCIPLES, MECHANISMS, AND APPLICATIONS

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ABSTRACT

Corrosion of metallic infrastructure presents a significant global challenge, both economically and in terms of safety, accounting for an estimated 3-4% of the global GDP. Historically, synthetic chemical inhibitors like chromates and nitrites, known for their toxicity, carcinogenicity, and environmental persistence, have been used to combat this issue. This has led to a major shift towards developing "green" corrosion inhibitors, adhering to Green Chemistry principles, which prioritize non-toxic, biodegradable, and renewable characteristics. This review offers a comprehensive overview of various green inhibitor classes, including plant extracts, biopolymers, amino acids, essential oils, and pharmaceutical compounds. It delves into their primary mechanism of action—adsorption onto the metal surface—and clarifies the distinction between physisorption (electrostatic) and chemisorption (coordinate bonding) pathways. These interactions are quantified using adsorption isotherms (e.g., Langmuir, Temkin) and their associated thermodynamic parameters (ΔG°ads). Furthermore, the paper details standard methodologies for evaluating inhibitor performance, ranging from basic gravimetric analysis to advanced electrochemical techniques (Potentiodynamic Polarization, EIS), surface analysis (SEM, AFM, XPS, FTIR), and computational methods (DFT, MD simulations). While green inhibitors offer notable advantages in environmental compatibility, cost-effectiveness, and alignment with circular economy principles, several critical challenges persist. These include issues with thermal and chemical stability, batch-to-batch reproducibility of natural extracts, and the difficulty of scaling laboratory successes in acidic environments to more complex, neutral, and saline industrial conditions. This paper provides a critical overview of the current research landscape and outlines future directions, such as the development of synergistic formulations and "smart" self-healing systems.

INTRODUCTION

2.1. The Problem of Corrosion

Corrosion is a natural, spontaneous electrochemical process where materials, especially metals, degrade due to reactions with their environment. It reflects the inherent tendency of refined metals to return to their more stable, original ore forms (e.g., oxides, sulfides). This pervasive global issue

leads to economic losses estimated by NACE International to be in the trillions of dollars annually. Beyond financial implications, corrosion compromises the structural integrity of vital infrastructure like bridges, pipelines, and aircraft, resulting in specific failure modes such as pitting, crevice corrosion, and stress corrosion cracking. Such failures pose substantial public safety risks and contribute to the depletion of non-renewable natural resources.

2.2. Traditional Corrosion Inhibitors.

For decades, chemical inhibitors have been the primary defense against industrial corrosion. These substances, even in small concentrations, can significantly reduce the corrosion rate. Highly effective compounds, including inorganic chromates (Cr(VI)), nitrites, phosphates, and organic molecules like benzotriazole, have seen extensive use. However, growing evidence of their severe toxicity and carcinogenic properties has necessitated a major re-evaluation. Chromates, for instance, are known human carcinogens. These heavy-metal-based compounds are environmentally persistent, harming aquatic life and contaminating water sources. Consequently, stringent environmental regulations, such as the EU's REACH, have banned or heavily restricted their use, creating a critical technological gap.

2.3. The Rise of "Green" Inhibitors.

This regulatory and ethical shift has spurred an urgent and extensive search for a new generation of "green" or "eco-friendly" corrosion inhibitors. Guided by the 12 Principles of Green Chemistry, an ideal green inhibitor should be non-toxic to humans and aquatic ecosystems, readily biodegradable (preventing bioaccumulation), and derived from abundant, renewable resources. For commercial viability, it must also be cost-effective and readily available. The "valorization" of agricultural or food industry waste products to produce these inhibitors is a particularly appealing strategy, aligning well with circular economy principles. This review aims to comprehensively summarize current research on green inhibitors, focusing on their primary sources, protective mechanisms, and the key challenges to their widespread adoption.

TYPES AND SOURCES OF GREEN CORROSION INHIBITORS

Green inhibitors are predominantly organic compounds with specific molecular features that enable them to interact with and protect metal surfaces. Their effectiveness typically stems from the presence of **heteroatoms (such as Oxygen, Nitrogen, and Sulfur)** with lone-pair electrons, and/or **pi (π) electrons** found in aromatic rings and multiple bonds. These electron-rich centers serve as active sites for adsorption. Extraction from natural sources commonly involves maceration, steam distillation, or Soxhlet extraction using solvents like water, ethanol, or methanol.

3.1. Plant Extracts (The most common type)

Extracts from various plant parts—leaves, seeds, bark, fruits, and even waste peels—constitute the most widely studied class of green inhibitors. These extracts are inherently complex mixtures of numerous phytochemicals that can act synergistically to provide corrosion protection. Key active compounds responsible for inhibition include:

- **Alkaloids:** Nitrogen-containing compounds (e.g., Piperine from *Black Pepper*, Berberine from *Berberis*).
- **Flavonoids & Tannins:** Polyphenolic compounds (e.g., Catechin from *Green Tea*, Quercetin from *onion peels*, Tannic acid from *bark*).
- **Other Polyphenols & Active Molecules:** A broad class of compounds such as Eugenol (from *cloves*), Linalool (from *lavender*), and Caffeic acid (from *coffee*).

Common examples in scientific literature include extracts from *Azadirachta indica* (Neem), *Camellia sinensis* (Green Tea), and *Olea europaea* (Olive) leaves.

3.2. Biopolymers

Biopolymers are large, long-chain molecules produced by living organisms. Their inhibitory mechanism is often more physical than chemical; their large molecular size allows them to cover a significant metal surface area, forming a macromolecular barrier film that physically obstructs corrosive species.

- **Chitosan:** A versatile polymer derived from chitin, a primary component of shrimp and crab shells, making it a "waste-to-value" product.
- **Natural Gums:** Water-soluble polysaccharides like Guar Gum, Xanthan Gum, and Gum Arabic are extensively studied for their high molecular weight and film-forming abilities.
- **Polysaccharides:** Other common examples include starch, cellulose, and alginates (from seaweed).

3.3. Amino Acids

As the fundamental building blocks of proteins, amino acids are simple, well-defined molecules that are inherently non-toxic and biodegradable. Their zwitterionic nature (possessing both a positive $-NH_3^+$ and negative $-COO^-$ group) allows them to exist in different forms depending on the solution's pH, which influences their adsorption.

- **Examples:** Cysteine and Methionine (containing sulfur, a highly effective heteroatom), Histidine (with an imidazole ring), Glycine, and Tryptophan have all demonstrated inhibitive properties.

3.4. Essential Oils

These are volatile, aromatic oils extracted from plants. Their volatility makes them suitable as **Volatile Corrosion Inhibitors (VCIs)**, used to protect metals from atmospheric corrosion in enclosed spaces (e.g., in packaging or boilers) without direct contact.

- **Examples:** Clove oil, Peppermint oil, and Cumin oil contain active compounds rich in heteroatoms and aromatic rings, making them excellent candidates for inhibition.

3.5. Pharmaceutical and Drug Waste

An emerging field involves utilizing expired or waste pharmaceuticals. Many drugs are, by design, organic molecules rich in N, O, and S heteroatoms and aromatic rings, making them excellent candidates for inhibition. This offers an innovative way to upcycle chemical waste that would otherwise require costly incineration.

- **Examples:** Expired antibiotics (like penicillin, amoxicillin), analgesics (like paracetamol), and vitamins (like ascorbic acid) have been successfully tested as corrosion inhibitors.

MECHANISM OF INHIBITION

Green inhibitors protect metals through **adsorption**, a process where inhibitor molecules spontaneously attach to the metal surface (M). This forms a thin, protective film that acts as a physical and/or chemical barrier, isolating the metal from corrosive agents (like H_3O^+, O_2, Cl^-) in the environment.

This adsorption process is a complex interaction influenced by several factors:

1. **The Metal:** The specific metal type and its surface charge. In acidic solutions, the metal surface often carries a positive charge.
2. **The Corrosive Medium:** The pH of the solution dictates the form of the inhibitor (e.g., protonated or neutral) and the nature of the corrosive species.
3. **The Inhibitor Molecule:** Its chemical structure, functional groups, and electron density.

Adsorption generally occurs via two primary mechanisms, often in combination:

1. **Physisorption (Physical Adsorption):** This is a relatively weak, non-specific form of adsorption. In acidic media, inhibitor molecules (Inh) can become protonated ($InhH^+$). This positively charged molecule is then electrostatically attracted to the metal surface, which has become negatively charged due to the prior adsorption of anions from the acid (e.g., Cl^-, SO_4^{2-}). It can also involve van der Waals forces. Physisorption is typically reversible, and its efficiency generally decreases with increasing temperature.
2. **Chemisorption (Chemical Adsorption):** This is a much stronger and more durable form of adsorption, involving the formation of a chemical bond—specifically, a coordinate covalent (or donor-acceptor) bond—between the inhibitor and the metal. This occurs when the electron-

rich centers of the inhibitor molecule (lone-pair electrons on O, N, or S atoms, or π-electrons from aromatic rings) are **donated** to the vacant d-orbitals of the metal atoms. This chemical bond creates a stable, robust, and long-lasting protective layer. Chemisorption is often irreversible, and its efficiency may *increase* with temperature (up to a certain point, before desorption or decomposition occurs).

To quantify adsorption behavior, researchers fit experimental data to **Adsorption Isotherms** (e.g., Langmuir, Freundlich, Temkin). These models describe the relationship between inhibitor concentration and the degree of surface coverage (θ). From these isotherms, thermodynamic parameters like the free energy of adsorption (ΔG°ads) can be calculated.

- **ΔG°ads values up to -20 kJ/mol** are characteristic of physisorption.
- **ΔG°ads values more negative than -40 kJ/mol** strongly indicate chemisorption.
- Values between -20 and -40 kJ/mol suggest a mixed-mode (physisorption and chemisorption) mechanism.

Methods Used to Evaluate Inhibitor Effectiveness

To validate the effectiveness of a potential green inhibitor, a standardized set of experimental and computational methods is employed.

5.1. Weight Loss (Gravimetric Method)

This is the most fundamental and straightforward technique. A pre-weighed metal sample (coupon) is immersed in the corrosive solution *without* the inhibitor (blank), and an identical coupon is immersed in the same solution *with* the inhibitor. After a specified period, the coupons are removed, cleaned (e.g., in an inhibited acid solution to remove only corrosion products), and re-weighed.

- Inhibition Efficiency (IE%): IE% = ((W_blank - W_inh) / W_blank) * 100 (where W_blank is the weight loss of the blank coupon and W_inh is the weight loss of the inhibited coupon).
- This method also allows for the calculation of the **Corrosion Rate (CR)** and the study of temperature and immersion time effects.

5.2. Electrochemical Techniques

These methods are fast, non-destructive, and offer in-depth insights into the corrosion *rate* and *mechanism* in real-time. They utilize a three-electrode setup (working electrode, reference electrode, counter electrode).

- **Potentiodynamic Polarization (Tafel Plots):** This technique measures the current response as the voltage is scanned. Extrapolating the linear (Tafel) regions of the plot yields two key parameters:

- **Corrosion Current (i_corr):** Directly proportional to the corrosion rate. A lower i_corr indicates better inhibition.
- **Corrosion Potential (E_corr):** The potential at which oxidation and reduction rates are equal. A significant shift in E_corr reveals the inhibitor type:
  - **Anodic Inhibitor:** Slows metal dissolution, shifting E_corr to more positive (anodic) values.
  - **Cathodic Inhibitor:** Slows hydrogen evolution or oxygen reduction, shifting E_corr to more negative (cathodic) values.
  - **Mixed-Type Inhibitor:** Affects both reactions, resulting in a minimal shift in E_corr. Most green inhibitors fall into this category.

- **Electrochemical Impedance Spectroscopy (EIS):** This powerful technique applies a small, sinusoidal AC voltage to the metal and measures the impedance (resistance) response. The data is often presented as a **Nyquist plot**.
  - In a simple corrosion system, this plot resembles a semicircle. The **diameter of this semicircle** corresponds to the **Charge Transfer Resistance (R_ct)**.
  - R_ct represents the resistance to electron flow (i.e., corrosion) at the metal/solution interface. A larger R_ct (a bigger semicircle) indicates better protection.
  - The plot also provides the **Double-Layer Capacitance (C_dl)**. A decrease in C_dl upon inhibitor addition confirms that inhibitor molecules are adsorbing, displacing water, and thickening the protective dielectric layer.

5.3. Surface Analysis

These methods provide visual and chemical evidence of the protective film.

- **Scanning Electron Microscopy (SEM):** Provides high-magnification images of the metal surface. A sample corroded *without* inhibitor will show a heavily pitted, cracked, and damaged "morphology," while a protected sample will appear smooth and intact, revealing the protective film.
- **Atomic Force Microscopy (AFM):** Offers 3D topographical data at the nanoscale, allowing for quantitative measurement of surface *roughness*. A protected surface will be significantly smoother (lower average roughness) than a corroded one.
- **Fourier-Transform Infrared (FTIR) Spectroscopy:** Compares the spectrum of the pure inhibitor with that of the protected metal surface. Shifts or disappearances of peaks (e.g., from –OH, –NH, C=O groups) provide direct evidence of these specific functional groups participating in adsorption and bonding to the metal.

- **X-ray Photoelectron Spectroscopy (XPS):** A highly sensitive technique that analyzes the elemental composition and chemical bonding of the outermost surface layers. It can confirm the presence of C, N, O, or S from the inhibitor on the metal surface and detect changes in the metal's oxidation state, proving protective film formation.

5.4. Computational and Theoretical Studies

These *in-silico* methods are now essential for pre-screening inhibitors and understanding their mechanism at a molecular level, thus saving time and resources.

- **Density Functional Theory (DFT):** This quantum chemical method models the inhibitor molecule and calculates its electronic properties.
    - **EHOMO (Highest Occupied Molecular Orbital):** The energy of this orbital indicates the molecule's ability to *donate* electrons to the metal's vacant d-orbitals (chemisorption). A higher (less negative) EHOMO value suggests a better electron donor.
    - **ELUMO (Lowest Unoccupied Molecular Orbital):** The energy of this orbital indicates the molecule's ability to *accept* electrons from the metal (retro-donation).
    - **Energy Gap (ΔE = ELUMO - EHOMO):** An indicator of the molecule's reactivity. A smaller ΔE generally implies higher reactivity and better inhibition potential.
- **Molecular Dynamics (MD) Simulations:** These simulations model the interaction of numerous inhibitor molecules with the metal surface and corrosive solution over time. They help to dynamically visualize *how* inhibitors orient themselves to form a stable, flat-lying film on the surface.

ADVANTAGES AND CURRENT CHALLENGES

6.1. Advantages

The move towards green inhibitors is driven by a compelling set of advantages. The most obvious is their **eco-friendliness**, as they are biodegradable and non-toxic, eliminating the environmental and health liabilities associated with traditional inhibitors. They are also often derived from **low-cost** and **readily available** sources, such as agricultural waste (e.g., fruit peels, seed husks, coffee grounds). This not only reduces costs but also fosters a **renewable** and **sustainable** supply chain, perfectly aligning with a **circular economy model** where "waste" is transformed into a valuable industrial product.6.2. Challenges and Disadvantages

Despite their promise, green inhibitors face significant obstacles to widespread adoption.

1. **Reproducibility and Purity:** Plant extracts are complex mixtures with compositions that vary based on plant species, geography, season, and extraction method. This lack of **standardization and reproducibility** is a major quality control issue for industry.
2. **Thermal and Chemical Stability:** Natural compounds often degrade at the high temperatures and pressures common in many industrial processes (e.g., oil and gas pipelines), limiting their effectiveness.
3. **Performance in Neutral/Saline Media:** While many green inhibitors perform exceptionally well in acidic solutions (used in industrial cleaning or oil well acidizing), their effectiveness in **neutral, chloride-rich environments (like seawater)** is often significantly lower. This is a major limitation, as most infrastructure corrosion occurs in such conditions.
4. **Scalability:** A process that works in a small laboratory beaker (e.g., a complex, multi-day extraction) may be difficult or cost-prohibitive to scale up for producing the thousands of gallons required for an industrial pipeline or cooling tower.
5. **Mechanism Complexity:** The "synergistic" effect of extracts is a double-edged sword; it is challenging to identify which of the dozens of compounds is the primary active ingredient, complicating optimization and modeling.

CONCLUSION AND FUTURE OUTLOOK

Green corrosion inhibitors represent one of the most critical and rapidly evolving fields in applied materials science. They offer a viable and necessary path forward, enabling the protection of vital infrastructure without the severe environmental collateral damage associated with their toxic predecessors. The extensive research over the past two decades clearly demonstrates their feasibility and effectiveness, particularly in acidic media.

The future of this field depends on overcoming current challenges. Research must increasingly shift from laboratory curiosities to robust, real-world industrial applications. Key future directions include:

1. **Identification, Isolation, and Synthesis:** Moving beyond crude extracts to identify and isolate the *single* most active compound, which can then be synthesized for greater purity, stability, and reliability.
2. **Synergistic Formulations:** Deliberately studying the combined effects of different green inhibitors, or green inhibitors with small amounts of other non-toxic substances (like iodide ions), to achieve efficiencies greater than the sum of their individual parts.
3. **"Smart" Inhibitor Systems:** Developing "smart" delivery systems, such as encapsulating inhibitors in nanocontainers (e.g., zeolites, micelles, or nanocapsules) that only release the

inhibitor in response to a corrosion trigger (like a local change in pH or the presence of metal ions).

4. **Computational and Machine Learning:** Leveraging machine learning and advanced computational chemistry to rapidly screen vast libraries of potential green molecules *in-silico*, accelerating the discovery of new, high-performance inhibitors.

By addressing these challenges, the scientific community can transition these promising, sustainable materials from the laboratory to the global market, contributing to a safer and more sustainable industrial future.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

REVIEW ON SUPPOSITORIES BY USING AZARDICA INDICA

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ABSTRACT

Suppositories are Solid dosage form of Medicament For insertion into body cavities other than mouth. they may be inserted into rectum, vagina, or nasal cavity. Vaginal infections are associated with a variety of serious adverse outcomes in pregnancy and generally have a major impact on quality of life. . Suppositories should not interfere in release or absorbance of drug. It should be stable on storage. It should not be softened or hardened on storage. It can cause irritation in some patients. Vaginal suppositories are solid medications that are inserted into the vagina with a special applicator. Neem (Azadirachta indica) contains a variety of bioactive compounds that contribute to its medicinal, pesticidal, and therapeutic properties. Neem seed is very vital because of its rich lipid content and bitter constituents. Herbal remedies like neem (Azadirachtaindica) offer safer, natural alternatives with proven antifungal, anti-inflammatory, and healing properties. This study aims to explore the potential of these herbs in suppository formulations for fungal infection treatment. Neem oil, derived from the seeds and fruits of the neem tree, contains potent bioactive compounds such as nimbin, nimbidin, and azadirachtin. These compounds have demonstrated broad-spectrum antimicrobial properties, including strong antifungal activity against Candida albicans and other pathogenic fungi. Neem oil also exerts anti-inflammatory and wound-healing effects. The main goal of this review is to develop and assess herbal-based suppository formulations aimed at delivering antifungal agents locally for the effective management of fungal infections. The Review focuses on leveraging the medicinal value of herbal extracts known for their antifungal action, while ensuring the formulation is safe, effective, and user-friendly. As a result, there has been a renewed interest in the use of herbal medicines for managing fungal infections. Herbal remedies are known for their historical use, favorable safety profiles, and diverse pharmacological actions. Among these, neem oil (Azadirachtaindica) have attracted considerable attention due to their well-documented antifungal and anti-inflammatory activities.

KEYWORDS

Herbal suppositories, Antifungal, Neem, Anti-inflammatory, Neem seed oil.

INTRODUCTION

A vaginal infections caused by Trichomonas vaginalis (TV) and Bacterial vaginosis (BV) and Candida albicans Vaginal infections are associated with a variety of serious adverse outcomes in pregnancy and

generally have a major impact on quality of life. Suppositories are Solid dosage form of Medicament For insertion into body cavities other than mouth. they may be inserted into rectum, vagina, or nasal cavity. The name "suppositorium" derives from the Latin word supponere, which means "substitute Suppositories can also be administered vaginally. [1] Suppositories can be taken by patients who are unable to take medicine orally due to nausea and vomiting, and neurological disorder. Suppositories are used over other dosage form because it comes in different shapes and sizes. [2]

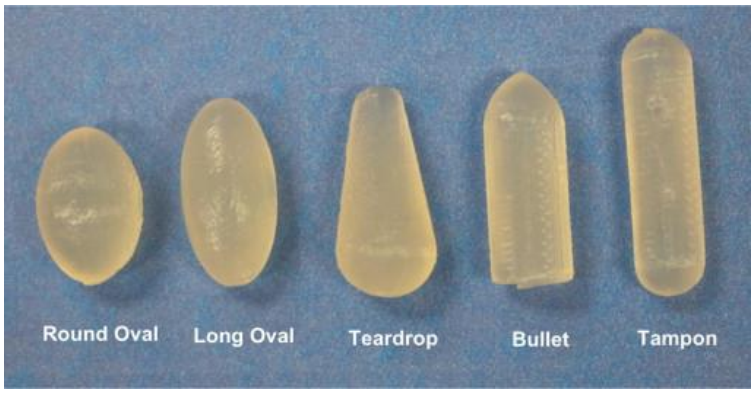

Fig 1- Shapes of Suppositories. [3]

It should melt at body temperature or dissolve, or it should be dispersed in the body fluids. It should release there medicaments radially. It should be compatible with any medicament when added. Most importantly it should be nontoxic and non-irritant to the mucous membrane. It should not interfere in release or absorbance of drug. It should be stable on storage. It should not be softened or hardened on storage. It must retain their shape and size. It should have kept their shape intact when handled. It should be stable when heated above its melting point. Also, it should not adhere to the surface of the mould and also it should shrink sufficiently. [4]

Advantages of Suppository:

1. It's easy to use for those patients, who are unable to take oral medication.
2. Increase the bioavailability of drugs.
3. Very useful to get local effects
4. It avoids the first-pass metabolism.
5. It provides rapid action.
6. Best for vaginal and rectum fungal infection. [5]

Disadvantages of Suppository:

1. It can cause irritation in some patients.
2. Some patients feel embarrassed.
3. Preparation is complicated compared to liquid and tablets.

4. Need low temperature to store.

5. Very few drugs can be delivered by this type of Dosage form. [6]

Classification of Suppositories:

1. Rectal Suppositories

2. Vaginal Suppositories

3. Urethral Suppositories

4. Ear Cones. [7]

Vaginal suppositories are solid medications that are inserted into the vagina with a special applicator. The body absorbs drugs from vaginal suppositories quickly. They work faster than medications you take by mouth. This is because suppositories melt inside the body and absorb directly into the bloodstream.[8]

MECHANISM OF ACTION

A suppository will first dissolve in the liquid or melt on the mucous layer depending on whether it is hydrophilic or lipophilic. The osmotic properties of the dissolving vehicle cause water to be drawn to the rectum or vagina, and when the suppository melts and dissolves, the drugs it contains will diffuse out toward the mucosal epithelial surfaces. If the drug is water immiscible, it must first break free from the base of the suppository by the action of gravity or ambulation before it may begin to dissolve in liquid. The softening and dispersion of lipophilic melting suppositories are not dependent on the presence of fluid. The same method of medication administration is used in suppositories. [9] Azadirachta indica A. Juss, traditionally named Neem (Meliaceae), has been widely known for centuries as a source of active ingredients to develop products for health providers in remote areas. Thus, primary healthcare in developing countries has included treatments with this tree or its parts. For instance, Indian traditional medicine reported cases of success that were not always scientifically tested. A. indica is considered a multipurpose medicinal tree. Outstanding for it wide distribution in nature, as well as assisting low toxicity, Neem can be considered a natural source of cosmetic basic materials for large-scale production. This tree is biologically close to Mahogany and all its parts (root, gum, leaves, flowers and fruits) can be used in agriculture, medical and cosmetology. Neem leaves contain not less than 1.0 percent w/w of the stated Amount of rutin calculated on the dry basis.

Categories:

Antimicrobial, Antiinflammatory, Antifungal, Antibacterial, Antioxidant, Antidiabetic, Anticancer Neem (Azadirachta indica) contains a variety of bioactive compounds that contribute to its medicinal, pesticidal, and therapeutic properties. These compounds are primarily found in the seeds, leaves, bark,

and oil of the neem tree. The most studied and significant components of neem include limonoids, fatty acids, flavonoids. [10]

1. **Scientific Name :** Azadirachta indica A. Juss.
2. **Common Name :** Arishtha, Margosa, Neem, Nim, Nimba, Nimbatiktam, Praneem.
3. **Kingdom** : Plantae.
4. **Phylum** **:** Spermatophytes
5. **Class** **:** Dicotyledonae
6. **Order** **:** Sapindales
7. **Family** **:** Meliaceae

Fig 2-Neem Leaves

Advantages

1. Heals infected skin, pimples, and rashes.

2. Makes your skin healthy.

3. The antibacterial nature of neem leaves also prevents skin infections.

4. By pulling out the impurities from the skin, neem leaves also work effectively on blackheads and whiteheads.

5. Neem's anti-aging properties help in reducing wrinkles and fine lines.

Disadvantages

• Side effects of neem oil for hair are minimal. It may cause scalp skin irritation if used too much or if applied undiluted.

• Long-term consumption of neem extracts may cause severe skin dryness.

• Wound, severe rash, or difficulty breathing could be a sign of allergic reaction

• If redness or itching develop, you may wish to further dilute the oil or avoid using it completely Neem.[11]

METHODOLOGY (EXCIPIENTS)

1. **Glycerine (Glycerol)**

Chemical Name: Glycerol Formula: $C_3H_8O_3$

Appearance: Colorless, odorless, viscous liquid.

Taste: Sweet

Fig -3 Glycerine.

Pharmaceutical Uses:

- Suppository base (with gelatin)
- Humectant (moisture retention)
- Solvent (for drugs/extracts)
- Plasticizer (adds flexibility
- Laxative (mild, osmotic action)

Role in Suppositories:

- Combined with gelatin/paraffin.
- Retains moisture, aids in slow, prolonged release.
- Suitable for hydrophilic drugs and herbal actives.[12]

2. Gelatin (Gelatine)

Basic Info

- Type Protein from animal collagen
- Type Protein from animal collagen
- Source: Bovine/porcine skin, bones, cartilage
- Appearance: Colorless/light yellow, tasteless, odorless solid (powder/sheets)
- Solubility: Swells in cold water, dissolves in hot water

Fig-3 Gelatin [13]

Composition:

• Rich in amino acids: glycine, proline, hydroxyproline, glutamic acid

• Gives it gelling, thickening, stabilizing properties

Pharmaceutical Uses:

• Suppository base (with glycerine)

• Capsule shells (hard/soft gelatin)

• Tablet coating

• Plasma expander (IV use)

• Stabilizer (vaccines, emulsions)

Role in Suppositories:

• Provides structure and firmness

• Swells with moisture, enabling slow drug release

• Ideal with glycerine and paraffin for herbal delivery (e.g., curcumin, neem oil) [14]

3. Purified Water

Water that has been physically processed to remove impurities such as ions, organic matter, particulates, and microorganisms. It meets the specifications of major pharmacopeias (e.g., IP, USP, BP) and is free from chemical contaminants and biological impurities.

• **Appearance:** Clear, colorless, odorless, and tasteless liquid

• **PH:** Typically between 5.0 and 7.0

Production Methods Purified water can be obtained through several purification processes, such as: Distillation Carbon Filtration. In pharmaceutical industries, multi-step purification is often used to ensure high purity and consistency. Pharmaceutical Uses Purified water is one of the most commonly used excipients in pharmaceutical preparations due to its:High safety Solvent properties Universal

compatibility Role in Suppository Formulation In your herbal suppository using glycerine, gelatin, liquid paraffin, curcumin, and neem oil: Purified water is used to hydrate gelatin, allowing it to swell and form a smooth, gel-like matrix. It helps dissolve or disperse hydrophilic components. Ensures uniform consistency of the suppository base. Aids in heat transfer and mixing during the melting and molding process. Storage Stored in sterile, clean, non-reactive containers (glass or pharmaceutical-grade plastic). Should be used promptly or stored under controlled conditions to prevent microbial growth. .[15]

Method of Preparations:

- Hand Rolling
- Co,pression Moulding
- Fusion Moulding
- Atomic Moulding method.[16]

Selection and Preparation of Herbal Actives

↓

Formulation of the Suppository Base

↓

Incorporation of Herbal Components

↓

Molding and Solidification Process

↓

Evaluation of Physical Characteristics

↓

Assessment of Antifungal Activity

↓

Stability Testing [17]

Neem extract preparation

The plant leaves were collected from the plants and distilled water is used to wash the leaves thoroughly. Then they shade dried for 10 days. After that the dried leaves are ground in powderform. 100 gm of powdered extract was assimilated with 350ml of 90% ethanol for 3 hours. Thenit is transferred to percolator and add 150 ml of 90% ethanol for maceration for 7 days with the occasional stirring. Then ethanoic extract is collected. After that it is concentrated to get blackish greenresidue.Extract was stored in dark and cool place. [18]

CONCLUSION

The Conclusion showed that Suppositories relieved symptoms of vaginal Infection Therefore, the use of Azardica Indica vaginal suppositories is recommended for the women with vaginal Infection. And inhibit the bacteria which are responsible for the bacterial infection of vagina.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

REVIEW ARTICLE: APPLICATION OF MOLECULAR DOCKING IN COVID-19 DRUG DISCOVERY: CURRENT INSIGHTS ASTHMA AND LUNGS RELATED DISEASE

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ABSTRACT

The Coronavirus Disease 2019 (COVID-19) pandemic, caused by SARS-CoV-2, created an unprecedented global health crisis, demanding the rapid development of effective therapeutics. The virus's primary tropism for the respiratory system results in a spectrum of illnesses from mild symptoms to severe viral pneumonia and life-threatening Acute Respiratory Distress Syndrome (ARDS). This pathology is particularly dangerous for individuals with pre-existing inflammatory lung conditions such as asthma and COPD. Traditional drug discovery pipelines were inadequate for this emergency, catalyzing the adoption of molecular docking as a critical accelerator. This review details the application of structure-based drug design against key SARS-CoV-2 and host protein targets (e.g., Mpro, PLpro, RdRp, Spike, ACE2, and TMPRSS2). We analyze the primary strategies—drug repurposing and de novo design—and highlight current insights, including the methodological shift towards AI-enhanced computational pipelines and the strategic pivot to "variant-proof" Host-Directed Therapies (HDTs). Furthermore, we provide a deep focus on computational efforts to identify therapeutics for severe lung pathologies, including the cytokine storm, ARDS-related tissue damage, comorbidity-specific targets for asthma, and the long-term sequelae of pulmonary fibrosis. The success of this in silico approach, underscored by drugs like Nirmatrelvir (Paxlovid), highlights the indispensable role of computational chemistry in modern pandemic preparedness.

KEYWORDS

Molecular Docking, COVID-19, SARS-CoV-2, Drug Discovery, Mpro, PLpro, RdRp, Spike-ACE-2, TMPRSS2, Asthma, Lungs Disease, Drug Repurposing.

INTRODUCTION

The emergence of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) in late 2019 marked the beginning of a devastating global pandemic. The resulting illness, COVID-19, has been defined by its profound respiratory impact, with a significant fraction of patients developing severe viral pneumonia that can progress to acute respiratory distress syndrome (ARDS) [2, 6]. A defining and often fatal feature of severe COVID-19 is a dysregulated immune response, commonly termed a "cytokine

storm," which leads to extensive lung tissue damage, systemic inflammation, and multi-organ failure [3].

This hyper-inflammatory state creates an environment of extreme risk for millions of individuals with pre-existing respiratory comorbidities. Patients with asthma and chronic obstructive pulmonary disease (COPD) are uniquely vulnerable; the viral infection and subsequent inflammatory cascade can trigger severe, life-threatening exacerbations [4]. The urgency to protect these populations exposed a critical flaw in traditional pharmacology: the drug discovery pipeline, which typically spans 10-15 years, was built for a different timescale.

This crisis catalyzed the global adoption of rapid-response in silico (computational) methodologies. Among these, molecular docking emerged as a frontline strategy [5]. Molecular docking is a computational technique that simulates the interaction between a small molecule (ligand) and a macromolecular target (protein). It predicts the preferred binding pose and affinity (scoring) of the ligand within the target's active or allosteric site. This allows researchers to perform high-throughput virtual screening (HTVS) of vast chemical libraries—containing millions of compounds—against a viral or host target in a matter of days. This review summarizes the pivotal applications of molecular docking, from targeting the virus itself to managing the complex, host-driven lung pathologies that define the disease.

KEY MOLECULAR TARGETS FOR DOCKING-BASED DISCOVERY

The successful application of molecular docking is entirely dependent on the availability of high-resolution 3D structures of essential biological targets. The rapid, open-source sharing of these structures was the catalyst for in silico drug discovery.

2.1. Targets for Inhibiting Viral Entry

● **Spike (S) Protein and hACE2:** The primary mechanism of viral entry involves the Receptor Binding Domain (RBD) of the SARS-CoV-2 Spike (S) protein binding to the human Angiotensin-Converting Enzyme 2 (hACE2) receptor [6]. This interaction is primed by the host protease TMPRSS2. The publication of the S-protein's cryo-EM structure [7] ignited a wave of docking studies screening for small molecules that could physically obstruct this critical S-protein-ACE2 interface [12].

2.2. Targets for Inhibiting Viral Replication

Once inside the host cell, the virus relies on its own enzymatic proteins, which are prime drug targets.

● **Main Protease (Mpro or 3CLpro):** Arguably the most successful anti-COVID-19 drug target, Mpro is a viral cysteine protease essential for cleaving the two large viral polyproteins into functional non-structural proteins (NSPs) [8]. Its lack of a close human homolog minimizes off-target effects. The rapid solution of its crystal structure [8] allowed for extensive docking campaigns that formed the foundation

for the rational, de novo design of Nirmatrelvir (Paxlovid), a covalent inhibitor that fits perfectly into the Mpro active site [9].

- **Papain-like Protease (PLpro):** This is the second viral protease, which also cleaves the polyprotein. Critically, it also strips ubiquitin from host proteins to help the virus evade the innate immune system [10]. Docking has sought inhibitors to block this dual-function enzyme.
- **RNA-dependent RNA polymerase (RdRp):** This enzyme (NSP12) is the core engine of viral replication, synthesizing new viral RNA. It is the established target of Remdesivir [11]. Docking has been used to identify non-nucleoside inhibitors (NNIs) that bind to allosteric sites to disrupt its function.

DOCKING-DRIVEN STRATEGIES AND CURRENT INSIGHTS

Two main strategies were deployed, with recent insights now refining these approaches.

3.1. Drug Repurposing (Repositioning)

This was the most immediate strategy: screening libraries of thousands of FDA-approved drugs. The rationale is that these compounds have known safety and pharmacokinetic profiles, allowing them to bypass years of pre-clinical development [12]. Docking identified numerous "hits," such as Lopinavir/Ritonavir and Hydroxychloroquine [13], and while many failed in clinical trials, this approach also produced critical successes like Baricitinib [17].

3.2. Natural Product Screening

In parallel, many research groups turned to the vast chemical diversity of nature. Large databases of natural products from medicinal plants and microbes were screened in silico [14]. Compounds like Hesperidin and Quercetin showed high predicted binding affinities to Mpro and the Spike protein [15], prompting further in vitro investigation.

3.3. Current Insight: The AI-Enhanced Computational Pipeline

The most significant methodological insight has been the move beyond traditional docking. Recent studies now commonly employ a multi-stage computational pipeline to improve accuracy and reduce false positives. This workflow typically involves:

1. **Artificial Intelligence (AI):** Using deep learning models, trained on vast experimental datasets (like the 700+ Mpro structures now in the PDB), to pre-screen billions of compounds and generate more accurate scoring functions.
2. **Molecular Docking:** Using the top-scoring AI-predicted hits for high-precision docking into the target's binding site.
3. **Molecular Dynamics (MD) Simulations:** Taking the best docking poses and running computationally expensive MD simulations to verify the stability of the drug-protein complex

in a simulated, dynamic biological environment over time. This AI → Docking → MD pipeline is far more predictive of real-world success.

3.4. Current Insight: The Shift to "Variant-Proof" Host-Directed Therapies (HDTs)

A major strategic insight has been the recognition of the limitations of targeting viral proteins, which mutate rapidly. The emergence of variants (e.g., Omicron, JN.1) can cause drugs targeting the Spike protein to lose efficacy. As a result, current docking efforts are increasingly focused on Host-Directed Therapies (HDTs). This strategy targets stable human proteins that the virus hijacks, such as the entry-enabling proteases TMPRSS2 and ACE2. Because these human proteins do not mutate, any inhibitor targeting them is inherently "variant-proof."

A DEEPER FOCUS: TARGETING HOST-DRIVEN LUNG PATHOLOGIES (ASTHMA, ARDS, AND FIBROSIS)

For patients with severe COVID-19, the therapeutic challenge shifts from targeting the virus to controlling the body's catastrophic immune response, which is the primary driver of severe lung disease.

4.1. Comorbidity-Specific Docking (Asthma)

A significant recent insight is the use of computational biology to find comorbidity-specific drug targets. Recent (2024) studies have analyzed the shared genetic and protein pathways (comorbidity signatures) between COVID-19 and asthma. For example, by identifying shared "hub genes" like ICAM1 (Intercellular Adhesion Molecule 1), which is involved in inflammation in both conditions, researchers can then perform specific docking screens. This work has proposed repurposing drugs like Rapamycin (an immunosuppressant) and Quercetin (a natural flavonoid) as potential candidates specifically for treating COVID-19 in patients with asthma [21].

4.2. Repurposing Asthma's Own Therapeutics

A parallel strategy has been to use docking to test if existing, widely-used asthma medications have a dual effect. Docking studies have shown that leukotriene receptor antagonists, such as Montelukast and Zafirlukast, not only control asthma's inflammatory pathway but also show a high binding affinity for the SARS-CoV-2 Main Protease (Mpro). This in silico evidence suggests these safe, common drugs could potentially serve a dual role: managing the underlying asthma while simultaneously inhibiting viral replication [22].

4.3. Targeting the ARDS Cytokine Storm (Kinases & Inflammasomes)

The "cytokine storm" is the direct cause of ARDS. Docking was instrumental in validating host-directed therapies to stop it.

- **Kinase Inhibitors:** Docking confirmed that Baricitinib, an approved JAK1/JAK2 inhibitor for rheumatoid arthritis, could bind and block the Janus kinase pathway, a central hub for

inflammatory signals. This provided the rationale for its successful repurposing to calm the cytokine storm in severe COVID-19 [17].

- **Inflammasome Inhibitors:** A more current insight is to target the "engine" of the storm. Recent docking efforts are focused on the NLRP3 inflammasome, a multi-protein complex inside immune cells. When activated by the virus, it produces the highly inflammatory cytokines IL-1β and IL-18. Docking is being used to find small molecules that can inhibit the assembly of this complex, shutting down a primary source of lung-damaging inflammation [23].

4.4. Mitigating Acute Lung Damage in ARDS

In the most severe ARDS cases, the lungs are actively destroyed by the immune response. A key culprit is the neutrophil, an immune cell that floods the lungs and releases a powerful enzyme called neutrophil elastase (NE). This enzyme indiscriminately digests the lung's delicate alveolar tissue. A current docking strategy is to find potent neutrophil elastase inhibitors, such as the approved drug Sivelestat, which can bind to and block NE, protecting the lung structure from this devastating "friendly fire" damage [24].

4.5. Addressing Long-Term Disease: Post-COVID Pulmonary Fibrosis

Finally, computational efforts are now targeting the sequelae (long-term consequences) of the infection, primarily pulmonary fibrosis—the irreversible scarring of lung tissue. This condition is driven by the over-production of collagen, a process orchestrated by the TGF-β1 signaling pathway. Docking campaigns are actively searching for small molecules that can inhibit the TGF-β1 receptor or other key proteins in this pathway. This in silico work provides a molecular basis for clinical trials of anti-fibrotic drugs, such as Colchicine, in post-COVID patients [25].

CHALLENGES AND "IN SILICO-TO-CLINIC" GAPS

Despite its successes, the pandemic also highlighted the significant limitations of molecular docking. The initial flood of in silico papers far outpaced experimental validation, with many predictions failing.

1. **Lack of Rigorous Validation:** An alarming finding was that a large percentage of early docking studies lacked adequate validation of their protocols (e.c, re-docking, use of decoy sets), leading to a high rate of false positives [19].
2. **Scoring Function Inaccuracies:** The "scoring functions" used to rank binding affinity are approximations of the true binding free energy. They often struggle to correctly rank diverse chemical scaffolds and may not correlate with in vitro potency [20].

3. Protein Flexibility and Solvation: Standard docking often treats the protein target as a rigid structure, which is not biologically accurate. This limitation, however, is being overcome with flexible docking protocols and, more importantly, by coupling docking with MD simulations.

4. The Pharmacokinetic (ADME/Tox) Barrier: Docking can predict if a molecule binds. It cannot predict if it is bioavailable, reaches the lungs, is metabolized too quickly, or is toxic. This remains the single biggest translational gap.

To address these critical gaps, the field is rapidly shifting away from simple docking and embracing the AI → Docking → MD pipeline, augmented with machine learning models trained specifically to predict ADME/Tox properties.

CONCLUSION AND FUTURE PERSPECTIVES

Molecular docking was an indispensable tool in the global scientific response to COVID-19. It provided the essential speed needed to screen vast chemical spaces, identify high-priority candidates, and accelerate the drug discovery pipeline from decades to months. This led to the de novo design of the highly successful Mpro inhibitor Nirmatrelvir (Paxlovid) and provided the rationale for repurposing life-saving immunomodulatory drugs like Baricitinib.

Current insights show the field evolving, prioritizing "variant-proof" Host-Directed Therapies (HDTs) and leveraging AI-enhanced pipelines to improve predictive accuracy. Furthermore, the application of docking has matured beyond just targeting the virus. It is now a critical tool in developing therapies for the most severe, host-driven lung pathologies, including the cytokine storm, ARDS-related tissue damage, specific asthma comorbidities, and the chronic challenge of post-COVID pulmonary fibrosis. This multi-faceted in silico approach has proven to be an essential and permanent part of the modern pandemic-preparedness arsenal.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

A REVIEW ON PERSONALIZED MEDICINE AND PHARMACOGENOMICS IN DRUG DESIGN

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ABSTRACT

From haphazard screening and coincidental discoveries to a more methodical and technologically advanced procedure, drug research and development have experienced a tremendous change. While contemporary methods have an emphasis on molecular knowledge and precision medicine, classic examples such as aspirin, cyclosporine, and penicillin show the early effectiveness of serendipity. By examining genetic differences that affect how each person reacts to medications, pharmacogenomics plays a crucial role in personalised medicine by enhancing therapeutic efficacy and safety. Finding new molecular targets, lowering drug attrition rates, and improving treatment plans are all made possible by the integration of genomics with drug research. Using pharmacogenomics, bioinformatics, and molecular profiling, personalised medicine seeks to administer the appropriate medication to the appropriate patient at the appropriate time. Additionally, molecular docking has emerged as a crucial computational technique in structure-based drug design, allowing for the highly accurate prediction of ligand–receptor interactions and binding affinities. The future of drug development is being shaped by the integration of computational modelling, genomics, and artificial intelligence, which will make it quicker, more economical, and patient-specific. The methods and developments in drug discovery, pharmacogenomics, personalised medicine, and molecular docking are outlined in this overview, with a focus on their uses, difficulties, and potential in the pharmaceutical sciences.

KEYWORDS

Pharmacogenomics, personalised medicine, drug discovery, Molecular docking, drug design based on structure, genomics, Precision pharmacotherapy, drug target, artificial intelligence, and ligand-receptor interaction

INTRODUCTION

1) DRUG DISCOVERY:

Penicillin, a medication that saved millions of lives during World War II and for which Fleming, Florey, and Chain were awarded the Nobel Prize in 1945 [1]. This medication is still in use today. Serendipity also led to the discovery of chlordiazepoxide, the first benzodiazepine. Leo Sternbach of the University of Cracow created a number of heptoxdiazines in the 1930s to create synthetic dyes. The first

immunosuppressive medication that altered organ transplantation research and practice was cyclosporin, which was being tested as an anti-tubercular antibiotic [2]. Aspirin was found by chemical modification [3]. Salicylic acid, a natural substance, was acetylated to improve stability and lessen irritation of the stomach mucosa. Drugs of various generations have better therapeutic properties as a result of minor chemical changes. For instance, pindolol is derived from propranolol but avoids the first-pass action in the liver and exhibits a higher degree of bioavailability [5], while ranitidine is a chemical modification of cimetidine with greater efficacy and a longer half-life [4].

2) PHARMACOGENOMICS:

Because different people react differently to comparable drugs, pharmacogenomics (PGx) is crucial for PM. These differences are often greater across members of a group than they are within the same population at a different time (or between monozygotic twins) [6]. It is estimated that 20 to 95 percent of the diversity in drug nature and outcomes can be attributed to genetics; the occurrence of large population variations through low interpatient variability is dependable with a legacy as a source of drug reply [7,8].While a number of nongenetic factors influence drug outcomes, such as age, organ function, related therapy, drug connections, and the type of illness, there are now many examples of factors where inter-individual differences in drug reaction are caused by sequence variations in genes encoding drug-metabolizing enzymes, drug carriers, or drug targets [9,10,11]. Pharmacogenomics is the study of how human genetic variations affect a person's response to medications, with a focus on drug distribution, metabolism, and absorption [12,13]. Pharmacogenomics plays a significant role in identifying drug reactants and nonreactants, avoiding adverse effects, and optimizing medicine dosage [14,15]. Lately, FDA has built a strong pharmacogenomics promoter in an attempt to prepare drugs safer and further valuable [16,17]. So as to adjust the property of now promoted medications, the FDA has appraised clear drug labels to contain PGx data. Presently, over one hundred FDA-approved medications take PGx data on their labels that define genes responsible for medication display, clinical reaction variability, and the possibility of adverse events [18].

3) PERSONALISED MEDICINES:

The main goal of personalized medicine (PM) is to provide the right medication for the right patient at the right time. PM, then, is defined as "the management of a patient's disease or disposition by utilizing the best molecular knowledge to accomplish the best medical result for that individual." The foundation of global health is PM. In fact, a number of cutting-edge medications have contributed to the consistent improvement in life expectancy around the world since the discovery of penicillin [19, 20]. Drug development has been costly and ineffective during the last ten years, with an average success rate of 10% [21].

This is frequently the outcome of higher safety standards required for limited approval in a healthcare environment that is far more advanced than we typically could have imagined prior to the conclusion of the Human Genome Project. However, despite rigorous regulatory fastidiousness, adverse drug reactions still occur that eventually lead to the withdrawal of pharmacological items [21,22]. The gap in drug safety between what is anticipated from clinical trials and what really occurs in custom can be closed by PM. Furthermore, we may be able to increase the proficiency of future drug development by focusing on the patient's needs rather than just the characteristics of the drug outcome or the disease [23,24]. The enormous advancements in genomics, including the possibility of resequencing entire genomes at the population stage for a small cost, have increased interest in PM on a global scale. Genetic alterations of a constitutive protein in the target cell [25] or the proteins in charge of the drug's distribution, absorption, metabolism, and elimination (pharmacogenomics pathway) [26] can be used to survey the imprint of genomics. The monoclonal antibody trastuzumab against HER-2, the human epidermal growth factor receptor that is overexpressed in individual breast cancer cells, and tyrosine phosphatase inhibitors used to treat chronic myelogenous leukemia are examples of the earlier route.

4) MOLECULAR DOCKING:

Due to its capacity to accurately forecast the conformation of small-molecule ligands inside the Molecules 2015, 20 13387 suitable target binding region (Figure 2) [27], molecular docking is one of the most widely utilised techniques in SBDD. Following the introduction of the first algorithms in the 1980s, molecular docking became an essential technique in drug discovery [28]. For instance, it is convenient to conduct studies involving important molecular events, such as ligand binding modalities and the related intermolecular interactions that stabilise the ligand-receptor complex [29]. Additionally, molecular docking methods provide rankings of docked molecules based on the binding affinity of ligand-receptor complexes by performing quantitative estimates of binding energetics [29].

DRUG DESIGN—HISTORICAL NOTES ON DRUG DESIGN

Drug design is now the primary method for both present-day and future drug discovery due to a number of significant advancements in the field [30]. The first of them is the understanding of drug–receptor recognition. In the early 1890s, Emil Fisher compared the drug–receptor interaction to the key and lock interplay. He believed that without altering their conformations, the medication and the receptor interacted as solid bodies. Daniel Koshland has proposed that during interaction, both molecules do experience conformational changes and take on the best configuration to bind to one another-ray structures and in silico simulations have repeatedly supported this theory, and it is now established that ligands do, in fact, alter their conformations during interactions to take on

conformations that best suit the contact surfaces. An internal molecule that contributes to the illness is the target macromolecule. Modifying the target macromolecule's functions may alter the disease's pathophysiology, aetiology, or only alleviate its symptoms. It has been estimated that approximately 3,000 of the 20,000 protein-coding genes in the human genome are part of the so-called druggable genome or druggable proteins [31]. These are proteins that have the ability to bind drug-like compounds. The entire proteome was categorised into four groups by Oprea et al. [32] based on the target development stage, or our level of understanding of a particular protein (Figure 2). Macromolecules associated with at least one licensed medication are considered clinically known targets. They make up 659, or 3% of the human proteome. Of them, 25% are enzymes, 21% are ion channels, 16% are gamma-protein-coupled receptors, 9% are various kinases, 4% are transporter proteins, 3% are nuclear receptors, and the other 22% are orphan receptors and other protein families. Proteins that are known to bind with great potency tiny compounds that are not yet pharmaceuticals are examples of chemically known targets. They make up 6% of the proteome of humans. Proteins that have been linked to any disease but have not been investigated for their ability to bind to small molecules are referred to be biologically known targets. This region is home to 53% of the human proteome. Unstudied proteins are among the "dark" targets. They make about 38% of the entire proteome. Obviously, there is a large field for future discoveries. The NIH has been funding an effort to shed light on the druggable genome since 2014. The Pharos website (pharos.nih.gov, viewed on February 20, 2022) contains all newly discovered data.

1.1 Future Trends in Drug Design

Upcoming Drug Design Trends Any scientific or technological advancement is instantly applied to pharmacy, medicine, and medication development. The better a drug candidate is developed during the experimental stage, the less probable it is that it would fail in the later phases, when testing is more costly, particularly in clinical trials. This makes drug design investments beneficial. We had to reconsider how to speed up the time it takes to find and develop new medications and vaccines because of the COVID pandemic. AI has the potential to supply new, efficient, and less expensive drug discovery techniques. The ability to create a particular, non-toxic, efficient, and patient-tailored medication in a matter of hours is the ultimate goal of future drug design. Even if this objective appears amazing right now, it is totally doable in the near future.

PHARMACOGENOMICS:

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of the diversity in drug nature and outcomes can be attributed to genetics; the occurrence of large population variations through low interpatient variability is dependable with a legacy as a source of drug reply [7,8].While a number of nongenetic factors influence drug outcomes, such as age, organ function, related therapy, drug connections, and the type of illness, there are now many examples of factors where inter-individual differences in drug reaction are caused by sequence variations in genes encoding drug-metabolizing enzymes, drug carriers, or drug targets [9,10,11]. Pharmacogenomics is the study of how human genetic variations affect a person's response to medications, with a focus on drug distribution, metabolism, and absorption [12,13]. Pharmacogenomics plays a significant role in identifying drug reactants and nonreactants, avoiding adverse effects, and optimising medicine dosage [14,15]. Lately, FDA has built a strong pharmacogenomics promoter in an attempt to prepare drugs safer and further valuable [16,17]. The FDA has evaluated clear drug labels to include PGx information in order to modify the properties of currently marketed pharmaceuticals. Currently, more than a hundred FDA-approved drugs have PGx information on their labels that identifies the genes in charge of drug display, clinical reaction variability, and adverse event potential [18].

2.1 Pharmacogenomics and drug discovery

Drug discovery and pharmacogenomics Figure 1 crudely illustrates the impact of recently applied sciences at several stages of the drug development system. According to this plan, pharmacogenomics and genomic technologies play a significant role in the development of new drugs. SNP data analysis has already led to the identification of several precandidate genes that are likely useful for drug discovery. Drug discovery will also make use of knowledge gained by studying genes, their interactions, their role in organic pathways, and their heterogeneity among the population. Potential targets for medication development are provided by an analysis of gene expression changes from normal tissues through the illness development process across exceptional groups. Eventually, genetics will have to be used to determine goals instead of the now common target validation. Reducing the number of hypotheses that can ultimately be shown to be incorrect is necessary when using genetic proof-established goal-decision techniques. Success in discovery is measured by lowering attrition and improving a product's return on investment. Decisions made in 2020 will undoubtedly contribute to the impacts in 2025 as molecules move through the progress pipelines [33].

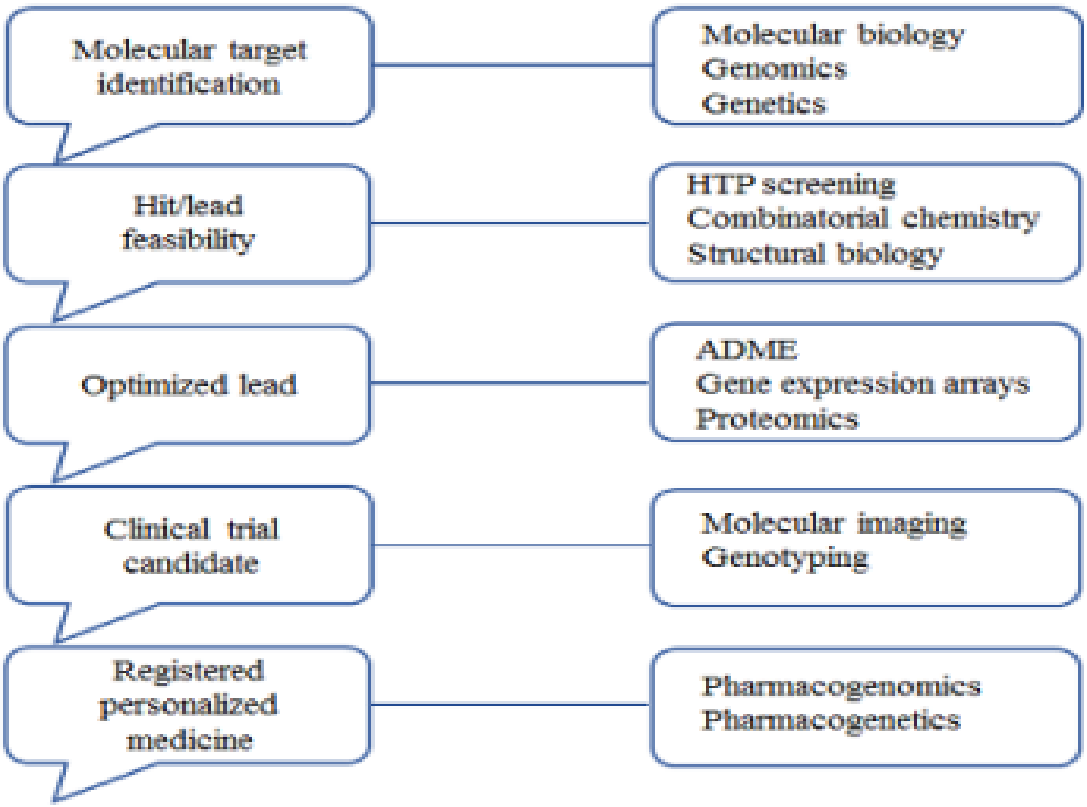

Figure 1. Influence of novel technologies at different steps of the drug discovery process [33]

Ethical Issues of Pharmacogenomics:

Pharmacogenomics advancements should be considered in light of several ethical and societal concerns. Pharmacogenomics is expected to cause ethical problems because of its intimate relationship to genetics. This paper will not go into great detail about a number of ethical issues that are related to pharmaceutical development, pharmacogenomics, and genetics; these topics have been covered in detail elsewhere [34, 35, 36]. The secrecy of study samples, the dissemination of research findings to participants, the potential for discrimination in employment and insurance, and the creation of new categories of orphan patients are some of these ethical concerns. Additionally, the science of pharmacogenomics has its own intricate and difficult ethical, legal, and social problems [37]. This section will address the problems most unique to pharmacogenomics research.

MOLECULAR DOCKING:

The potential of molecular docking There are two primary methods used for molecular docking.

The stimulation method: This method involves physically separating the ligand from the target, and then allowing the ligand to associate into the indented target's groove after a series of conformational space shifts. The ligand's internal or external structural alteration during the movement, as well as the ligand's interaction with the receptor, restricts the amount of energy that can be released. It is

discovered that this method is better suited for accepting ligand flexibility. Additionally, it makes molecular identification between the ligand and the target more accessible. However, due to the significant quantity of energy removed from a specific conformational shift, a longer period of time is needed to estimate an excellent docked conformer. In order to make the stimulation method more user-friendly, grid-based techniques and rapid optimisation techniques are now dominating this drawback. [38, 39]

Shape complementarity: This method uses the target and ligand as structural surface features that provide molecular interaction. The target's surface was linked to the solvent's reachable surface area, and the ligand's molecular surface should exhibit an illustration that corresponds with the target's surface area. Shape matching and complementarity between two surfaces aid in locating the ligand indentation on the intended surface. For instance, twists discovered in main chain atoms are used to analyse the hydrophobicity of proteins as a target molecule. This approach is favoured since it is quicker and entails scanning a variety of ligands in a short amount of time to find the expected binding characteristics of the ligand on the target molecular surface. [40, 41] Docking types Molecular docking makes use of search strategies such as molecular dynamics, fragment-based algorithms, and genetic algorithms. In addition to this, several technologies, such DOCK, GOLD, Flex, and ICM, are primarily used for high throughput docking simulations. Additionally, there are other kinds of molecular docking procedures related to either the ligand or the target, which may be flexible or rigid depending on the goals of the docking stimulation. [42, 43] Understanding ligand binding and protein function depends on the molecular flexibility of the ligand and the mutual adaptation of the ligand and its receptor. Accounting for adaptation in docking calculations is one of the difficulties in molecular docking.

3.1 DOCKING METHODS

Rigid receptor and rigid ligand:

This approach uses stiff ligand and receptor objects with three translational and rotational degrees of freedom in the search space. The flexible ligand used in this docking approach is named based on a pre-computed set of ligand conformations and may also permit some degree of overlap between the ligand and the protein. DOCK and FLOG are the first known versions of docking. In addition, a small number of well-known programs use the FTDOK technique, which keeps the ligand and receptor stiff during the docking process. [44, 45]

Rigid receptor and flexible ligand:

Molecules with nature were used by this system, enabling an induced fit parameter. [46, 47] When both the ligand and the receptor change their conformation to form a perfect match complex with the least amount of energy, it is crucial to evaluate the flexibilities of both. However, when the receptor is

flexible, the cost becomes prohibitive. However, this system's viewpoint is frequently employed as a trade-off between dependability and computer-assisted time utilised by the flexible ligand and the rigid receptor during docking. This approach has been used by almost all docking applications, including AutoDock and Flex. [48, 49] In order to make the ligand flexible and the receptor stiff, AutoDock 3.0 introduces annealing, a genetic algorithm method. AMBER, which comprises desolvation, interactions Vander Waal, electrostatic, unpredictability, or entropy conformational, is the primary basis for the score attribute.

Flexible receptor and flexible ligand:

It has been established that the internal mobility of proteins is closely related to the nature of ligand binding. [50, 51] Flexibility insertion into the receptor is a challenging endeavour, particularly in the docking area. The ligand and receptor complex's full degrees of freedom can also be represented by the preferred use of molecular dynamics simulation; however, molecular dynamics has the drawback of improper sampling. Other obstacles include the computational cost that prevents this method from being used for extensive database screening or analysis. Conformer induction selection is a well-known method for demonstrating the ligand-protein connection, and several hypotheses for induced fit models were also put forth. Conformer selection refers to the process by which a ligand selectively binds to the proper conformation among a variety of protein conformations, and conformation-related induction reveals a mechanism by which the ligand guides the protein to the conformation that would not frequently unbound the state. Only a small percentage of conformational change incidents might be likened to partial protein refolding.

Monte Carlo Local Move (LMMC):

In essence, it is a novel approach that seeks to sample ligand conformation within the loop that contains the active site. This sample for flexible receptor docking local movement began with one torsion angle alteration, followed by six more torsions, allowing the remaining chain to remain in its original position while maintaining the length and angles of all bonds. Go and Scheraga carried out the majority of the work related to LMMC. They created solutions for a system of equations that describe the values of six torsion angles while maintaining the bond lengths and backbone. [52, 53] This approach, which incorporates a suitable Jacobian to stabilise the equilibrium, was initially applied in polyalanine folding by the other researcher Hoffmann et al. Additionally, they demonstrated that this approach is far more effective than individual moves at sampling the conformational space. [54, 55] Amino acid proline, which includes peptides, proteins, and nucleic acids, has also undergone this procedure. [56, 57]

3.2 Applications of molecular docking:

However, this docking was used to demonstrate the viability through any biochemical process that has previously been carried out for any known experimental component of the study. Molecular docking has been applied to a few different fields. The activation or drug-binding characteristics of nucleic acids can mostly be predicted by the relationship between proteins and micromolecules. [58] Because the relationship between a drug's molecular structure and cytotoxicity is established by this factor. As this point demonstrates, medicinal chemists are always working to describe how medications work at the molecular level in anticancer therapy by investigating how pharmaceuticals and nucleic acids interact when copper is present.[59] Medicinal chemist performing in silco analysed the main finding for predicting that the drug is interacting with DNA/ protein. Beside it, if docking program predicts the association between drug and macromolecules then it their experimental findings were available for finding out the method of complex. It will lead to formation of new anticancer drug. Therefore, this elucidation can be instrumental for finding the changes in drug which would lead to sequence or structural association with its target.[60]

CONCLUSION

From random observations, drug discovery has developed into a multidisciplinary field that incorporates pharmacogenomics, computational chemistry, and molecular biology. Personalised medicine, which emphasises patient-specific treatment based on genetic, environmental, and molecular factors, represents a paradigm change in healthcare. By clarifying the genetic factors that influence drug response, pharmacogenomics improves efficacy and reduces side effects while bridging the gap between drug design and patient variability. A potent computational method for comprehending drug-receptor interactions and expediting the discovery of possible therapeutic options is molecular docking. Advances in bioinformatics, molecular modelling, and artificial intelligence will drive future trends in drug design with the goal of creating safer, more efficient, and customised treatments in less time. Precision medicine for everyone and the transformation of global healthcare are both greatly enhanced by the integration of these scientific fields.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

A REVIEW ON HERBAL MOUTH ULCER GEL

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ABSTRACT

Aphthous ulcers, another name for mouth ulcers, are painful lesions that irritate and cause discomfort to the oral mucosa. Traditional therapies, including corticosteroids and antibacterial gels, offer short-term respite but may cause negative side effects if used repeatedly. Bioactive substances such flavonoids, tannins, and polyphenols found in guava leaves (Psidium guajava) have antibacterial, anti-inflammatory, and wound-healing qualities. This work focuses on creating a straightforward Herbalgel to treat mouth ulcers using Carbopol 934 as a basis. Guava leaf extract was added to a Carbopol-based gel matrix to create the gel, which was then tested for stability, drug content, pH, viscosity, and spreadability. The formulation was safe and effective for oral use since it had good Nanogel characteristics, the right viscosity, and a pH of 6.5 to 7.5. According to this study, a natural and affordable solution for treating oral ulcers may be a herbagel made from guava leaves.

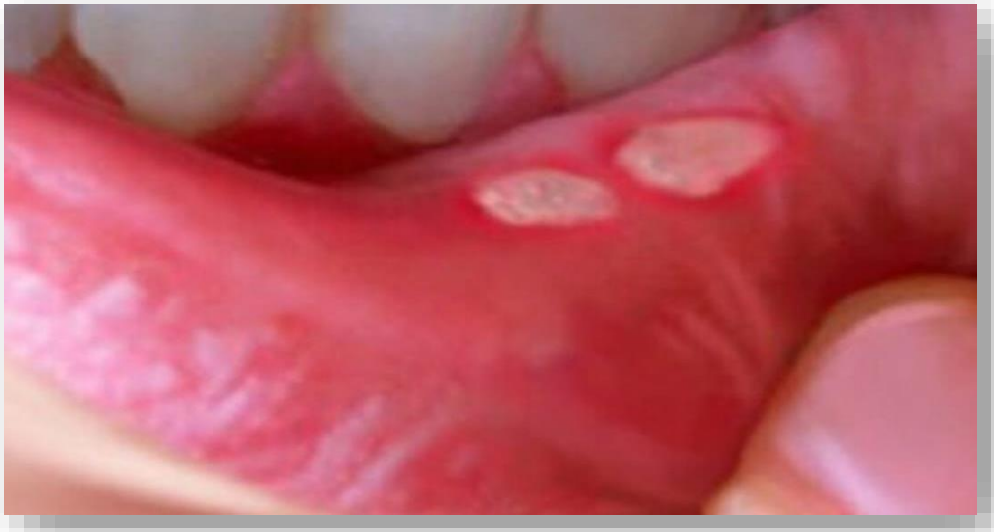
KEYWORDS

Guava leaves, bamboo shoots, mouth ulcers, anti-inflammatory properties, cooling effects, etc.

INTRODUCTION

Gel is a semisolid system made up of a network of solid particles scattered throughout a liquid.One kind of herbal substance is herbal gel, which is made up of a network of polymer chains scattered across a gel matrix. These materials are perfect for a variety of applications because of their adjustable qualities and capacity to absorb huge volumes of water or other solvents. Herbal gels are renowned for their biocompatibility, flexibility, and controlled release of compounds. Because of this, they are very successful in industries including biotechnology, cosmetics, and medicine (1,).A vocal ulcer results in the dissolution or displacement of the upper mucosal layer. This is one of the most frequently encountered pathological disorders of linguistic depression. These sores are typically unsightly and most frequently appear on the inside of the lips and cheeks. Although the exact cause of mouth ulcers is unknown, a number of factors are believed to play a role in their development. . Their progression has been linked to a number of viral, organismal, treponemal, immune system, hormonal, mental, and cancer-related variables. The kind, location, duration, and recurrence of mouth ulcers may be impacted by any underlying systemic conditions (such as cyclic neutropenia or inflammatory bowel disease). Repetitive aphthous stomatitis (RAS) is a severe and excruciatingly painful condition that

affects the nonkeratinized oral mucosa. These ulcers are often round, with an erythematous corona and a fair, possibly elevated margin. The following ulcer types can be chosen based on their size and quantity..(5,6)



(Fig. Mouth Ulcer)

Guava Leaves:

A Summary of Their Therapeutic Benefits Because of their high concentration of bioactive chemicals, guava (Psidium guajava) leaves are well known for their therapeutic properties. They have been used historically to treat a wide range of illnesses. The many health advantages of guava leaves are attributed to their abundance of bioactive substances. (7) They include flavonoids that promote antioxidant activity, lower inflammation, and aid in tissue regeneration, such as kaempferol, rutin, and myricetin, as well as quercetin, a strong antioxidant with anti-inflammatory, antibacterial, and antiviral qualities. Strong antibacterial and antioxidant properties are provided by tannins such as gallic and ellagic acids, which also aid in wound healing by covering damaged tissue with a protective coating. Caryophyllene, eucalyptol, and terpinene are among the essential oils found in guava leaves that have antibacterial, antifungal, and anti-inflammatory qualities. Ferulic acid and chlorogenic acid are examples of phenolic chemicals that help fight oxidative stress and lower inflammation. Saponins also reduce inflammation and have antibacterial and immune-boosting properties. Because of their antioxidant qualities, carotenoids—especially β-carotene—act as a precursor to vitamin A, fostering the growth and repair of healthy cells. (2,3)

(Fig.No.1 Psidium Guajava)

Bamboo Shoot:

Bamboo shoot (Bambusa Vulgaris) is the new tender growth of young culm from the rhizome apex having compressed internodes which are protected by numerous leathery sheaths. The natural distribution of bamboo encompasses mainly the tropical, subtropical and mild temperate zones of worldwide. Bamboo shoot is the new tender growth of young culm from the rhizome apex having compressed internodes which are protected by numerous leathery sheaths. There are more than 1,250 species which belong to 75 genera worldwide; indeed India has more than 125 species belonging to 23 genera. Examples: Dendrocalamus strictus, Bambusabambos, Bambusanutans, Bambusatulda, Dendrocalamus giganteusand etc. Bamboo shoot times vary from species to species. The temperate climate bamboos known as runners sprout in the spring, while the tropical and subtropical clumpers sprout in the late summer and fall.A fantastic source of nutritional fiber, carbs, antioxidants, amino acids, minerals, vitamins, and protein, bamboo shoots are also low in calories and fat but high in important fatty acids that have health benefits. Anti-inflammatory, anti-cancer, antibacterial, antifungal, and antiviral qualities are among the health benefits of bamboo shoots. Sheath, tender bamboo, and the entire bamboo shoot are its three components.

Kingdom: Plantae

Order: Poales

Family: Poaceae

Subfamily: Bambusoideae

(Fig.No.2 Bambooshoot

Advantages of gel formulations:

Compared to traditional semisolid dose formulations, the gel formulation offers a number of significant advantages. Compared to other formulations, gels are straightforward to make. (5)

1. Gel is an elegant, non-greasy formula.
2. Gels have excellent adherence to the area of application.
3. Gels are biocompatible and environmentally benign.
4. Have extraordinary fortitude in the face of adversity.

Disadvantages of gel formulation:

Despite the fact that it has certain advantages. Gel compositions may have some disadvantages. (13, 14)

1. Gels work more subtly and last longer.
2. People may become irritated by the gelators or additives.
3. The presence of water raises the possibility of microbial or fungal attack on gel.
4. The solvent loss in the formulation dries to gel.
5. Some gels become unstable due to flocculation.

Causes of Mouth Ulcer:

Although the precise etiology of mouth ulcers is not always known, a number of factors can lead to their development.

Nutritional Deficiencies: Low levels of certain nutrients, particularly iron, vitamin B12, and vitamin C, can cause mouth ulcers. (15)

Poor Oral Hygiene: Inappropriate brushing or flossing can cause irritation to the delicate oral tissues, which might result in ulcer development.

Infections: Mouth ulcers can be brought on by bacterial infections or viral illnesses like herpes simplex.

Stress and Depression: The development of mouth sores has been connected to emotional stress and worry.

Indigestion: Acid reflux and gastritis are two digestive disorders that can occasionally result in mouth ulcers.

Mechanical Trauma: Biting the cheek, using a hard toothbrush, or wearing dentures that don't fit properly are all examples of oral injuries that can result in ulcers.

Food Sensitivity: Some foods, such spicy foods, acidic fruits, or food allergies, can irritate the mouth mucosa and cause ulcers.

Hormonal Imbalance: Mouth ulcers can be brought on by hormonal changes, particularly during menstruation, pregnancy, or menopause.

Systemic Diseases: Mouth ulcers might be a symptom of an autoimmune disease, celiac disease, or inflammatory bowel disease (IBD). (6,7,8,9)

MATERIAL AND METHOD:

Collection of Guava Leaf and Bamboo Shoot

Plant Material: The local market provided the herbal plant material. The guava leaves were gathered from the local natural region.

1**. Guava Leaf Preparation and Extraction**:

250 g of the dry powder was steeped in 95% ethanol in a percolator for 24 hours.

The extract was gathered in Petri dishes after it had been left to slowly percolate for 24 hours. (16) A rotary flash evaporator was used to concentrate the extract under vacuum. A net yield of 22.6 g of concentrated extract (9.12%) was obtained. (10)

2. Preparation & Extraction of Bamboo Shoot:

The shells of 15 kg of Gigantochloa albocillata bamboo shoots were separated and allowed to air dry at 30°C. The shoots were dried in a drying oven (17) set at 110 °C for two days after being chopped into cubes about 3 cm on each side. The dried bamboo shoots were ground in a grinder and allowed to dry in a jar before the extraction procedure (18).

Extraction of bamboo shoot

50 percent distilled water and 100 percent methanol are taken: A 250 milliliter distillation flask was filled with 50 percent methanol.

Each teabag was filled with 10 grams of dried powdered bamboo shoots for a 5-hour Soxhlet extraction.

UAE was carried out using a 40 kHz fixed-frequency ultrasonic bath. The 50 ml obtained in each conical flask was sonicated for 30 minutes in an ultrasonic bath (19). Using a rotary evaporator, the extract was evaporated at 40 °C.

The concentration was then ascertained using a gallic acid standard curve by spectrophotometrically measuring the concentrated extract at 760 nm (11).

List of Chemical Ingredient & their Role:

Sr. No.	Ingredients	Category
1.	Guava Leaves	Anti-Inflammatory & Anti-Bacterial Activity
2.	Bamboo Shoot	Cooling Effect & Anti-Inflammatory Activity
3.	Carbopol 934	Gelling Agent
4.	Triethanolamine	Neutralizer
5.	Propyleneglycol	Co-Solvent
6.	Propyl Paraben	Preservative

List of Equipment:

Sr.No.	Equipment
1.	Measuring Cylinder
2.	Test Tube
3.	Glass Rod
4.	Beakers
5.	Spatula
6.	Viscometer
7.	PH Meter

Evaluation Parameter:

Visual inspection: The color, smell, and look of the prepared gel were assessed.

PH: The pH was measured using a pH meter. After weighing and dissolving roughly 0.5 grams of the gel in 50.0 milliliters of distilled water, the pH of the mixture was determined.

Viscosity: A Brookefield viscometer was used to measure the gel's viscosity. A spindle No. 63 was used to measure the digital reading between the slides while a certain load was applied. The sample (50 g) was put in a beaker and let five minutes to equilibrate. The quicker the slide is separated, the better

Spreadability:

Spreadability is expressed in terms of time in seconds taken by two slides to slip off from gel that is placed in between the slides under the direction of a certain load. Lesser the time taken to separate the slide better is the spreadability.10 Spreadability is calculated by using the

formula: S =M L/T

Where,

M=weight tied to upper slide

L =length of glass slides

T =time taken to separate the slides

FUTURE SCOPE

Advanced formulation techniques such microparticle and nanogel technology are part of the more effective future scope of the bamboo shoot and guava leaf mouth ulcer gel, which aims to provide controlled medication release and improved bioavailability. Long-lasting therapeutic effects can result from the incorporation of biocompatible polymers like HPMC and Carbopol, which can enhance mucoadhesion and stability. In order to confirm the gel's safety and effectiveness in humans, clinical and in vivo research are required. Herbal extracts and contemporary drug delivery methods can be used to provide a new, safe, affordable, and patient-friendly mouth ulcer treatment with fewer adverse effects. To improve patient compliance and economic feasibility, different dose forms such as oral sprays or strips and synergistic herbal combinations should be investigated. Following these instructions should make this herbal gel a dependable therapeutic choice for oral healthcare.

CONCLUSION

The herbal mouth ulcer gel formulated with guava leaf extract and bamboo shoot shows promising anti-inflammatory, antimicrobial, and wound healing properties. The gel is stable, mucoadhesive, and easy to apply, providing effective localized treatment with minimal side effects. This natural

formulation offers a safe, cost-effective alternative for managing mouthulcers and promotes faster healing. Further clinical studies are recommended to confirm its therapeutic potential.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

IMPACT OF GREEN MARKETING ON BRAND IMAGE AMONG URBAN CONSUMERS

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ABSTRACT

Growing environmental awareness has encouraged both consumers and companies to rethink their buying decisions. As brands increasingly adopt eco-friendly strategies, understanding how these initiatives influence consumer perception becomes vital. This study examines the impact of green marketing awareness on brand image among urban consumers. A quantitative and descriptive research design was employed, using a structured online questionnaire distributed to 132 respondents residing in urban areas. The survey measured consumers' awareness of green marketing practices, such as the use of sustainable materials and transparent communication, and their overall perception of brand image. The findings highlight the strategic importance of integrating authentic environmental messages into marketing communication to build trust, strengthen reputation, and create long-term brand equity among environmentally conscious urban consumers.

KEYWORDS

Green Marketing, Brand Image, Consumer Perception, Urban Consumers

INTRODUCTION

In recent years, environmental sustainability has become a core concern in both public policy and corporate strategy. A positive brand image can be defined as consumers' perceptions and associations related to a brand that is critical for influencing purchase intentions and long-term loyalty (Keller, 2013). When consumers perceive that a company is committed to sustainability, their trust and emotional attachment toward the brand tend to increase (Rahbar & Wahid, 2011).

At present environmental sustainability has become one of the most important global priorities, impacting the attitudes and behaviours of consumers, businesses, and governments. Businesses are implementing more sustainable and responsible practices as a result of increased awareness of ecological imbalance, resource depletion, and climate change. In this regard, green marketing has emerged as a crucial strategic instrument that enables businesses to convey their environmental dedication while enhancing their standing with customers.

Sustainability has evolved from a fad to a crucial component of business identity and competitive advantage as contemporary consumers favour companies that share their ethical and ecological values. For marketers and policymakers looking to encourage responsible consumption and enduring brand loyalty, it is crucial to comprehend how consumer perceptions and brand image are impacted by awareness of these green practices. Therefore, it is essential to empirically examine whether awareness of genuine green marketing practices actually enhances consumers' brand image perceptions.

In the Indian context, several lifestyle and retail brands such as The Body Shop and FabIndia have positioned themselves as environmentally responsible through cruelty-free products, natural materials, and sustainable packaging. Yet, limited empirical research has explored whether these initiatives truly strengthen brand image among urban Indian consumers, who represent a rapidly growing and environmentally aware market segment.

The present study seeks to address this gap by investigating the impact of green marketing awareness on brand image using a consumer survey. The findings aim to contribute to both academic understanding and managerial practice by clarifying whether green marketing initiatives translate into perceptual advantages for brands operating in urban India.

REVIEW OF LITERATURE

Genoveva and Samukti (2020) explored the influence of green marketing on consumers' purchase decisions, mediated by brand image, using the case of Ades mineral water in Indonesia. The study applied a descriptive quantitative design with 268 respondents and analyzed data through Structural Equation Modeling (SEM). The findings indicated that green marketing significantly influences both brand image and purchase decisions, directly and indirectly, through the mediating role of brand image. The paper emphasized that environmentally responsible practices—such as eco-friendly packaging and advertising—enhance a company's image and consumer trust. This study highlighted the importance of adopting a holistic green marketing strategy, encompassing product design, pricing, distribution, and promotion, to reinforce sustainable branding and competitive advantage in the marketplace.

Kumar (2025) conducted a mixed-method study to assess how green marketing strategies affect consumer purchasing behaviour in India, using a stratified random sample of 500 respondents. The study found that environmental awareness, perceived product effectiveness, and brand trust significantly predict green purchasing intentions. Socio-demographic factors such as income, education, and region also moderated these relationships, revealing disparities between urban and rural consumers. While eco-conscious consumer's demonstrated interest in green products, scepticism

about authenticity and higher prices hindered adoption. The paper suggested that transparent marketing, eco-labelling, and sustainability certifications can enhance brand credibility and trust. By integrating behavioural theories such as the Theory of Planned Behaviour and Value-Belief-Norm theory, this research provided a comprehensive understanding of the psychological, social, and demographic dimensions of green consumerism in emerging markets like India.

Patel and Chaudhary (2025) examined how sustainability practices, particularly green marketing, impact brand image and consumer loyalty. Using a descriptive research design and primary survey data from 100 respondents, the study found that 70% of consumers were aware of green marketing, and a majority perceived sustainable brands as more trustworthy. Key factors such as recyclable packaging, reduced plastic usage, and renewable energy adoption positively influenced brand perception. The research revealed that sustainability not only enhances brand image but also drives brand switching and long-term loyalty. The authors concluded that modern consumers associate environmental responsibility with reliability and ethics, urging companies to embed genuine sustainability initiatives into their marketing strategies to strengthen consumer trust and competitive positioning.

RESEARCH METHODOLOGY

The study adopted a quantitative and descriptive research design to examine the relationship between consumers' awareness of green marketing practices and their perception of brand image. This approach was selected as it enables the collection of measurable data and facilitates statistical testing of relationships between variables. The research focused on understanding whether consumers' perceptions of a brand's green marketing initiatives influence their evaluation of the brand's image. The target population comprised consumers residing in urban areas who are aware of or purchase products from eco-conscious brands such as The Body Shop and FabIndia. A convenience sampling method was employed to collect responses due to the accessibility of participants through online platforms. Data were gathered from 134 respondents, of which 132 valid responses from urban consumers were retained for analysis after excluding two non-urban entries. Each sampling unit represented an individual consumer aged 18 years and above. Primary data were collected through a structured online questionnaire designed using Google Forms.

Objectives:

1. To assess consumers' awareness and perception of green marketing practices adopted by brands.
2. To evaluate consumers' perception of brand image in relation to these green marketing efforts.
3. To examine the relationship between green marketing awareness and brand image perception among urban consumers.

Hypothesis:

(H_o): There is no significant relationship between consumers' of green marketing awareness and their brand image perception.

(H_1): There is a significant relationship between consumers' of green marketing awareness and their brand image perception.

Data Analysis:

Table 1: Descriptive Statistics

Variable	N	Mean (M)	Standard Deviation (SD)
Green Marketing Awareness	132	3.98	0.52
Brand Image Perception	132	4.10	0.48

Table 2: Correlations

		Green Marketing Awareness	Brand Image Perception
Green Marketing Awareness	Pearson Correlation		1
	Sig. (2-tailed)		
	N		132
Brand Image Perception	Pearson Correlation		0.729
	Sig. (2-tailed)		.000
	N		132

Interpretation:

- The mean scores suggest that respondents generally agree with statements related to both green marketing efforts and brand image, indicating overall positive perceptions.
- The standard deviations are moderate, suggesting relatively consistent responses among participants.
- The Pearson correlation coefficient (r = 0.729) confirms a strong, statistically significant positive relationship between consumers' perception of green marketing and their brand image perception.
- The statistical analysis revealed a strong and significant positive correlation ($r = 0.729$, $p < 0.001$) between the two constructs.

Hence, the null hypothesis that there is no significant relationship between green marketing awareness and brand image perception is not accepted.

DISCUSSION

The findings are consistent with previous research highlighting that consumers who perceive brands as environmentally responsible are more likely to trust and favour those brands. The strong positive correlation demonstrates that green marketing initiatives such as sustainable packaging, genuine environmental claims, and visible eco-friendly practices effectively enhance brand credibility and image. This implies that green marketing is not merely an ethical or regulatory necessity but also a strategic branding tool. When consumers recognize authenticity in a brand's sustainability efforts, their trust and loyalty toward that brand increase, contributing to a stronger and more resilient brand image. The results reinforce the growing importance of sustainability-driven communication strategies in influencing urban consumer behaviour, especially among younger and environmentally conscious segments. Future studies could extend this work by examining whether such positive associations also translate into actual purchase behaviour and long-term brand loyalty.

CONCLUSION

The present study set out to examine the relationship between consumers' awareness of green marketing initiatives and their perception of brand image among urban consumers. The statistical analysis revealed a strong and significant positive correlation ($r = 0.729$, $p < 0.001$) between the two constructs. This finding establishes that brands engaging in authentic, visible, and credible green marketing practices are perceived more favourably by consumers in urban markets.

The results confirm that green marketing plays a decisive role in shaping brand image, extending beyond environmental compliance to influence brand trust, perceived quality, and overall reputation. Urban consumers, who are generally more informed and environmentally conscious, tend to evaluate brands through the lens of sustainability. Consequently, when brands communicate their eco-friendly initiatives transparently, they not only enhance consumer goodwill but also strengthen long-term brand equity.

The study thus contributes to the growing body of evidence that sustainability and marketing strategy are deeply interlinked. Green marketing should therefore be viewed as a core element of strategic brand management rather than an optional promotional tactic.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

PREGNANCY COMPLICATIONS AND AUTOIMMUNE DISEASES IN WOMEN

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ABSTRACT

Autoimmune diseases (AIDs) disproportionately affect women of reproductive age and confer elevated risks of obstetric and neonatal complications. This narrative review integrates recent (2019–2025) evidence from systematic reviews, meta-analyses, and major society guidelines to summarize maternal–fetal risks, immunopathology, and management across key autoimmune conditions: systemic lupus erythematosus (SLE), antiphospholipid syndrome (APS), rheumatoid arthritis (RA), systemic sclerosis (SSc), autoimmune thyroid disease (AITD), type 1 diabetes mellitus (T1DM), inflammatory bowel disease (IBD), multiple sclerosis (MS), neuromyelitis optica spectrum disorder (NMOSD), primary Sjögren's syndrome (pSS), psoriasis/psoriatic arthritis (PsO/PsA), autoimmune hepatitis (AIH), myasthenia gravis (MG), immune thrombocytopenia (ITP), and celiac disease (CeD). We highlight disease-specific patterns of risk (e.g., preeclampsia, fetal growth restriction, pregnancy loss, preterm birth), the impact of disease activity at conception, and medication safety. Modern multidisciplinary care, preconception counseling, and maintenance of disease remission enable the majority of pregnancies to achieve favorable outcomes.

KEYWORDS

pregnancy, autoimmune disease, maternal outcomes, fetal outcomes, preeclampsia, preterm birth, miscarriage, neonatal lupus, disease-modifying therapy

INTRODUCTION

Autoimmune disorders are common among young and middle-aged women and account for a significant morbidity and early death rates (7to10 per cent) [1,2]. These chronic diseases are the result of a self-destructive immune reaction, which attacks the own tissues, which normally occurs in the biologically vulnerable individuals after being triggered by an immune-stimulating environmental stimulus. Autoimmune diseases can be divided into systemic (e.g. systemic lupus erythematosus) and organ-specific (e.g. Graves' disease, which attacks the thyroid gland). The sex differences are also impressive: women constitute as much as 80 percent of the cases with female to male ratio of 9:1 in

some diseases in reproductive years [3,4]. Even though the root cause of such gender bias has not been completely demonstrated, there are female-specific reproductive biology causes, such as pregnancy-related events [5]. Preeclampsia, stillbirth, spontaneous preterm birth, and fetal growth restriction are pregnancy complications that impact 15 7000 pregnancies and are linked to an increased risk of chronic disease in later adulthood [6, 7]. These complications are multifactorial yet have similar patterns of abnormal immune and inflammatory [8, 9], proposing a potential connection with subsequent autoimmune disease. Two systematic reviews have shown an association between pregnancy complications and subsequent autoimmune disease in women (; but most of them were constrained by the small size or homogenous samples, [10,11] possible recall bias due to self-report, and lack of optimal control of confounders. This paper is thus a study aimed at exploring the dynamic relationship between pregnancy complications and the later occurrence of autoimmune disease in the women throughout these life periods.

SCOPE AND SOURCES

1. Scope

Pregnancy complications and autoimmune diseases represent major public health challenges affecting women worldwide. Both conditions significantly influence maternal and fetal health, quality of life, and long-term disease outcomes. [12]

A. Pregnancy Complications

These include a wide range of physiological and pathological conditions that arise during pregnancy, childbirth, or postpartum, affecting either the mother or the fetus.

The scope includes:

Maternal morbidity and mortality: Complications like preeclampsia, eclampsia, gestational diabetes, and hemorrhage remain major causes of maternal death, particularly in developing countries. [13]

Fetal complications: Preterm birth, low birth weight, intrauterine growth restriction (IUGR), and congenital. [14]

Long-term effects: Women with pregnancy complications (like preeclampsia or gestational diabetes) have an increased risk of developing cardiovascular disease, type 2 diabetes, or kidney disease later in life. [15]

B. Autoimmune Diseases in Women

Autoimmune disorders occur when the immune system attacks the body's own cells. Around 80% of autoimmune disease cases occur in women, especially during the reproductive years. [16]

The scope includes: Systemic diseases: Such as systemic lupus erythematosus (SLE), rheumatoid arthritis (RA), and multiple sclerosis (MS). [17]

Organ-specific diseases: Like Hashimoto's thyroiditis, Graves' disease, and autoimmune diabetes. [18]
Impact on pregnancy: Autoimmune diseases can increase the risk of miscarriage, preterm labor, preeclampsia, and neonatal complications. [19]
Postpartum autoimmune flare-ups: Pregnancy-induced immune modulation often reverses after delivery, triggering disease relapse. [12]

2. Sources / Causes

A. Pregnancy Complications

1. Genetic Factors: Chromosomal abnormalities (e.g., Down syndrome, Turner syndrome) Genetic predisposition to hypertension, diabetes, or clotting disorders. [20]

2. Physiological and Hormonal Changes: Altered insulin resistance leading to gestational diabetes mellitus (GDM) Increased blood volume and vascular changes contributing to preeclampsia. [21]

3. Lifestyle and Environmental Factors: Poor nutrition, alcohol or tobacco use Exposure to environmental toxins and pollutants. [13]

4. Infections: TORCH infections (Toxoplasmosis, Rubella, Cytomegalovirus, Herpes simplex) Urinary tract and reproductive tract infections. [23]

5. Medical Conditions: Pre-existing hypertension, diabetes, thyroid disorders, or autoimmune diseases. [19]

A. Sources / Causes of Autoimmune Diseases in Women

1. Genetic Susceptibility: HLA gene variants (e.g., HLA-DR, HLA-DQ) associated with autoimmune diseases Family history of autoimmune disorders. [24]

2. Hormonal Influences: Estrogen enhances immune response, possibly increasing susceptibility in women Hormonal fluctuations during menstruation, pregnancy, and menopause modulate immune activity. [16]

3. Environmental Triggers: Viral and bacterial infections (molecular mimicry mechanism) Exposure to ultraviolet (UV) radiation, chemicals, and certain drugs. [18]

4. Epigenetic Factors: DNA methylation and microRNA alterations influencing immune gene expression. [25]

5. Pregnancy-Related Immune Modulation: Immune system shifts toward tolerance during pregnancy; however, postpartum immune reactivation may trigger or worsen autoimmune diseases such as lupus or thyroiditis. [12]

Pathophysiological Links Between Autoimmunity and Adverse Pregnancy

In autoimmune diseases, multiple pathways are regularly involved in contributing to obstetric risk. (1) immune-mediated endothelial and trophoblast damage through cytokines (e.g., TNF a, IL 6, IFN g) and

type I interferon signaling; (2) complement activation and microvascular dysfunction resulting in placental malperfusion; (3) autoantibody-drived pathology (e.g. anti-phospholipid antibodies; anti-Ro/SSA and anti-La/SSB with (4) disease flares triggered by pregnancy-associated immune shifts or medication withdrawal; and (5) comorbid conditions (hypertension, diabetes, renal disease) that amplify preeclampsia, fetal growth restriction (FGR), and preterm birth risks.

Pregnancy complications

1. Pre-Eclampsia
2. Gestational hypertension
3. Placental abruption
4. Preterm birth
5. Gestational diabetes
6. Low birth weight
7. Still birth
8. Recurrent miscarriage
9. First trimester miscarriage

Autoimmune disease

1. systemic lupus erythematosus
2. Rhumetoid arthritis
3. systemic sclerosis
4. Type 1 diabetes mellitus
5. Inflammatory bowel diseases
6. Sjogren syndrome and neonatal lupus
7. Multiple Sclerosis
8. Myasthenia gravis

1. PRE-ECLAMPSIA

Pre-eclampsia is a pregnancy-acquired multisystem disorder, that is marked by onset post-20-weeks hypertension, dysfunction of an organ such as proteinuria, disturbed liver or renal function, coagulopathy or fetal growth retardation. Defective placentation is believed to contribute to a generalized inflammatory response that may impair endothelial performance although it has not been completely established. This in combination with the requirements of the sub optimally implanted feta- placental unit lead to hypertension. Essential hypertension is also characterized by endothelial disturbance which is also a cause of atherosclerosis. In the case of coronary heart diseases (CHD), heart failure, stroke and CVD death, the adjusted risk ratio (aRR) was in the 10-year period (after affected

pregnancy) compared to >10-year period (after affected pregnancy).A systematic review by Wu et al. provides this information on pre-eclampsia history as a predictor of future ischemic heart disease (aRR 2.11 [95% CI: 1.60 2.77]) a 3.5-fold higher risk of heart failure (RR 3.62 [95% CI: 2.25–5.85]) and a 71% higher risk of stroke (RR 1.71 [95% CI: 1.38–2.11]) according to a systematic review by Wu et al.12 For coronary heart diseases (CHD), heart failure, stroke and CVD death, the adjusted risk ratio (aRR) was in the first 10 years following the affected pregnancy, compared to >10 years postpartum. [26,27,28,29,30]

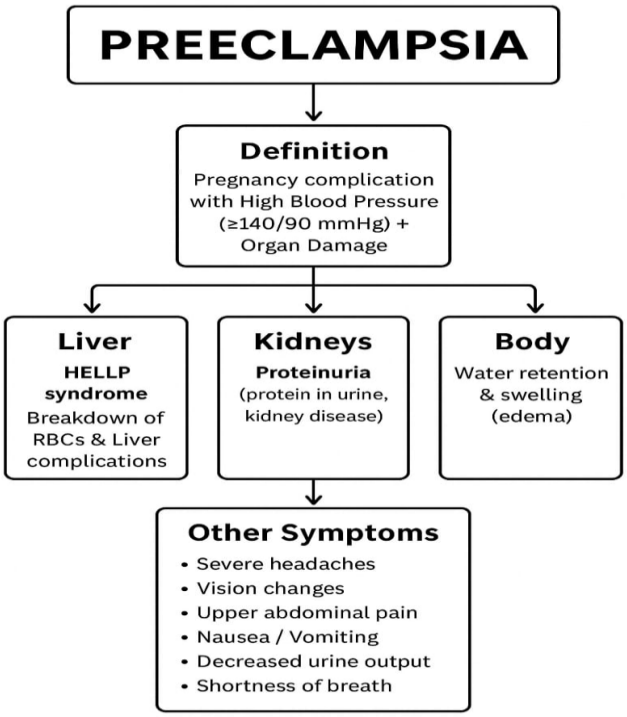


Fig. pre-eclampsia

Risk of no communicable disease following Pre-eclampsia.

- Heart failure RR 3.62 (95% CI: 2.25–5.85)
- Coronary heart disease RR 2.11 (95% CI: 1.60–2.77)
- Composite cardiovascular disease RR 1.65 (95% CI: 1.36–2.21)
- Cerebrovascular morbidity OR 2.95 (95% ICI: 1.10–7.90)
- Vascular dementia HR 3.46 (95% CI: 1.05–1.99)
- Stroke RR 1.71 (95% CI: 1.38–2.11)
- Venous thromboembolism aHR 2.4(95% CL:1.3-4.2)
- Diabetes RR 2.37(95% CL 1.37-4.10)
- Chronic kidney diseases HR:1.82(95% CL:1.27-2.62

- End stage renal disease HR 3.01 (95% CI: 1.92–.70)

2. GESTATIONAL HYPERTENSION

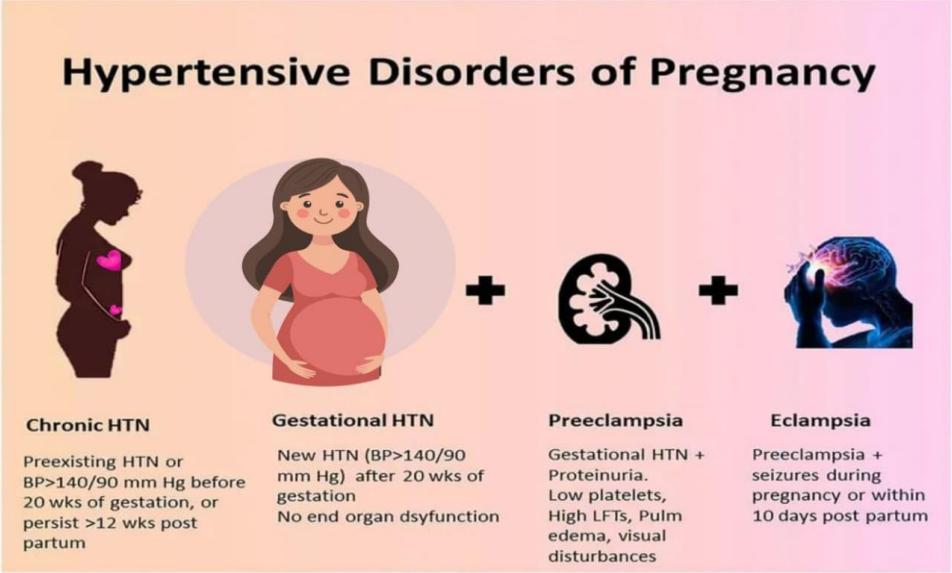


Fig. Gestational hypertension

Gestational hypertension is a designation used by International Society For the Study of hypertension in pregnancy to classify new onset hypertension (SBP >/= 140 mmHg or DBP >/= 90 mmHg) occurring after 20 weeks of Gestation and does not contain the characteristics of pre-eclampsia.It is still not Proved whether it is a spectrum of disease of pre-eclampsia, Or it is a separate entity. There is a multifactorial pathophysiology of essential hypertension. They are Genetics, environment, sex and Ethnicity, vascular, renal, hormonal and sympathetic nervous system Mechanisms, and obesity, insulin resistance And Sleep apnea may be Contributing factors in cases of gestational Hypertension, or the physiological requirements of pregnancy may merely provide a Revealed susceptibility. Grandi 14 performed a systematic review and meta-analysis that combined the results of 9 cohort studies to investigate 3 204 633 women whose median follow-up time was 4.917.9 years. They discovered that Gestational hypertension, but when analysed separately in the absence of preeclampsia, is related to a 67per cent greater risk of cardiovascular morbidity, including coronary artery disease, myocardial infarction, Coronary revascularization, peripheral arterial disease, transient Ischemic attack, and stroke (pooled OR 1.41 [95% CI: 1.31-1.52])14. [6,26,28,30,32]

3. PLACENTAL ABRUPTION

Placental abruption occurs when the decidual arteries rupture and Cause premature Separation of the placenta.23 Some of the underlying pathological processes decribed are Associated with

placental abruption, pre-eclampsia, fetal growth restriction and preterm Labor. Placental inflammation is caused by abnormal vascular remodeling or failure of Deep placentation, thrombosis and angiogenesis To some extent, the underlying pathology Placental abruption is associated with an overall 82 increased risk of cardiovascular morbidity and mortality (OR = 1.82 [95 percent ICI: 1.4-2.3] and OR = 2.2 [95 percent ICI: 1.1-4.5]).14 It also contributes to the development of One or more of the following Pregnancy complications acute Myocardial infarction and hypertensive heart disease (HR = 1.9 [95 percent.[6,32]

4. PRETERM BIRTH

The preterm birth is said to be the birth of the infant before 37 Completed weeks. The exact pathogenesis of spontaneous preterm birth is not always proved in a specific case. It Is believed to be a syndrome induced by various factors such as inflammation, uteroplacental ischemia or hemorrhage, uteroplacental Infection, uterine over-distension, stress and other immune mediated reactions. Abnormal placentation may be the triggering factor or inflammation may be the process that connects spontaneous preterm delivery to subsequent CVD. Iatrogenic preterm birth is more strongly related to future Composite cardiovascular morbidity (OR 1.63 [95% ICI: 1.39193]) 14 CHD (RR 1.49 [95% CI: 1.38 160]) and stroke (RR 1.65 [95% CI: 1.51179]) but future All-cause mortality is a stronger outcome in relation to Spontaneous preterm birth relative to Iatrogenic preterm delivery.[6,14,32]

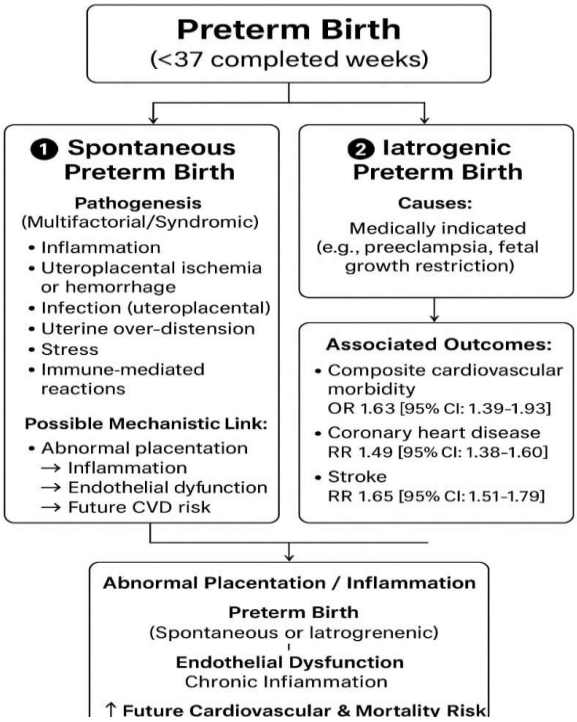


Fig. preterm birth

5. LOW BIRTHWEIGHT

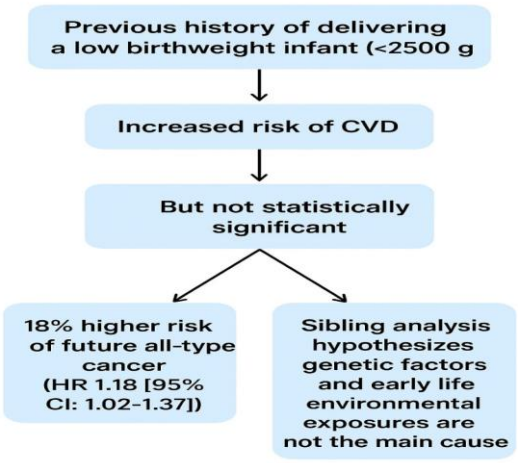


Fig. Low birthweight

Previous history of delivering a low-birthweight infant (birthweight<2500 g) May also be a risk factor to future maternal CVD. Meta-analysis of the Four Studies which have analyzed the use of low birthweight infant as a risk factor demonstrated A Trend of increased risk of CVD, but was not statistically Significant. Studies which have analyzed the effect of IUGR secondary to placental insufficiency would be needed in order to further investigate this, but since CVD is related to abnormal placentation, a relationship is possible. A retrospective cohort Study of 982 091 women demonstrated that delivery of a very-low birthweight infant was associated With a 18% higher risk of future all-type cancer (HR 1.18 [95% CI: 1.02 -1.37]) which is consistent with this finding. Co sibling analysis in the Crump et al. cohort study hypothesized That Such an outcome was not due to genetic factors and early life environmental exposure.[31,32]

6. GESTATIONAL DIABETES

Insulin sensitivity changes are part of the physiological adaptation to normal pregnancy. Insulin sensitivity increases in early gestation, promoting glucose uptake to store energy for the later stages of pregnancy. As pregnancy progresses, increases in local and placental hormones cause a shift towards insulin resistance. Blood glucose levels become slightly elevated to promote glucose transfer to the growing fetus. Glucose homeostasis is maintained by hypertrophy and hyperplasia of the pancreatic B-cells, and increased glucose-stimulated insulin secretion. Approximately 80% of GDM cases are caused by beta-cell dysfunction on a background of chronic insulin resistance, compounded by the physiological insulin resistance of pregnancy.[32] This pathophysiology is similar to that of T2DM, and there has been some debate about whether they should be considered part of the same disease spectrum. The remainder of cases are attributed to evolving

autoimmune diabetes and other [32] GDM is associated with an almost 10-fold higher risk of developing T2DM (RR 9.51 [95% CI: 7.14–12.67]) compared to normoglycemic pregnancy. Diabetes of any cause is a risk factor for CVD.[32]

7. SYSTEMIC LUPUS ERYTHEMATOSUS (SLE)

The initial manifestation of systemic lupus erythematosus predominantly occurs before the age of 30 years. Prevalence is estimated to be 55 per 100,000 in the Female population. The incidence of fetal, maternal, and obstetric complications is significant; in addition to Preterm birth and growth restriction, these include Preeclampsia and thromboembolic disease . Disease activity is one of the most important risk factors. For example, the likelihood of preterm birth rises from 5.5% to 33.3% in the case of active systemic lupus Erythematosus . The risk is also increased in the case of positive antiphospholipid antibodies (aPL) and lupus nephritis. The likelihood of Flares rises by 60% in pregnant compared to non-pregnant patients. How good the chances Are for a pregnancy with few complications in stable Systemic lupus erythematosus is demonstrated by the PROMISSE study, in which 80% of pregnancies had an Uncomplicated course and severe flares occurred in Only 5% of cases . The special fetal aspects resulting from the detection of autoantibodies to the ENA Antigens SS-A/Ro and SS-B/La are explained in the Section “Fetal monitoring” as well as in . The same applies to women with primary or secondary Sjögren’s syndrome , Antiphospholipid syndrome develops in the setting of systemic lupus erythematosus in approximately 20% of affected individuals. Antiphospholipid antibodies are associated with a higher risk of thrombosis And obstetric complications, most notably late miscarriage and placental insufficiency. Depending on the Clinical and serological constellation, treatment consists of acetylsalicylic acid (ASA) and/or heparin Pregnancy in systemic lupus erythematosus should Be planned after 6–12 months of absent or mild disease activity. During the preconception phase, treatment should be reviewed and an acceptable immunosuppressive therapy either continued or switched to in Order to maintain remission. After a change in medication, tolerance and efficacy needs to be followed-up For 6 months. Hydroxychloroquine should always be Continued or, if not contraindicated, newly initiated. Low-dose ASA for preeclampsia prevention is recommended in all patients.In the case of renal involvement, it is best to plan Pregnancy during inactive lupus nephritis (at least 6 Months), namely, proteinuria <0.5 g/day, normal renal Function, and normal blood pressure. In pregnancy, Active nephritis is sometimes challenging to distinguish from ppreeclampsia, since an increase in proteinuria and blood pressure can be suggestive of both. Here, for example, evidence of erythrocyturia, a fall In complement, and symptoms typical of systemic Lupus erythematosus

should be considered. Acceptable immunosuppressive treatment should also be Continued in this situation in order to maintain Remission.[33]

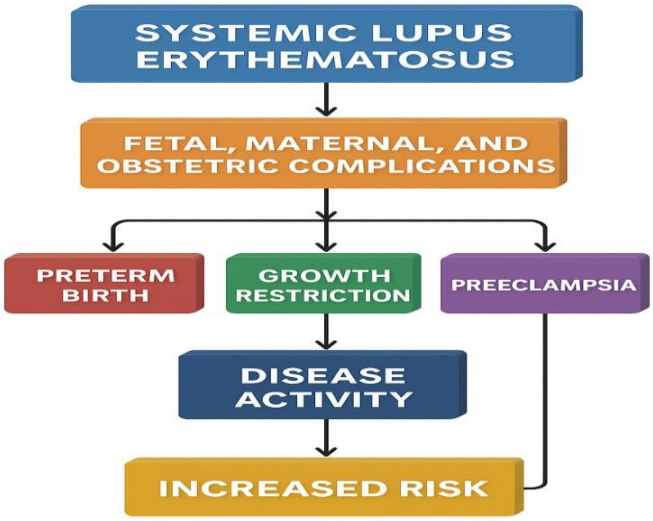


Fig . Systemic Lupus Erythematosus

8. ANTIPHOSPHOLIPID SYNDROME (APS)

The risk of thrombosis among women with antiphospholipid antibodies may be increased . Thrombosis is presumed to cause many of the pregnancy complications associated with APS. The most common obstetric manifestation of this syndrome is recurrent miscarriage. Recurrent miscarriage occurs in about 1% of the general population attempting to have children . About 10-15% of women with recurrent miscarriage are diagnosed with antiphospholipid syndrome . Fetal loss (≥10 weeks of gestation) is more strongly associated with aPL than are earlier pregnancy losses . Lupus anticoagulant has been strongly associated with recurrent miscarriage before the 24th week of gestation . Overall, approximately half of aPL-associated pregnancy losses occur in the first trimester (pre-embryonic and embryonic loss, < 10 weeks of gestation). The diagnosis of APS should be made only with three or more consecutive losses in the absence of other identifiable etiologies.

Treatment: The optimal treatment of pregnant women with antiphospholipid antibodies and 1 or more fetal losses after 10 weeks' gestation without thrombosis is controversial.[34]

9. RHEUMATOID ARTHRITIS (RA)

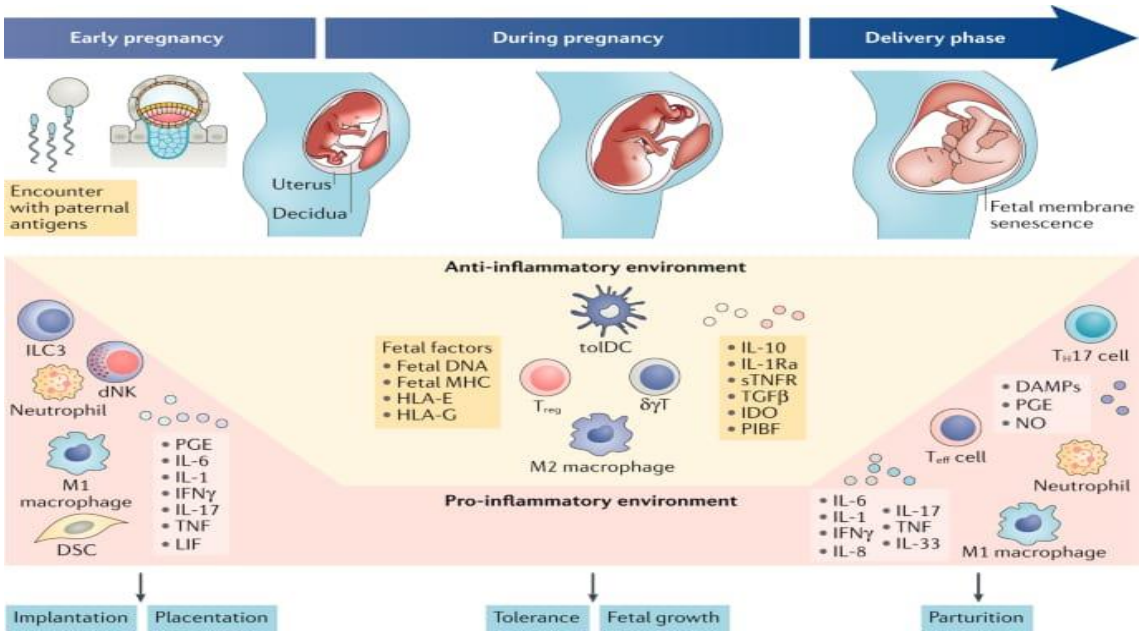


Fig Rheumatoid Arthritis (RA)

Childbearing age is around 0.2%. Rheumatoid Arthritis women are at a one-and-half to Two-fold risk of hypertensive complications during pregnancy (710%), fetal growth retardation (1520%), preterm birth (1012%), and Cesarean Delivery (2042%), despite parity control (16, 17). The rate of venous thromboembolism is two to four times higher than in healthy pregnant women (0.2 -0.4%). The disease activity and increased doses of glucocorticoids have been linked to preterm birth and growth restriction Rheumatoid arthritis activity has been shown to respond well to pregnancy. Validated instruments were used to assess disease activity, in which 4860 percent of previously active rheumatoid arthritis women showed indications of improvement during pregnancy (18). After birth, 3950% had a flare. Among the women who want to be pregnant, they should conceive during a period when there is no or low activity of the disease and, where possible, they should continue taking the maintenance therapy that does not affect pregnancy and also lactation since soon after birth the risk of flares is high (19). Pediatric long-term sequelae in case of the disease of a mother are not known.[33]

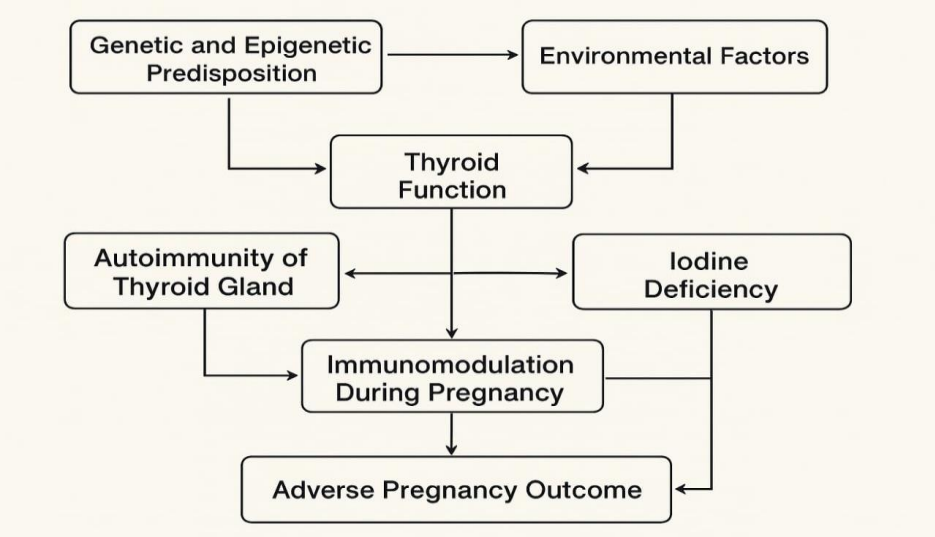
10. SYSTEMIC SCLEROSIS (SSC)

Systemic sclerosis (SSc) is a rare systemic autoimmune disease that can influence reproductive health. SSc has a strong female predominance, and the disease onset can occur during fertility age in almost 50% of patients. Preconception counseling, adjustment of treatment, and close surveillance during pregnancy by a multidisciplinary team, are key points to minimize fetal and maternal risks and favor successful pregnancy outcomes. The rates of spontaneous pregnancy losses are comparable to those of the general obstetric population, except for patients with diffuse cutaneous SSc and severe internal

organ involvement who may carry a higher risk of abortion. Preterm birth can frequently occur in women with SSc, as it happens in other rheumatic diseases. Overall disease activity generally remains stable during pregnancy, but particular attention should be paid to women with major organ disease, such as renal and cardiopulmonary involvement. Women with such severe involvement should be thoroughly informed about the risks during pregnancy and possibly discouraged from getting pregnant. [35]

11. AUTOIMMUNE THYROID DISEASE (AITD)

The complex network of factors that influence thyroid function and pregnancy outcome. Both thyroid function and a successful pregnancy are influenced by genetic and epigenetic predispositions as well as environmental factors that, when out of balance, can lead to AITD and an adverse pregnancy outcome. Immunomodulation during pregnancy, which is necessary for a successful pregnancy outcome, also affects thyroid function, especially in the presence of AITD. On the other hand, autoimmunity of the thyroid gland can affect the normal immunological changes and the outcome of pregnancy. As iodine deficiency is preventable and can be avoided by adequate iodine supplementation during and before pregnancy, the importance of developing an effective strategy to avoid iodine imbalance becomes clear. Recent surveillance studies have shown that pregnant women have become moderately iodine deficient over the past decade . Similar studies from various countries, including Australia , the United Kingdom , Spain , the Netherlands and the United States , have also reported iodine deficiency in pregnant women. This global concern regarding maternal iodine supply has attracted much attention. Recent research in Shanghai also confirms that current iodine intake in pregnant women is inadequate .[36]



12. TYPE 1 DIABETES MELLITUS (T1DM)

Risks: Women with preexisting diabetes face a substantially higher risk of adverse pregnancy outcomes compared with those without diabetes. These include increased rates of preeclampsia, preterm delivery, congenital anomalies, and neonatal complications. The degree of risk is closely linked to first-trimester HbA1c levels and the presence of diabetic nephropathy, underscoring the importance of optimal metabolic control before conception.

Pathophysiology: T1DM Is caused by an immune-mediated destruction of insulin-producing β cells, located in the pancreatic islets of Langerhans. Although the exact cause of this disease still eludes scientists, it is known that a general inflammatory state, termed insulitis, precedes overt diabetes. During this state of inflammation, macrophages, B lymphocytes, CD4+, and CD8+ T lymphocytes can be seen to infiltrate the islets of Langerhans. A complex cycle of antigen presentation and propagation leads to an eventual accumulation of CD8+ lymphocytes, and gradual destruction of insulin-producing β cells.5 This decline in β-cell mass eventually leads to an insulin-deficient state, causing hyperglycemia in the affected patient. Pregnancy itself is usually regarded as a diabetogenic state in which postprandial glucose levels are elevated and insulin sensitivity is decreased. Classically, the decreased response to insulin activity observed in pregnancy has been attributed to increases in hormones such as cortisol, progesterone, estrogen, prolactin, and human placental lactogen. Most recently, new molecules such as leptin, tumor necrosis factor-α (TNF-α), and resistin have been implicated in this matter. Kirwan and colleagues showed that TNF-α is the strongest independent predictor of insulin sensitivity during the late gestational period. In vitro studies showed that TNF-α disrupted insulin signaling and inhibited glucose uptake. This study attributed the rise of TNF-α to increased placental production with advancing gestational age.

Management: Low-dose aspirin is recommended to reduce the risk of preeclampsia, and women should be screened and managed for microvascular complications such as retinopathy and nephropathy to optimize maternal and fetal outcomes.[37]

13. MULTIPLE SCLEROSIS (MS)

Pregnancy is still a major concern for the majority of woman diagnosed with MS. Recently, an Italian study investigated childlessness in female MS patients (N = 303) and age-matched controls (N = 500) once they reached the end of their reproductive period (>43 years of age). Sixty-seven MS women (22%) were childless compared with 66 controls (13%). The most cited reason for childlessness was lack of stable relationship followed by no childbearing desires. Female MS patients and age-matched controls had their first child at the same age (27 years of age) and the study did not suggest impaired fertility in women with MS.

Inactivated vaccines, e.g. seasonal influenza and tetanus, can be used safely at any stage during pregnancy. Vaccines with bacteria (Bacillus Calmette–Guérin (BCG), typhoid) and those with attenuated viruses (measles mumps-rubella, varicella/zoster and rotavirus) are safe during preconception and in the last trimester of pregnancy. If needed, polysaccharide pneumococcal and hepatitis B vaccination may be used during pregnancy. However live-virus vaccines (e.g. yellow fever) should be avoided in pregnant women with MS.[38]

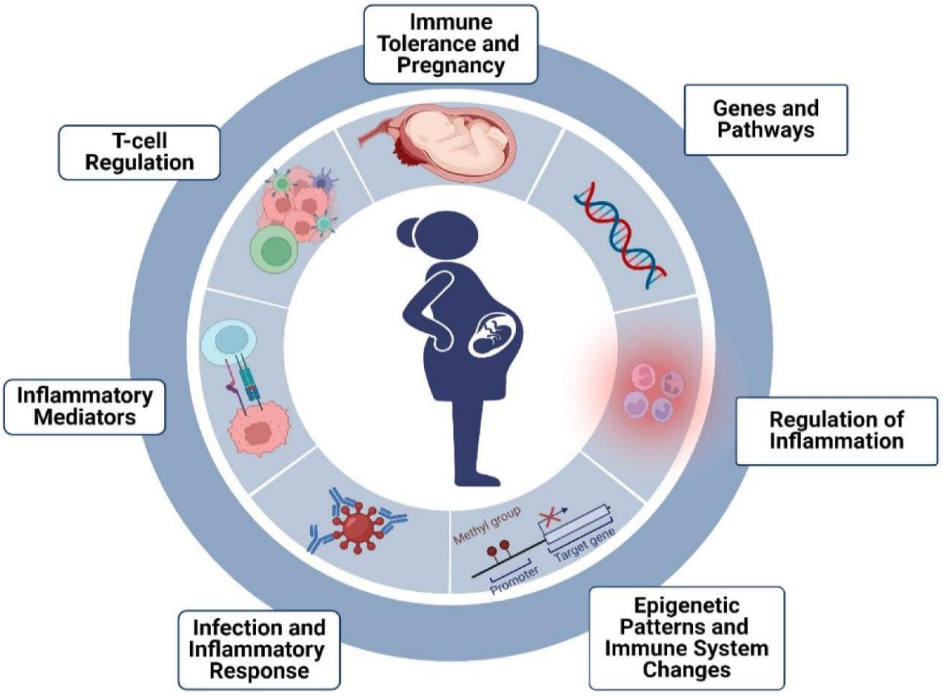


Fig. Multiple sclerosis

14. MYASTHENIA GRAVIS (MG)

There is a bimodal age distribution of myasthenia gravis with Two peaks (in the third decade and past the Sixth decade) with mostly females as affected persons in the younger age group. A Generalized and an ocular form are distinguished with the latter being associated with a Better prognosis. Mooted is an increased risk of preterm birth, otherwise it cannot be said that pregnancy complications are increased. A recent study in the US of insurance statistics indicates a higher number of Respiratory complications in the mother and higher hospitalization (healthy women: 0.1; women with myasthenia gravis: 2.26) was found. The pregnancy course of the myasthenia gravis disease is different in many cases. Although the Condition is stable in the majority of pregnant women, it Can also exacerbate, and in a minor proportion of women Even improve. Progression during pregnancy and/or the postpartum period. Myasthenia crisis during pregnancy must be addressed In line with general principles of treatment, e.g. intravenous immunoglobulins or plasmapheresis, and an Interdisciplinary team should

consider handling this as an emergency. A minimum effective dose of steroids should be chosen in the general treatment of Myasthenia gravis. Management of magnesium for preeclampsia in the affected pregnant women may result in a serious exacerbation. Close collaboration between the specialists in the sphere of neurology, fetal and maternal Medicine and neonatology must be established in the case of active Disease in order to identify, diagnose and differentiate the symptoms and Complications associated with maternal disease. Vaginal delivery is also indicated in women With myasthenia gravis but mode of Delivery in this case must be based on the general state i.e. no tender of Respiratory/moto fatigue, smooth muscle fibre and therefore uterine contractions. But, Muscular or even respiratory fatigue can be experienced during the labor process, which can force the vaginal operative labor or cesarean section. Regional anesthetic techniques Should be used wherever possible. Epidural anesthesia can also be done. Some medications, including several of the antibiotic Classes and benzodiazepines, are aggravating Myasthenia gravis and are not to be taken (Box). In myasthenia Gravis, the transplacental Passage of pathogenic antibodies is described as causing special fetal aspects that are described in the section Fetal monitoring.[33]

15. CELIAC DISEASE (CED)

Celiac disease (CD) is an immune-mediated enteropathy induced by the consumption of foods comprising of gluten, the only treatment of which is a gluten-free diet (GFD) throughout life. It is believed that its prevalence is 1% or more in the general population, even though in many regions it has not been diagnosed in fewer than 5%. It was traditionally considered a disease with mainly gastrointestinal symptoms with children below 2 years, but the epidemiology of CD has changed so that most people are now presenting as adults with varied symptoms in their 4-5 decade life trio range, which explains the prevalence of missed diagnoses. CD is a disease that is mostly identified in women. The prevalence of CD is higher in women as compared to in men, but is also associated with the fact that women access healthcare services more than men do. In the majority of the present population, 60-70 percent of the diagnosed CD patients are women.[39]

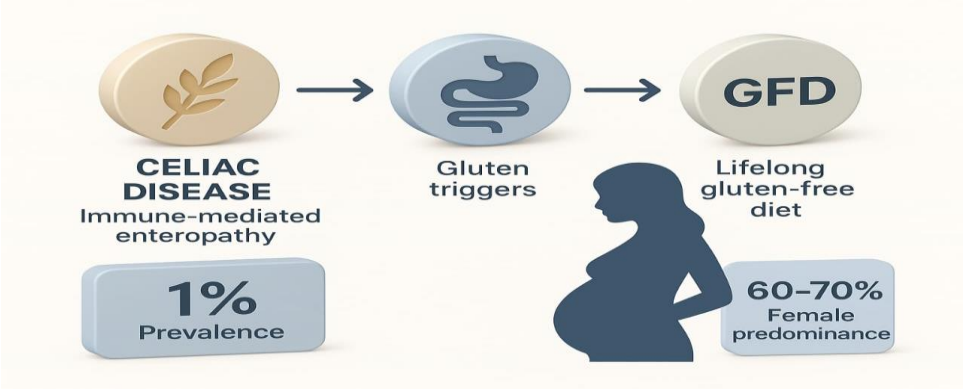


Fig. Celiac Disease

Role of pregnancy and hormones in the onset of autoimmune diseases

Pregnancy results in an influx of hormonal and bodily changes, with hormonal changes continuing until at least one-year post-pregnancy. Such changes serve as a trigger for the development of autoimmune diseases. There are various physiological changes that occur during pregnancy, such as increased basal metabolic rate, lipid levels, and weight gain. Pregnancy will also induce various changes in the levels of hormones such as estriol, progesterone, and prolactin. The fetus, containing foreign antigens, relies on the mother to serve as its host, resulting in immune changes that tend to cause a suppression of the maternal immune system. This is believed to be carried out in order to prevent rejection of the fetus but leads to a suppressed immune system, which can certainly trigger the onset of autoimmune diseases. Hormonal changes will also occur during the post-partum period leading to an increased incidence of certain autoimmune diseases, such as rheumatoid arthritis. A study found that in the post-partum, there is significant rise in the incidence of rheumatoid arthritis cases having an incidence rate ratio of 1:7 in the 24 months after delivery. A cohort study done by various doctors published in the Journal of Rheumatology revealed a high risk of developing rheumatoid arthritis in the first-year post-partum [OR = 3.8 (95% CI: 1.5, 9.9)] in comparison with subsequent years (P = 0.004) . The amplified risk of rheumatoid arthritis was at its highest during the first three months [OR = 5.6 (95% CI: 1.8, 17.6)] and had decreased during the following nine months [OR = 2.6 (95% CI: 0.8, 7.9)] . The changes in hormone levels in females going through puberty increases their risk of developing autoimmune diseases. A study was conducted in Taiwan to indicate the vast difference in the likelihood of developing an autoimmune disease such as SLE for girls rather than boys. This epidemiological study had indicated a substantial increase in the prevalence of juvenile SLE amongst Taiwanese girls in comparison to boys who were of the same age. The prevalence of SLE in girls at the age of one was 0.65 per 100,000 children, which increased to 6.7 per 100,000 at age seven and eventually to 34.6 per 100,000 at age fifteen. For boys, the prevalence was almost zero per 100,000 at ages 1 and 7, and to 7.8 per 100,000 at age 15. It is also found that for multiple sclerosis, its pubertal onset is rare, with only 3% to 5% of cases reported for individuals under the age of 18. After the onset of puberty, there is an increase in incidence with pubertal girls found to be at a greater risk for developing multiple sclerosis than pre-pubertal girls. Such reports suggest that the hormonal changes which occur during pubertal development could be an underlying factor in the gender disparity of autoimmune diseases. Evidence has shown that the changing hormonal climate which occurs during the menopausal transition plays a role in the increased susceptibility of pre and post-menopausal women to autoimmune diseases due to its effect on inflammatory processes. For instance, in women around 50

years of age, the neutrophil percentage dropped, whereas lymphocyte percentage rose, thereby subject in thereby subjecting premenopausal women to an increased risk of lymphocyte mediated autoimmune diseases. Autoimmune diseases such as rheumatoid arthritis and SLE affect women over the age of 40 more frequently. It can be deduced that certain autoimmune conditions are more prevalent given the age and physiological state of the patient. For example, researchers are unsure as to why it has been shown that high levels of estrogen and progesterone are protective for disease activity in rheumatoid arthritis. Therefore, pregnancy would be considered protective against the risk of disease development, due to the increase in estrogen and progesterone levels. On the contrary, menopause and post-partum are often associated with disease worsening due to a drop in estrogen and progesterone levels. There is also a surge of female sex hormones during puberty such as estrogen. High levels of estrogen have been observed in the synovial fluid of patients who are affected by both SLE and rheumatoid arthritis. This is due to the action of aromatase on peripheral tissues. Inflammatory cytokines, such as TNFα, IL-1 and IL-6, which are produced by macrophages will stimulate the action of aromatase which in turn is responsible for the conversion of androgens (dehydroepiandrosterone [DHEA], testosterone, progesterone) into 17-β-estradiol. 17-β-estradiol then acts on immunocompetent cells, thereby activating the macrophages, resulting in a cycle that causes the production of pro-inflammatory cytokine production. [40]

FUTURE PERSPECTIVE

Emerging evidence suggests that certain pregnancy complications (notably pre-eclampsia, gestational hypertension, fetal growth restriction and some forms of pregnancy loss) are associated with a modestly increased risk of new-onset autoimmune disease later in life. Future research should prioritize large, prospective pregnancy-to-midlife cohorts with harmonized exposure and outcome definitions, longitudinal biospecimen banking for multi-omics and autoantibody discovery, and mechanistic studies linking placental pathology to systemic immune dysregulation. Analytic methods that address time-varying risk and confounding (including family-based designs) will improve causal inference. If robust predictive markers are identified, pilot intervention trials and validated clinical risk scores could enable targeted postpartum surveillance and secondary prevention. Greater inclusion of diverse global populations and integrated implementation research are essential to translate these findings into equitable maternal-health practice. [41]

CONCLUSION

Suffering adverse pregnancy outcomes not only leads to immediate maternal and fetal health, but also it increases the long-term susceptibility of a woman to noncommunicable disease, such as autoimmune disorders. This is a large population-based study with 1.7 million births where pregnancy

complications of preeclampsia, stillbirth and spontaneous preterm birth were linked with an increased incidence of maternal autoimmune disease 19 years after delivery and with the highest risk observed in the first three years after delivery. These risks were usually leveled off but they were high with time. The results suggest that the pregnancy history should be acknowledged as a female risk factor in the screening and clinical evaluation of autoimmune diseases. Optimal screening windows and evidence-based preventive actions would help to enhance long-term health outcomes among women who have had pregnancy complications.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

A REVIEW ON HERBAL EYE DROP FORMULATION IN TREATMENT OF DRY EYE DISEASE

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ABSTRACT

We have developed a herbal remedy for ocular conditions in our study. Due to the rapid advancement of human civilization, the number of ocular disorders is rising daily. Despite the availability of synthetic formulations, the demand for herbal alternatives is rising daily as people become more health conscious and aware of the possible risks associated with synthetic products. This demand is enough for the development of formulation. We have used herbs like Linum usitatissimum as its use is well known for reducing inflammation and other underlying issues. All required procedures were followed, and the formulation was manufactured in a sterile manner. To ensure safe and effective formulation, several pre-evaluations and post-evaluations of the product were carried out in accordance with the guidelines supplied by diverse publications. Dry eye syndrome (DES) is a preocular tear film condition that causes ocular surface damage and is linked to discomfort feelings. Other names for DES include keratoconjunctivitis sicca (KCS), keratitis sicca, xerophthalmia, dry eye disease (DED), ocular surface disease (OSD), dysfunctional tear syndrome (DTS), or just dry eyes. Linum usitatissimum L., Linseed, often known as flaxseed or common flax, is an annual plant belonging to the genus Linum that is primarily grown in cooler regions of Asia, Europe, and the Mediterranean [1].

KEYWORDS

Linum usitatissimum, Eye Drop, Ocular, Dry Eye.

INTRODUCTION

Medication delivery to the human eye is a crucial aspect of healthcare. One of the most fascinating and difficult positions for pharmaceutical chemists is ophthalmic medication delivery [2]. Eye design, physiology, and biochemistry render it very insensitive to foreign substances. Bypassing the eye protective barrier without inflicting irreversible tissue damage is a significant challenge for formulators. Ocular delivery systems with great treatment efficacy are still being made possible by newer, more sensitive diagnostic methods and the creation of innovative therapeutic compounds [3]. Mucins are glycosylated glycoproteins secreted by the stratified, nonkeratinized squamous cells that comprise the epithelium of the cornea and conjunctiva. Because they produce the glycocalyx, which lubricates the mucosal barrier and aids the aqueous layer in adhering to the hydrophobic cornea, mucins are essential for preserving the integrity of the tear film.

Topical administration is the most straightforward and minimally intrusive way to administer drugs to the anterior area of the eye [4]. As a result, eye drops—which make up 90% of the commercially available products in the global ophthalmic medication market—are the recommended treatment for a variety of ocular conditions, including infection, inflammation, glaucoma, dry eye, and allergies. However, the main disadvantage of topical treatment remains its extremely low efficacy. Drug distribution through the anterior segment is limited and has low bioavailability because of the unique physiology and anatomy of the eye [5]. Multiple daily injections and localized eye irritation may limit their clinical utility. Increasing topical absorption and reducing eye irritation can improve the clinical efficacy of aqueous eye drop formulations. Prior studies have shown that acidic eye drop solutions, as opposed to neutral ones, improve the transport of dorzolamide and closely related CAIs into the eye. The eye is the most important organ because of its characteristics for drug disposal. Topical administration is usually preferred for eye diseases over systemic administration since any drug molecule taken through the ocular route must first pass through the precorneal barriers to reach the anatomical barrier of the cornea. The initial barriers that stop an active chemical from swiftly entering the eye are the conjunctiva and tear film. When the drug is taken, it activates physiological processes including tear formation that serve as a barrier against ophthalmic drug transport. The most common way to administer medication to the eyes is by directly applying the ocular formulation to the eye's surface. Eye drops are the most widely used formulation for anterior segment illnesses; however, tears quickly eliminate them 0.5 to 1 minute after application. Consequently, a medication effect on the surface of the eye is only temporary [6].

Advantages of Eye Drop [7]:

a. Compared to other dosage designs, it is cost-effective and simple to make.
b. It is possible to improve the ophthalmic solutions' dosage consistency.
c. enhanced bioavailability in the eyes.

Quality [8]:

Eye Drop must:

1. Boost the ratio of systemic to local effects.
2. Be easy to manage yourself.
3. does not leave a lasting blurring, an unpleasant aftertaste, or a foreign body sensation.
4. possess the ability to use a recognized process for industrial-scale sterilization.
5. It is not recommended to rely on "exotic" components such as new chemicals or difficult-to-find excipients (unless this is a critical component). Excipients should preferably have a drug master file and a history of safe human use.

6. be appropriate for packaging or a potent antimicrobial preservative.
7. be suitable for packaging or a strong antibacterial preservative.

Anatomy of Eye:

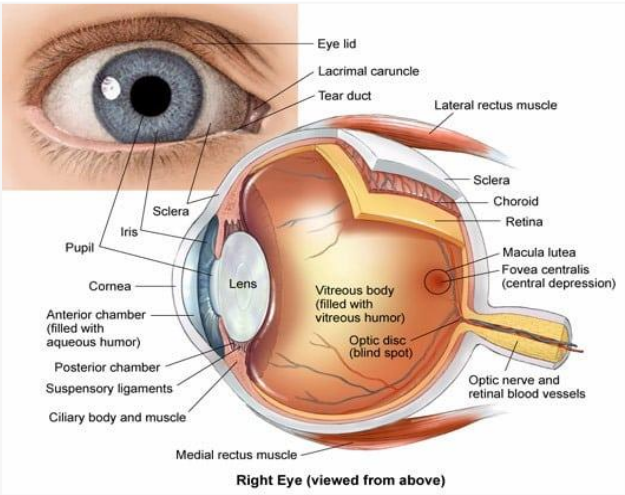

Fig: Anatomy of Eye (Viewed from right) [9]

Dry Eye Disease:

Dry eye syndrome (DES) is a preocular tear film condition that causes ocular surface damage and is linked to discomfort feelings [10]. Other names for DES include keratoconjunctivitis sicca (KCS), keratitis sicca, xerophthalmia, dry eye disease (DED), ocular surface disease (OSD), dysfunctional tear syndrome (DTS), or just dry eyes. Keratoconjunctivitis The literal translation of the Latin word sicca is "dryness of the cornea and conjunctiva." The fact that "sicca" is a component of the English term "desiccate" may be useful. "Sjogren's syndrome" is another name for dry eye condition, which is characterized by insufficient tear production [11].

The hallmark of dry eye illness is tear film instability, which can be brought on by either inadequate tear production or poor tear film quality, which causes more tears to evaporate. Dry eye therefore can mainly be divided into two groups, namely, [12]

1. Aqueous production of deficient dry eye disease.
2. Evaporative dry eye disease

Insufficient tears are linked to discomfort symptoms and harm the interpalpebral ocular surface. According to the International Dry Eye Workshop (2007), dry eye is a multifactorial disease of the tears and ocular surface that causes discomfort, disruption of vision, instability of the tear film, and possible ocular surface injury. It is accompanied by irritation of the ocular surface and an increase in the osmolarity of the tear film. DES is linked to a reduction in the capacity to carry out tasks requiring visual concentration, such as reading, driving, and computer-related employment. Patients' quality of life is

negatively impacted by persistent and severe dry eye problems. DES is a prevalent eye condition that affects a sizable portion of the population, particularly those over 50. Due to the high frequency of contact lens use, systemic medication side effects, autoimmune disorders, and refractive operations, middle-aged and older persons are the most often impacted demographic.

Fig: Dry Eye Disease [13]

Dry eye is known to result from the lachrymal functional unit being disrupted. The ocular surface, which includes the cornea, conjunctiva, eyelids, meibomian glands, ocular nerves, and goblet cells, makes up the lachrymal functional unit. There are three primary layers that make up the tear film. Conjunctival cells create the thinnest mucus layer, which is the innermost layer. The mucus facilitates the even spreading of the aqueous layer across the eye. The glands of the upper lids and the supplementary tear glands generate the middle aqueous layer, which is the thickest and biggest layer and essentially includes a very diluted saltwater solution [14].

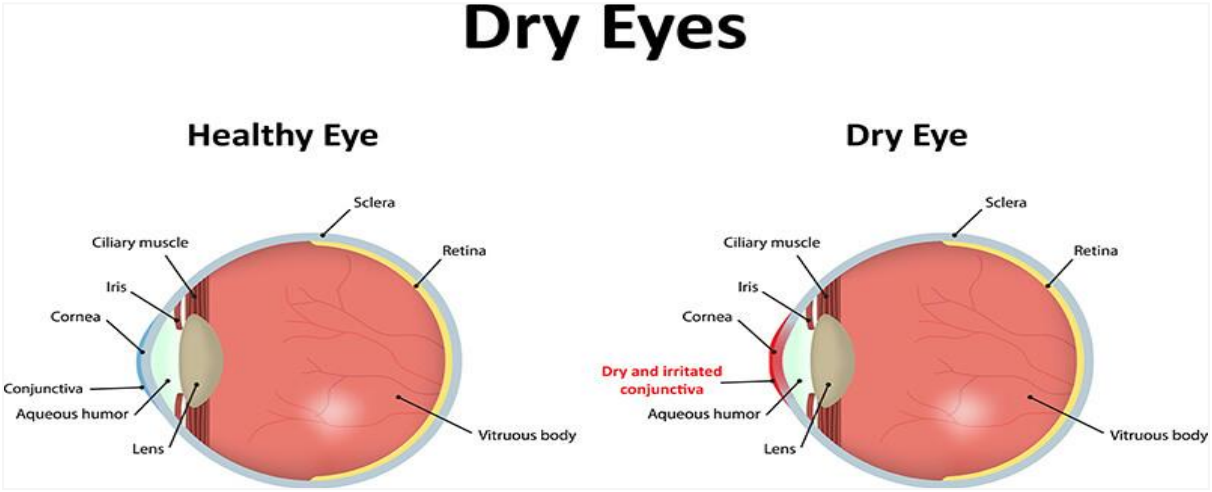

Fig: Dry Eye and Healthy Eye [15]

Reasons for DES included reduced tear production, increased tear evaporation, and aberrant mucus or lipid formation of the tear layer. Lemp's 1995 study divided KCS into two categories: evaporative dry eyes and tear deficient eyes.

MATERIAL AND METHOD

- **Linum usitatissimum:**

Fig: Linum usitatissimum [16]

Linum usitatissimum is the plant chosen for the planned investigation. Flax (binomial name: Linum usitatissimum) belongs to the genus Linum in the family Linaceae. It is sometimes referred to as common flax or linseed [17].

Taxonomy [18]:

- **Kingdom:** Plantae
- **Subkingdom:** Tracheobionta
- **Super division:** Spermatophyta
- **Division:** Magnoliophyta
- **Class:** Magnoliopsida
- **Subclass:** Rosidae
- **Order:** Linales
- **Family:** Linaceae
- **Genus:** Linum
- **Species:** usitatissimum

Components of flaxseed: Alpha-linolenic acid (ALA), cyanogenic glycosides (linamarin, linustatin, neolinustin), unsaturated fatty acids (linolenic acid, linoleic acid, oleic acid), lignans (secoisolariciresinol diglycoside (SDG)), monoglycerides, triglycerides, free sterols, sterol esters, hydrocarbons (protein), balast, and derivatives of phenylpropane.

Components of flax root: The roots of *L. usitatissimum* contain measurable concentrations of lignans and isoflavones. It also includes acetic acid, chlorides of calcium, magnesium and potassium, fixed oil, linamarin, glucoside, mucilage, phosphate, resins, sugar, sulphates, wax, etc.

Components of flaxseed oil: Alpha-linolenic acid (ALA), unsaturated fatty acids (linolenic acid, linoleic acid, and oleic acid).

Uses:

- **Anti-Inflammatory Effects:** The omega-3 fatty acids in flaxseed oil help decrease inflammation on the ocular surface, a key factor in the development and progression of dry eye symptoms [19].
- **Tear Film Stabilization:** The lipid layer of the tear film, which is frequently lacking in evaporative DED, is replenished by flaxseed oil, a lipid-based substance. This maintains the surface of the eyes moist and lessens the evaporation of tears.
- **Adjunct Therapy:** These eye drops are frequently used in addition to other dry eye remedies, and they may provide better therapeutic results when paired with conventional artificial tears or oral flaxseed oil supplements.

Extraction Process for Linum usitatissimum:

Soxhlet Extraction: Linum usitatissimum (flaxseed) is extracted using the Soxhlet method, which involves placing the ground seeds in a thimble and inserting it into the Soxhlet apparatus. The apparatus consists of an extraction chamber, a condenser, and a boiling flask filled with a solvent such as ethanol or hexane. The flaxseed oil is dissolved and extracted while the solvent cycles through the thimble while boiling and condensing. The collected oil-containing solvent is separated after a predetermined amount of time, and the extracted oil is obtained by evaporating the solvent [20].

Material:

Sr. No.	Ingredient	Activity
1	Linum usitatissimum	Anti- Inflammation
2	Sodium Chloride	Vehicle
3	Monobasic Sodium Phosphate	P^H Adjuster
4	Dibasic Sodium Phosphate	P^H Adjuster
5	Phenyl ethyl alcohol	Preservative

Method:

1. The production of distillate, making the distillate isotonic to lacrimal fluid, adjusting pH, adding preservative, and packing under sterile conditions are all steps in the step-by-step development of eye drops.

2. The extract of Linum usitatissimum was taken and NaCl (Sodium chloride) was added as a vehicle.
3. The distillate was made isotonic to lacrimal fluid by adding NaCl to distillate and dissolving properly and adding isotonic phosphate buffer of monobasic Sodium phosphate and dibasic Sodium phosphate.
4. Lastly, the eye drops' pH was brought down to 6.9–7.30. After adding phenyl ethyl alcohol as a preservative, the pH was once more measured and determined to be within the ophthalmic drops designated range (pH 6.9-7.30).
5. After adding the preservative, a sterility test was conducted and the preparation was monitored for 48 hours.
6. Ten milliliter amber glass vials that had been autoclaved and sterilized were used for packing.
7. The finished product was tested for quality assurance and safety and the analytical specifications complied specified parameters of Indian pharmacopeia for ophthalmic preparations [21].

Evaluation Test [22]:

1. Sterility Test:

A sterility test is carried out to detect the presence of a viable form of microorganism in the all-injectable preparation of each lot. Sterility is an absolute requirement for all ophthalmic formulations. There are two general methods for sterility testing:

1. Membrane Filtration method
2. Direct inoculation method

2. Clarity Test:

Foreign particles must be removed from ophthalmic solutions, which is often accomplished via membrane filter filtration. Clarity of the solution is another benefit of the filtration procedure. Particulate Matter: Particles that are visible upon eye inspection should be virtually absent from ophthalmic solutions. This test does not apply to ophthalmic medications that are gels, emulsions, or suspensions.

3. Tonicity/Iso-tonicity:

The word "isotonic" refers to an equal tone. When a solution's effective osmole concentration is equal to that of another solution, it is referred to as isotonic. If the concentration of solutes outside the cell is equal to the concentration of solutes inside the cell, the solutions on either side of a cell membrane in biology are said to be isotonic. Because there is no concentration gradient to cause the diffusion of

significant volumes of water across the cell membrane, the cell in this instance neither swells nor shrinks.

4. Viscosity

In an ophthalmic solution, a viscosity of 25 to 50 cps is typically preferred.

5. P^H Determination:

A pH meter with a glass electrode or pH test strips are used to measure the pH of an ophthalmic solution. The pH of ophthalmic solutions is important for ocular comfort; an ideal range for eye drops is 6.5–7.8 to match the pH of natural tears (around 7.4) and prevent discomfort.

CONCLUSION

The conclusion demonstrated that Dry eye syndrome (DES) symptoms were alleviated with eye drops containing Linum usitatissimum. Therefore, it is advised that individuals with Dry eye syndrome take Linum usitatissimum eye drops and suppress the inflammation and give lubricated eyes.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

A REVIEW ON NANOMATERIAL

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ABSTRACT

Nanomaterials with unique mechanical, optical, and electrical properties have led to their widespread use in pharmacology and medicine. Nanomaterials are used in novel treatments, biological molecule detection, and disease tissue imaging. Miniaturization biosensors are made possible using nano-based particles (1–100 nm), which allow for the use of smaller samples for various biochemical analyses and point-of-care diagnostics. In drug delivery systems, nano pharmaceutics are tuned to maximize the drug's bioavailability at the target site. Diagnostic compounds based on nanoparticles have recently been developed to treat conditions like diabetes, cancer, and allergies. In this review article, we provide an overview of the most recent advancements in less toxic and more effective nanomaterials that are useful in the fields of tissue engineering, disease therapy, imaging systems, diagnosis, and drug delivery.

KEYWORDS

Nanoparticles, Medicine, Drug delivery, Nanomachinery, Tissue Engineering.

INTRODUCTION

Nanotechnology is an interdisciplinary field that creates new technological eras by bridging disciplines like physics, chemistry, engineering, and medicine through biology [1]. The study of particles at the nanoscale, or one thousand millionth of a meter, is known as nanotechnology. Because the nanoscale range exhibits different qualities from the big size, researchers are exhibiting interest in it. Since it governs the physical and chemical macroscopic qualities, the interaction between individual molecules and groups of molecules about its bulk macroscopic properties was taken into consideration at the nanoscale. The most important use of nanotechnology is "nanomedicine," which uses the molecular understanding of the human body to diagnose, prevent, and treat diseases at the molecular level [2]. The importance of the most recent nanoscience technologies that can be used in the medical field is discussed in this article. Nanoparticles can be modified to display a range of sizes, forms, and surface properties, which subsequently allow for exceptional optical, electronic, magnetic, and biological uses. Nanomaterials were employed in drug delivery, gene transfer, pathogen and protein detection, DNA

structure analysis, tissue engineering, tumor identification, and the purification of biological molecules [3].

Nanomachinery:

The long-term objective of nanomedicine research is the development of nanomachinery. This endeavor focuses on characterizing quantitative molecular-scale components [4]. A comprehensive understanding of cellular mechanisms, along with early diagnosis and treatment, constitutes the essential aspects of nanomachinery. The creation of nanomachines and nanorobots is a captivating area within advanced nanotechnology. Researchers have been greatly intrigued by their unique features, functions, and abilities to perform a wide range of tasks. These characteristics have led to significant applications in nanomedicine and healthcare, such as medical diagnostics, drug delivery, chemotherapy, and even environmental remediation [5].

Nano imaging:

Quantum dots, commonly referred to as Q dots, are a well-known type of semiconducting nanocrystals [6]. When exposed to ultraviolet light, the electrons within these Q dots become excited, causing a transition between two energy levels. As the electrons return from the excited state to the ground state, they emit energy in the form of fluorescent light. The energy difference between these states is solely dependent on the size of the Q dots. A broad spectrum of different colors is utilized to locate and identify various cells and biological activities. Quantum dots are highly effective detectors, capable of detecting at least ten times more than organic fluorescent molecules [7]. However, due to concerns about their toxicity, they are currently used only in vitro research diagnostics. Iron oxide nanoparticles coated with peptides can enhance cancer treatment and Magnetic Resonance Imaging (MRI) scan images. The use of FDA-approved iron oxide nanoparticles can also improve liver imaging. Gold nanoparticles are a significant nanomaterial utilized in vitro diagnostics and cancer treatment. Additionally, they are used in ovulation tests, rapid pregnancy tests, and for detecting flu viruses and human immunodeficiency viruses (HIV). The molecular biological processes that take place during an underlying disease can be seen with the aid of molecular imaging. This offers a fundamental basis for creative nanoprobe design. These nanoprobes have enormous potential to enhance biomarkers' sensitivity and signaling in human diseases. Additionally, they can provide accurate details at the cellular level and have good resolutions [8].

Tissue engineering:

The primary objective of tissue engineering is to improve tissue engineering's competitiveness by offering effective control over the delivery of cells [9]. To improve and enrich the biological functionalities of encapsulated pharmaceuticals and cells, biomaterials are being employed at the

nanoscale with controlled organizations. The nanomaterials known as nanofiber-based scaffolds were shown to be advantageous for cell adhesion, growth, and proliferation because of their high surface area to volume ratio and wide range of pore size distribution [10]. This offers a solid foundation for future tissue-engineering optimization of an electrospun nanofibrous scaffold. The scaffold has been extensively utilized in the integration of gene delivery to improve the interaction between cells. The normal growth of tissues is maintained by the transport of genes to specific places, which introduce signals to cells in a temporal and geographical manner. Therefore, the therapeutic genes were used to speed up tissue growth and absorption with surrounding tissues. Gene delivery using biopolymers was able to serve as both structural scaffolds for tissue engineering applications and DNA complexing agents. Tissue engineering and gene therapy were used to create a novel regeneration of medicine treatment [11].

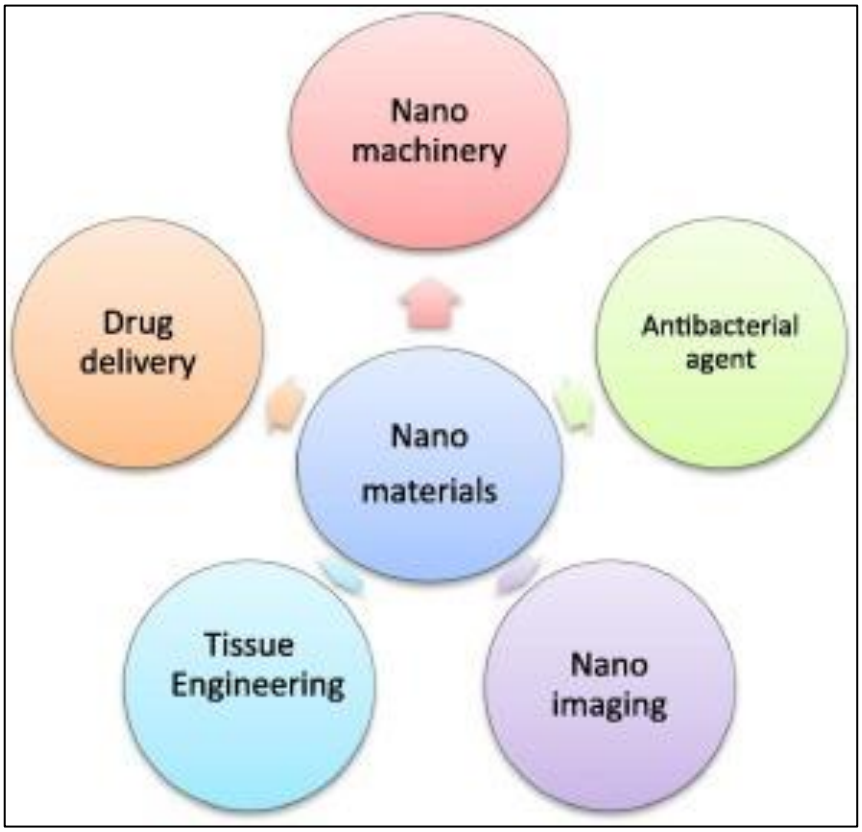

Fig: Approaches of nanomaterials in different fields

Drug Delivery:

Polymer or solid fat nanoparticles can be used to transport a variety of compounds, whereas inorganic materials are not an option [12]. There is less opportunity to use additional particles, particularly inorganic ones. During the 1970s, anti-tumor drugs, proteins, and peptides were transported via

polymer nanoparticles. Nanoparticles of fat, dendrimers, fullerenes, and nanocrystals emerged later in the mid-1990s [13]. The development of suitable techniques to improve the delivery systems' selectivity for target cells and to more effectively transfer active ingredients to the destination inside the cell presented some challenges despite the promising future of drug delivery systems. Inadequate control over the bioavailability of active ingredients in the target tissue is another barrier. Because of their large surface area and ability to absorb, carbon nanotubes have been successfully used in medicine. They turned proven to be a great way to deliver medications straight into cells without going through the body's metabolism. A novel method known as gene therapy can be used to treat a variety of illnesses, including cancer, AIDS, and cardiovascular conditions. This technique involves introducing faulty genes that cause illness development into a patient's particular cells. Genes must be encapsulated to prevent macromolecule disposal and serum-induced gene breakdown until the gene reaches its destination [14]. There is a new substance that releases nitric oxide (NO) and is thought to have antibacterial and wound-healing properties. Because of its regulatory, protective, and harmful properties, researchers expressed interest in the design and synthesis of NO-donating medications and materials. The ability of the nanoparticles that release NO-scaffolds to store and deliver in a more controlled and efficient way makes them very promising [15]. They are applied as patches, wound dressings, and coatings for medical equipment that comes into touch with blood.

Nanoparticle as antibacterial agent:

The use of antibiotics to treat most bacterial illnesses transformed the medical field. Unfortunately, a lot of bacteria have adapted to avoid the antibiotics that are now in use. Antibiotic-resistant bacteria include Enterococcus faecium, Staphylococcus aureus, Klebisella pneumoniae, Acinetobacter baumannii, Pseudomonas aeruginosa, and Enterobacter species. Because of its unique characteristics, gold nanoparticles are used as antibacterial agents. The researchers expressed interest in creating gold nanoparticles and using them for medicine delivery and cancer treatment [16].

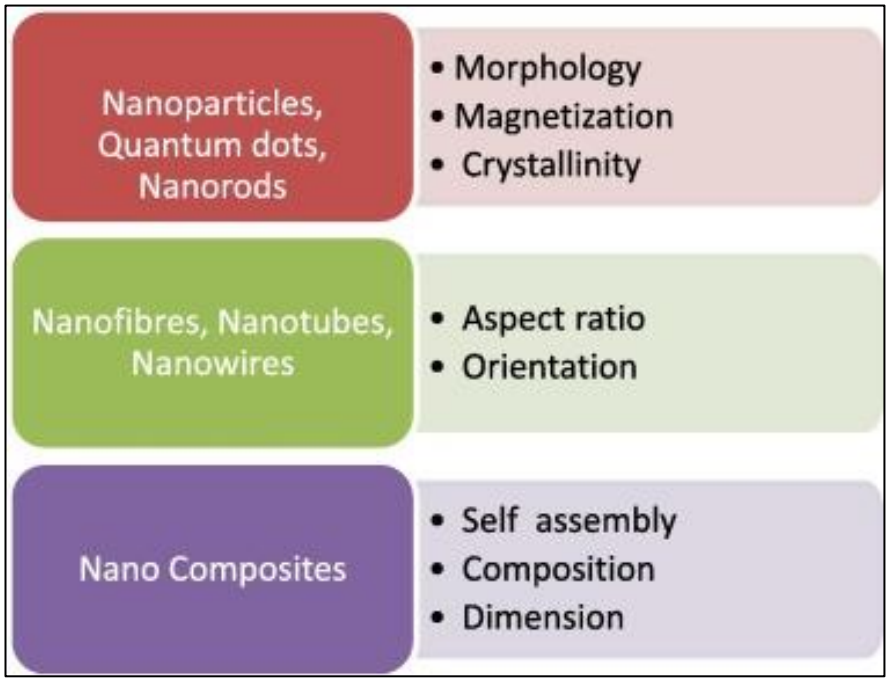

Fig: Properties of Nanomaterials

Based on the dimensions of nanoscale (<100 nm) they are classified as follows [17]:

1. Zero-dimensional nanomaterials (0-D): In this case, the nanomaterials' three dimensions are all inside the nanoscale range. It will include nanoparticles.
2. One dimensional nanomaterial (1-D): Any one of these dimensions will fall inside the nanoscale range, while the other two dimensions are outside of it. This class includes nanorods, nanotubes, and nanowires.
3. Two-dimensional nanomaterials (2-D): One dimension is outside the nanoscale range, while any two dimensions fall within it. These consist of nanocoating's, nanolayers, and nanofilms.
4. Three dimensional or bulk nanomaterials (3-D): These nanoparticles are not in the nanoscale range in any dimension. This indicates that they are larger than 100 nm in three arbitrary dimensions. These consist of bundles of nanowires, bundles of nanotubes, multi-nanolayers, nanocomposites, and core shells.

The nanomaterials are of different types based on their morphology, size, properties, and constituents. They are carbon-based nanomaterials, metal nanoparticles, semiconductor nanomaterials, polymeric nanomaterials, and lipid-based nanomaterials [18].

1. Carbon-based nanomaterials: The carbon is the primary component of these kinds of nanomaterials [19]. This category includes fullerenes and carbon nanotubes. In essence, graphene sheets that have been coiled into a tube are inserted into the CNTs. These can be

helpful for improving structural integrity and are far stronger than steel. There are two types of CNTs: single-walled and multi-walled.

Particles with a hollow cage structure and sixty or more carbon atoms are known as fullerenes. These are carbon allotropes. Its structure is arranged in a regular way and resembles a hollow football with pentagonal and hexagonal carbon particles [20]. They exhibit great strength, electron affinity, and strong electrical conductivity.

2. Metal based nanomaterials: Divalent and trivalent metal ions are the first components of metal nanomaterials [21]. Metal nanoparticles can be prepared using a variety of techniques, such as chemical or photochemical procedures. Metal ions are converted to metal nanoparticles by employing reducing agents. These have a large surface area and are good at adsorbing small compounds. They are extensively employed in environmental and bioimaging studies, among other fields of study. It is possible to achieve both a single nanoparticle and a mixture of two or more nanoparticles with size control. The primary element properties can be altered by doping several metals, including rare earth metals. Doping certain elements in various constitutions also causes their properties to change [22].
3. Semiconductor nanomaterials: There are metallic and non-metallic semiconductor nanomaterials properties. By altering it, they display huge band gaps. distinct qualities. These are frequently employed in photocatalysis and electronic gadgets. For instance, ZnS, ZnO, CdS, CdSe, CdTe, are related to group II-VI semiconductor materials [23]. GaN, GaP, InP, InAs are from Group III-V. Semiconductor graphene nanocomposites have recently drawn attention from researchers [24]. The semiconductor's chemical and physical characteristics can be enhanced by graphene. Materials with graphene composites and piezoelectric qualities can be used for gas sensitivity [25].
4. Nanocomposites: A polyphase solid material with one, two, or three dimensions less than 100 nm is called a nanocomposite [26]. In contrast to conventional composites, nanocomposites have a high surface to volume ratio. Like nanomaterials, there are various kinds of nanocomposites. The three varieties are Polymer Matrix Nanocomposites (PMNC), Metal Matrix Nanocomposites (MMNC), and Ceramic Matrix Nanocomposites (CMNC). In them, graphene-based polymer composites have seen significant development in recent years. The carbon moiety makes up graphene. The hexagonal matrix of carbon atoms in a single layer. It has a zero-band gap and electrons that are nearly massless, making it a suitable electrical medium in two dimensions. Graphene oxide (GO), the precursor to graphene, has an extremely low electrical conductivity. Therefore, superior outcomes with high conductivity are

obtained when GO is converted to reduced graphene oxide (rGO). The GO can be converted to rGO using a variety of techniques, including exfoliation, CVD, thermal reduction, chemical reduction, and multistep reduction. Metal oxide/grapheme and metal chalcogenide/grapheme nanocomposites are two of the various kinds of semiconductor graphene family nanocomposites [27].

5. Different properties of the nanomaterials: Nanomaterials smaller than 100 nm, which is the crucial size, exhibit Interest in them was sparked by their distinctive and intriguing qualities. These Nanomaterials differ from bulk materials in their characteristics. However, the macro-structured characteristics are the same as those of their bulk. As the particle size decreases, the quantity of particles on the surface face gets bigger. Surface atoms have a lower coordination number. They are therefore more mobile than inner atoms. According to the survey face property, we may use nanoparticles in a variety of sectors, such as adsorbents, nanoelectronics, functional coatings, catalysis, and sensors. At the nanoscale, the characteristics of excitation, emission, chemical reactivity, and stability also rely on size. In addition to size, shape was a significant factor in determining the nanomaterial property. Nanoparticles have quantum size effects when their diameter is smaller than the quasiparticle interaction, and their size is closer to the de Broglie wavelength limit. Controlling the size of nanomaterials during their production through various techniques allows for the modification and control of their properties. They can be used as catalysts since they have a larger surface area. Most metal nanoparticles are useful for catalysts. The following fields can employ nanoparticles by utilizing the surface phenomenon: The electronic band structure of a metal determines its electronic properties. The particle size affects the band's structure. The molecular states exhibit delocalized bands. The nanocrystal's band structure lies between the continuous bands of crystals and the discrete states of atoms (and molecules) [28]. The size of the particle determines the energy gap between the adjacent lines. The separation between energy levels rises as the size decreases. The metallic quality diminishes and eventually transforms into a semiconductor. Magnetic materials can be classified as dia, para, ferro, antiferro, or ferromagnetic. Based on their coercivity, magnetic materials can be classified as either soft or hard. A low magnetic field can magnetize the soft materials, which have a tiny hysteresis area and low coercivity. This contrasts with hard magnets. The size of the particles will affect coercivity. Coercivity and saturation magnetization typically rise with increasing surface area and decreasing particle size [29]. Thus, the nanoparticles exhibit strong magnetic strength and have a larger surface area with smaller grain sizes. Ferromagnetic particles

become paramagnetic materials due to instability if the particle size is further reduced. These paramagnetic materials are referred to be superparamagnetic since their behavior differs from that of bulk materials. Data storage capacity, electronic circuits, actuators, transformers, power generators, and many more can all benefit from the use of magnetic materials [30].

Applications of Nanomaterials:

Because of their magnetic, electrical, optical, and chemical properties, ferrite nanoparticles are virtually universally used in every field. They are used in both contemporary industry and the medical field. They are used in the fields of information technologies, biomedicine, wastewater treatment, and catalysis. They are employed as electrochemical, optical, piezoelectric, and magnetic field sensors and biosensors. They can be used in energy storage devices such as electrodes, which are helpful in making batteries and supercapacitors. They can also be used in audio and video recordings. They are also utilized in circulators, shifters, and isolators. They are also helpful in the dyeing and wastewater treatment industries [31].

In medicine for diagnosis and drug delivery: Nanotechnology has been used in medicine since 1965 [32]. They are useful in medical imaging because of their many unique characteristics. It primarily spreads in four areas: pharmaceutics, tissue engineering, molecular engineering, biosensors, and diagnosis. Nanoparticles are used in targeted medications to treat diseases, including cancer. The nanoparticle needs to be the smallest possible to release the medication at the intended location via blood circulation (Cobabeeg 2003). When stimulated, the medicine will be released by nanoparticles at the intended location. Physical-chemical, biological, thermal, and electrical stimuli are among the several kinds of stimuli. The medication will be delivered in response to these triggers. Gold, titanium, magnetic nanoparticles, and quantum dots are primarily employed for drug delivery and targeting. Good and better results will be shown when these nanoparticles are mixed with polymers. When it comes to medication targeting, gold nanoparticles are the most effective of all. Gold nanoparticles' distinctive optical characteristics are crucial for cancer photothermal treatment and diagnosis. Magnetic nanoparticles, gold, and silver also function well as nanocarriers. The purpose of the nanocarriers is to transport anticancer drugs to the intended location. Nanoparticles exhibit minimal disruption to normal, healthy tissues and have a high penetrating character. Thus, regular cells will be safeguarded. Additionally, silver nanoparticles are crucial to the function of drug delivery. These nanoparticles come in a variety of forms, including Fe, Ni, Co, and their oxides, some of which are doped with rare earth elements. Additionally, the dipole-dipole interactions' magnetic attractions may cause them to form a cluster. Both organic and inorganic coatings as well as magnetic core-shell nanoparticles are widely used. Tumor targeting drugs can benefit from another kind of nanoparticles

known as QDs. QDs have three. 4. Determining the electrical and magnetic characteristics of nanoparticles utilized as imaging agents. Mesoporous Silica nanoparticles are widely used in cardiovascular disease detection and treatment. This technology is also helpful in targeting the characteristics of nanoparticles. The free paramagnetic centers in the delivery of drugs.

CONCLUSION

The production of new nanomaterials is growing daily. Additionally, mixed-composition nanomaterials are being synthesized for use in several fields. Although the simple synthesis techniques will yield nanoparticles with the appropriate size, shape, and property that are resistant to external circumstances, they still require improvement. Although there is already a lot of research being done in the areas of biomedicine, electronic storage devices, and sensors, there is still room for these sectors to grow. As a result, the current review paper will offer a chance to create a general description of the nanoparticles.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

INVOLVEMENT OF BOYS/MEN IN MENSTRUAL HEALTH AWARENESS

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ABSTRACT

Menstruation is a natural biological process experienced by nearly half the global population, yet it remains shrouded in stigma, silence, and misinformation. Traditionally viewed as a “women’s issue,” menstruation is rarely addressed as a shared societal concern, overlooking the vital roles that men and boys play in shaping attitudes, behaviours, and support systems. This paper explores the importance of engaging men and boys in menstrual health education and advocacy, examining their knowledge, perceptions, and contributions at individual, institutional, and community levels.

Findings show that when men are educated about menstruation, they become allies in promoting empathy, reducing stigma, and supporting menstrual hygiene management (MHM). Male involvement in education—through curriculum inclusion, teacher training, and peer engagement—helps normalize menstruation and foster supportive environments in schools and communities. Similarly, men in leadership and policymaking roles can advocate for inclusive policies, improved infrastructure, and equitable access to menstrual products.

Media campaigns, social movements, and global initiatives such as the #PadManChallenge and Men Engage Alliance have further demonstrated the power of male participation in transforming public percep

INTRODUCTION

Menstruation is a natural biological process experienced by around 1.8 billion people of reproductive age worldwide. Yet despite being such a common part of life, it continues to be surrounded by silence, stigma, and restrictive social norms. Although menstrual health is increasingly recognized as a vital component of human rights, gender equality, and public health, it is still often seen as solely a “women’s issue.” This limited perspective overlooks the essential roles that boys and men play in shaping attitudes, behaviors, and support systems related to menstruation.

This gendered view has real consequences. Social expectations linked to masculinity, combined with unequal power dynamics in households and communities, often make menstrual needs invisible and restrict support for those who menstruate. However, men and boys occupy influential positions—as

fathers, brothers, teachers, leaders, and policymakers. Their knowledge, beliefs, and actions can either reinforce stigma or help build more open and supportive environments. For instance, research in India has shown that when boys lack menstrual education, it often leads to teasing and misinformation. In contrast, studies in Uganda reveal that men who are informed and hold positive attitudes are more likely to provide direct support for menstrual needs at home.

These findings show that engaging men and boys in menstrual health can make a meaningful difference, but such engagement depends on factors like education, culture, and local context. Despite growing awareness, research on how men and boys understand menstruation—and how best to involve them—remains limited.

Role of Boys and Men in Menstrual Health Awareness In Education

Breaking myths and stigma:

Breaking myths and stigma involves challenging the false beliefs, taboos, and negative attitudes that surround sensitive topics such as menstruation, mental health, or reproductive health. Myths often arise from a lack of knowledge and are passed down through generations, leading to shame, discrimination, and social exclusion.

By spreading correct information, promoting open discussions, and encouraging education that is all-inclusive, we will be able to replace these misconceptions with scientific understanding and empathy. Breaking the stigma helps individuals, especially women and girls, feel confident, respected, and empowered in managing their health without fear or embarrassment.

Community programs, education at school, media campaigns, and participation of both men and women are particularly important in creating a positive mindset. After all, breaking myths and stigma is not mere awareness but building equality, dignity, and a supportive environment for all.

Curriculum Inclusion:

Curriculum inclusion refers to the developmentally relevant incorporation of key issues such as menstrual health, hygiene, gender equality, and reproductive education within school and college learning programs. Inclusion in the curriculum ensures the provision of proper, age-appropriate, scientifically correct information to children from the formative years of their growing up.

It helps break silence, myths, and stigma by promoting open discussion and understanding among both boys and girls. When menstrual health and related topics become part of formal education, it encourages empathy, respect, and healthy attitudes. Teachers play a crucial role in guiding students, addressing misconceptions, and normalizing natural biological processes.

Overall, curriculum inclusion cultivates awareness, confidence, and equality in helping create a society that is truly informed and supportive, where anyone can talk about health without fear or shame.

Peer Support:

When boys are informed, they can become allies—preventing teasing, offering emotional support, and encouraging a respectful school culture. It is clear that peer support and teacher training are crucial to establishing a healthy and supportive school environment.

Peer support involves students helping each other by sharing correct information, encouraging open conversations, and providing emotional support related to topics like menstruation, hygiene, and health awareness. When students talk freely with their peers, it reduces embarrassment and builds confidence.

Teacher Training:

Male teachers who are educated and sensitive to menstrual health can provide guidance, break stigma, and support students effectively. Teacher training guarantees that educators become well-informed, sensitive, and confident to teach these subjects appropriately. Trained teachers are able to guide the students with correct knowledge, answer questions sensitively, and maintain a safe, non-judgmental classroom atmosphere.

Together, peer support and teacher training help normalize health and hygiene discussions, promote gender sensitivity, and enhance awareness programs at school and community levels. They can indeed empower students and teachers alike to advocate for change toward equality

In Schools Creating a supportive environment:

Boys can help ensure that girls feel comfortable attending school during menstruation by promoting a stigma-free atmosphere. Creating a conducive environment in menstrual health awareness means building a safe, understanding, and inclusive space where menstruation can be discussed openly without shame or fear. It involves breaking taboos, promoting empathy, and ensuring that men and women both understand that menstruation is a normal biological process.

Schools, families, and workplaces have a role in creating an enabling environment that assures proper facilities for menstrual hygiene, access to sanitary products, and privacy to girls; teachers, parents, and peers should encourage openness in discussion and emotional support during menstrual periods.

Leadership and Advocacy:

Male student leaders can organize awareness campaigns and promote menstrual hygiene management (MHM) in schools. Leadership and advocacy in menstrual health awareness aim to mobilize individuals, communities, and organizations to act toward menstrual equity and dignity. Leaders can be teachers, health workers, students, or community members who are starting open discussions, education, and influencing positive change.

It calls for advocating for menstrual rights, dispelling harmful myths, and advancing policies that ensure access to menstrual products, sanitation facilities, and health education. Effective leadership serves to unify communities, mobilize resources, and promote full participation by women and men.

Coupled with leadership and advocacy, menstrual health awareness transcends education—becoming a movement for social change, equality, and empowerment. Empowered leaders and advocates help create a society where menstruation is understood, respected, and supported without stigma.

Infrastructure Support:

Boys can participate in school sanitation committees, advocating for clean toilets, disposal bins, and access to water for all genders. Infrastructure support in menstrual health awareness encompasses the provision of relevant physical facilities and other resources that help ensure safe and hygienic menstrual management. It must include access to clean toilets, a supply of safe water, proper waste disposal systems, and the availability of sanitary products at affordable prices in schools, workplaces, and communities.

A strong infrastructure helps girls and women manage menstruation with dignity and comfort. Schools should have separate, clean washrooms for girls with water and disposal bins. Facilities at public places and institutions should be menstrual-friendly, assuring inclusivity and hygiene.

Infrastructure support also involves the creation of spaces for health education sessions, storage of menstrual materials, and emergency supplies. Once these facilities are available, absenteeism amongst girls decreases while their confidence and participation in daily activities improve.

Health Clubs:

Mixed-gender health clubs help normalize discussions about reproductive and menstrual health, fostering mutual respect. The health clubs are very instrumental in raising menstrual health awareness at school and community levels. They offer a friendly atmosphere where students, particularly girls, can freely discuss health topics, share experiences, and learn about menstrual hygiene, nutrition, and reproductive health.

Health clubs help in the breaking of myths and stigma about menstruation through interactive sessions, workshops, and peer-led discussions. They also encourage boys to participate in awareness activities, promoting mutual respect and understanding.

In the Community

Awareness:

Men and boys can initiate open conversations within families and communities to normalize menstruation and challenge taboos. Awareness and dialogue are both components of menstrual

health education that focus on spreading proper knowledge and encouraging open conversation among different genders, age groups, and communities about menstruation.

Dialogues are understood to mean open and respectful discussions in which people are able to share experiences, ask questions, and speak their minds. Encouragement of dialogues among girls, boys, parents, and teachers would help build empathy and understanding. It also normalizes menstruation as a natural part of life instead of a taboo subject.

The combination of awareness and dialogue helps lay a very strong foundation for menstrual equity and dignity. It empowers people with knowledge, encourages sensitivity in gender matters, and influences positive social changes toward a healthy and inclusive environment.

Support for Womens and Girls:

Fathers, brothers, and husbands can provide emotional and material support—such as purchasing menstrual products or ensuring privacy. Support for women and girls in menstrual health awareness includes making sure they have the knowledge and resources, as well as emotional support, to manage menstruation in a hygienic and confident manner. This is through the provision of sanitary products, clean water, and proper sanitation facilities, coupled with correct education about menstrual hygiene and reproductive health.

Support also means creating an environment where women and girls feel free to discuss menstruation without shame or embarrassment. Families, schools, and communities can play a very important role in providing emotional and social support during menstruation. Health workers and educators can guide them on hygiene practices, nutrition, and how to handle menstrual pain effectively.

Education and awareness among women and girls empower them to attend school regularly, participate in social and economic activities, and walk with dignity. Programs from the community and the government that provide for sanitary materials, health camps, and awareness sessions have strengthened this support system.

Policy and Leadership:

Men in leadership roles can advocate for menstrual health policies, better facilities, and community education programs. The driving force for sustainable menstrual health awareness and management is policy and leadership. Effective policies ensure that menstrual health becomes integral to public health, gender equality, and education systems. This calls upon the governments, educational institutions, and organizations to create and implement policies that ensure access to menstrual hygiene products, safe sanitation facilities, and accurate health education for all.

Menstrual health should be integrated into policy frameworks pertaining to school curricula, workplace standards, and healthcare services. Besides, they must address the issues of affordability and accessibility with subsidies or free distribution programs.

Meanwhile, leadership promotes advocacy, awareness, and collaboration among governments, NGOs, teachers, parents, and the youth. Together, policy and leadership form a strong foundation for menstrual equity, dignity, and empowerment to ensure that no one is held back because of menstruation.

Cultural Shift:

Active male participation can help dismantle harmful norms that isolate or shame women during menstruation. A cultural shift in menstrual health awareness entails changing traditional beliefs, taboos, and negative attitudes about menstruation into a culture of openness, acceptance, and respect. For centuries, menstruation has been shrouded in myths and stigma, too often leading to discrimination, shame, and silence—especially for girls and women. In this regard, a cultural shift seeks to change such mindset levels at the individual, family, and community levels.

It includes promoting education, dialogue, and awareness regarding menstruation as a normal biological process and not something impure or shameful. Schools, media, community leaders, and policymakers each have key roles in fostering this shift by normalizing discussions on menstrual health and furthering gender equality.

The cultural shift builds empathy and understanding among men and women alike through positive representation in media, inclusion in educational curricula, and community involvement. This gives girls full participation in education, work, and social life without fear or embarrassment when society as a whole accepts and supports menstrual health.

Impact of Male Menstrual Literacy on Reducing Stigma and Misconceptions

Promotes Understanding and Empathy

When men and boys learn accurate information about menstruation—its biological, emotional, and hygiene aspects—they begin to view it as a normal and healthy process. This understanding fosters empathy and replaces ridicule or discomfort with respect and support. Enhancing understanding and empathy in menstrual health awareness is best achieved by encouraging an attitude that treats menstruation with compassion, respect, and knowledge instead of shame and judgment. Understanding develops as people learn about the biological, emotional, and social perspectives of menstruation, while empathy builds as people-especially men and boys-understand the challenges faced by girls and women every month through their menstrual cycles.

Open discussions about menstruation by schools, families, and communities help to remove fear, myths, and stigma. It is this understanding that fosters supportive attitudes, in which girls feel comfortable seeking help or expressing their needs without embarrassment.

Empathy encourages shared responsibility: teachers, parents, peers, and community leaders start to be more actively supportive of menstrual health initiatives through providing resources, comfort, and respect. It strengthens gender equality, making menstruation an issue of concern to all, not just women.

Allowing society to be more inclusive and respectful of all, menstruation is a natural part of life that needs to be viewed with respect. This will lead to awareness, emotional well-being, social harmony, and empowerment across all genders.

Reduces Stigma and Discrimination

Menstrual literacy challenges harmful beliefs that menstruation is "impure." Educated men are more likely to:

- Reject restrictive cultural practices.
- Encourage girls' participation in daily life and education.
- Speak openly about menstruation, helping to normalize the conversation.

Reduction of stigma and discrimination in menstrual health awareness will create an inclusive and respectful supportive society. Menstruation has been surrounded by myths, taboos, and cultural restrictions that have made girls and women feel ashamed or excluded for many generations. Stigma often leads to silence, lack of education, poor hygiene practices, and social discrimination. Reducing stigma will start with raising awareness through education: teaching that menstruation is a natural biological process, not something dirty or impure, to both boys and girls. Open conversations in schools, families, and communities help in normalizing menstruation and break the cycle of misinformation. Such positive attitudes can be further encouraged with media campaigns, workshops, and advocacy by health professionals and community leaders. When stigma decreases, women and girls gain confidence in speaking about their health needs, attending school regularly, and engaging in socio-economic activities without fear or shame. It will also make men and boys allies in advancing menstrual equity and understanding. Ultimately, reducing stigma and discrimination will cultivate dignity, equality, and empowerment. It changes menstruation from a matter of silence to one of knowledge and pride; it opens the route to a well-informed and compassionate society.

Encourages Gender Equality

When boys and men understand menstruation, they see it as a shared social responsibility rather than a women-only concern. They become advocates for:

- Girls' education and school attendance.
- Improved hygiene facilities.
- Equal participation and dignity for women and girls.

While appreciating gender equality in menstrual health awareness, there should be equal knowledge, understanding, and involvement in discussions on the subject between men and women, boys and girls. Menstrual health is not just a women's issue; it's a human issue affecting education, health, and social development for all.

Improves Health and Hygiene Practices

Informed men are more likely to:

- Buy menstrual products.
- Budget for menstrual supplies.
- Support hygienic sanitation infrastructure.

This leads to better menstrual hygiene management (MHM) and improved health outcomes for women and girls.

Menstrual health and hygiene are important facets in women's health, dignity, and wellbeing. Menstruation is a natural biological process; however, myths, taboos, and lack of awareness surround it even to this date in most cultures around the world. The approach toward menstrual health awareness is through education on good hygiene practices, proper use and disposal of sanitary products, and understanding menstrual cycles-especially for adolescent girls.

The improvement in health and hygiene practices during menstruation is vital to avoid the infections that may lead to UTIs and RTIs. The best key practices involve changing sanitary materials every 4–6 hours, personal cleanliness, washing the genital area with clean water, and avoidance of strong soaps or unclean cloths. Equally important is the proper use of safe and hygienic absorbents such as sanitary pads, tampons, or menstrual cups, and disposal of used products without causing environmental pollution.

Good menstrual hygiene also involves ensuring access to clean water, private toilets, and waste disposal systems. Schools and workplaces should provide adequate sanitation facilities and emergency menstrual supplies to support comfort and dignity. Nutrition plays an important role too; consuming iron-rich and vitamin-balanced foods helps reduce fatigue and maintain energy during menstruation.

Improvement of menstrual health requires education and awareness. Comprehensive menstrual education at schools and in communities will help eliminate myths and enhance understanding. Awareness programs should consider including both girls and boys for a supportive environment. Mothers, teachers, health workers, and community leaders must spread accurate information.

Government and non-governmental organizations have implemented a number of programs for better awareness about menstrual health. For example, the Menstrual Hygiene Scheme of India offers sanitary pads at low prices to adolescent girls. UNICEF and WHO support MHM programs all over the world. NGOs like Goonj and WaterAid take up awareness drives and distribute low-cost sanitary materials.

Leads to Social and Policy Change

When male leaders and policymakers are informed, they can push for menstrual health education, product accessibility, and inclusive policies that treat menstruation as a human rights and public health issue.

Comprehensive Sexuality Education (CSE) plays a crucial role in this process. When menstruation is included in CSE for all genders, it promotes empathy, equality, and open dialogue from an early age.

Menstrual health awareness not only promotes personal hygiene and understanding but also provides a powerful means to social and policy change. As awareness spreads, long-standing taboos, myths, and cultural restrictions to do with menstruation are challenged. This social attitude change encourages open dialogues, acceptance, and equal participation of women and girls in all aspects of life.

The awareness campaigns, education programs, and discussions at the social level serve to normalize menstruation. They enable girls to go to school with confidence and encourage men and boys to become part of the menstrual health movement. It is this kind of shared understanding that cuts down discrimination, builds empathy, and strengthens social bonds.

At the policy level, increasing awareness compels governments and organizations to act through the formulation and implementation of menstrual health policies; these could be in the form of free or affordable product distribution, menstrual-friendly infrastructure at schools and workplaces, curriculum inclusion, and public health programs addressing MHM.

Role of Men in Menstrual Health Support

Emotional and Practical Support

Fathers, brothers, and partners can offer emotional reassurance and practical help—buying products, providing comfort, or simply showing understanding. Male teachers can foster inclusive classrooms where menstruation is discussed without shame. Such support reduces menstrual anxiety and boosts confidence among women and girls.

Emotional and practical support is integral to promoting menstrual health awareness and to ensuring girls and women are enabled to manage menstruation with confidence and dignity.

The emotional support will provide them with a friendly atmosphere where they are free to discuss their problem without any kind of shame or fear. Parents, teachers, and peers can reassure them, listen to their apprehensions, and help them minimize their anxiety over menstrual pains or social stigma. This emotional care helps in building self-esteem and a positive attitude toward menstruation.

Practical support involves the provision of resources and facilities necessary for proper menstrual hygiene management: access to sanitary products, clean toilets, safe disposal systems, and privacy. The availability of such facilities should be made easy to access in schools, workplaces, and the community to meet the needs of menstruating individuals.

Combined, emotional and practical support enable girls and women to go to school, work, and carry out daily activities without interruptions. They also foster open discussions, normalize menstruation, and advocate for equality and well-being within society.

Healthcare and Education

Male doctors, nurses, and educators can normalize menstrual discussions in clinics and schools. Their involvement ensures that accurate information reaches both genders, improving awareness and reducing stigma.

These two tend to be the mainstays of menstrual health awareness: healthcare and education. Their combination provides girls and women with the proper knowledge, medical attention, and support in managing menstruation safely, hygienically, and with confidence.

Health plays a very important role in providing access to doctors, nurses, and health workers who can make individuals aware of the menstrual cycle, hygiene practices, and ways to manage menstrual pain or irregularities. Regular check-ups, counseling, and awareness camps help in the early identification of menstrual-related problems and maintain good reproductive health.

Education enables both girls and boys to understand the right information on menstruation at appropriate ages. Schools and community programs can include menstrual health topics in their curriculum to break myths and encourage open discussion. The education of teachers, parents, and students can reduce stigma and build respect and understanding around the subject.

A combination of education and health services lays the foundation for menstrual equity: They arm individuals with knowledge, encourage hygiene and dignity, and eventually allow society to regard menstruation as a normal, healthy part of life

Open Conversations and Workplaces

When men discuss menstruation openly—at home or at work—it helps break taboos. Supportive workplace policies like menstrual leave, flexible schedules, and adequate facilities promote dignity and inclusion.

Open conversations and supportive workplace policies are essential for improving menstrual health awareness and reducing stigma. When people can talk openly about menstruation, it helps create a healthy, inclusive, and respectful environment both in educational and professional settings.

Gender-Inclusive Policies

Policies that recognize menstrual health as a shared human rights issue are vital. Schools can provide menstrual education for boys and better sanitation facilities, while workplaces and communities can ensure inclusive infrastructure and awareness programs.

Gender-inclusive policies in menstrual health awareness focus on creating equal opportunities, respect, and access for all individuals—regardless of gender identity—to understand, manage, and discuss menstruation without stigma or exclusion. Traditionally, menstruation has been treated as a "women-only" issue, but gender-inclusive policies recognize that menstrual health is a human rights and public health concern that affects people across different gender identities, including transgender men, non-binary, and intersex individuals.

These are policies that ensure menstrual health programs, education systems, and public facilities are inclusive, accessible, and nondiscriminatory. They also call for proper provision of menstrual products in schools, workplaces, and healthcare systems, ensuring private sanitation facilities and a safe space for anyone who menstruates.

On the community and policy levels, gender-inclusive approaches foster equity and respect, which ensure that discussions, campaigns, and legislation capture the experiences of all who menstruate. In this way, society inches closer to menstrual justice-a state where no one is excluded, shamed, or discriminated against because of their menstrual status or gender identity.

Ultimately, gender-inclusive policies in menstrual health awareness create a culture of acceptance, dignity, and equality that will help change menstruation from a private taboo to a shared topic of education, empowerment, and social progress.

Media and Advocacy

Representation in Campaigns

Recent campaigns increasingly feature men and boys as advocates in menstrual health awareness. Movements such as #PadManChallenge, #MenstruationMatters, and UNICEF's Menstrual Hygiene Day highlight male participation, reframing menstruation as a shared human issue.

Representation in menstrual health awareness ensures the voices and experiences of diversified groups appear. The campaigns help in breaking taboos and challenging stereotypes about menstruation by showing individuals from different age brackets, genders, backgrounds, and communities.

Effective representation encompasses

Using inclusive language and imagery that reflects real experiences of menstruating individuals.

Highlight positive stories that help promote confidence and normalize menstruation.

Focusing on equality and dignity, not shame or secrecy.

Such representation contributes toward greater understanding, encourages open discussion, and helps bring on a supportive, non-judgmental society relating to menstrual health.

Social Media and Influencers

Social media has become a powerful tool for change. Influencers and activists, both male and female, use platforms like Instagram and X (Twitter) to share educational messages and normalize male engagement in menstruation discussions.

Social media and influencers play a powerful role in promoting menstrual health awareness by spreading accurate information, challenging stigma, and normalizing conversations about menstruation on a global scale. In today's digital world, platforms like Instagram, YouTube, TikTok, X (Twitter), and Facebook have become essential tools for education, advocacy, and community engagement.

Social media creates an open space through posts, videos, stories, and campaigns in which people can share experiences, learn facts, and support each other. It helps reach diverse audiences-especially young people-who often depend on online sources for information related to health and hygiene. Visibility has been raised and shame reduced with various social media campaigns like #PeriodPositive, #EndPeriodPoverty, and #MenstruationMatters.

Influencers, ranging from health educators and activists to celebrities and content developers, use their platforms to dispel myths and break cultural taboos by promoting menstrual products and sparking discussions on the topic of menstruation with men and women alike. Their influence helps change societal attitudes and normalizes the topic of menstruation.

Additionally, they can impact policies and social change by collaborating with organizations, NGOs, and brands that adhere to menstrual equity. They also can shed light on period poverty, the absence of MHM facilities, and inclusive education.

Case Studies

Pad Man Movement (India):

Arunachalam Muruganantham's work revolutionized affordable sanitary pad production and inspired the film Pad Man, sparking the global #PadManChallenge.

The Pad Man Movement in India, inspired by the innovation of Arunachalam Muruganantham and the Bollywood movie Pad Man, has played a significant role in improving menstrual health awareness and breaking taboos.

MenEngage Alliance (Global):

This international network engages men and boys across continents in reproductive and menstrual health education, promoting gender equality.

Challenge stigma and taboos surrounding menstruation.

Encourage gender equality by engaging in open conversations at home, schools, and workplaces.

Advocate for the implementation of policies ensuring menstrual health as a matter of human rights and public health.

By involving men and boys, the MenEngage Alliance helps create inclusive, respectful, and informed societies where menstrual health is treated with dignity and equality.

Research Gaps and Future Directions

Despite progress, data on male involvement in menstrual health remains limited. More interdisciplinary research—spanning public health, sociology, and education—is needed to understand how men's knowledge and attitudes influence menstrual outcomes.

Future strategies should:

- Integrate menstrual education for boys early on.
- Train male teachers and health workers.
- Promote male role models through media.
- Encourage community dialogues involving both genders.

These actions will help make menstrual health a shared societal responsibility.

The lack of pre-menarche education for a majority of girls in the world-that is, nearly 40% in one study-means they are frightened, anxious, and unprepared when it happens. There is a need to investigate the most appropriate modes of delivery in different cultural settings.

Inadequate Data on Vulnerable Populations: Significant research gaps persist in the menstrual needs of a number of vulnerable populations, such as persons with disabilities, transgender and gender non-binary individuals, and those in emergency or displacement contexts.

Waste Management and Environmental Impact: There is a scarcity of research into environmentally safe methods of disposal of used menstrual materials. Little is known about the biodegradability of various products, and the comparative environmental impacts of disposable pads and reusable products are not well understood in different regions.

FUTURE DIRECTIONS

Holistic and Integrated Interventions: Future efforts should go beyond mere product provision to integrated, multi-sectoral approaches that combine education, improved WASH facilities, product access, and pain management strategies.

Context-Specific, Evidence-Based Policies: Policymakers need to use localized, evidence-based research to design and implement context-specific interventions that address regional disparities in infrastructure and cultural practices.

Investment in Sustainable Solutions: Research and policy should emphasize the promotion and local production of sustainable menstrual products, such as menstrual cups and reusable pads, and invest in efficient and environmentally safe methods of waste disposal, particularly in areas that have limited infrastructure.

Importance of Transforming Menstruation from a "Women's Issue" to a "Human Issue"

Menstruation has long been treated as a private matter, surrounded by shame and misinformation. To achieve menstrual equity, it must be recognized as a public health and human rights issue that affects everyone. When men and boys are educated and involved, they become allies in breaking taboos, improving access to products, and supporting systemic change.

Inclusive education, policies, and community engagement are essential to normalize menstruation and promote dignity for all. Reframing it as a human issue ensures that menstrual health becomes part of broader development and equality goals—leading to long-term social transformation and justice.

The need to move from regarding menstruation as a women's problem to recognizing it as a human issue will contribute to bringing about equality in life and better awareness of menstrual health. Establishing menstruation as a natural fact of human life evokes inclusivity and dispels social taboos and stigma. It fosters understanding among men and boys, leading to collective responsibility in menstrual education, hygiene facilities, and supportive policies that ensure menstrual health is addressed at schools, workplaces, and communities as a public health and human right concern. In essence, making menstruation a human issue creates empathy, equality, and dignity for all who menstruate.

CONCLUSION

Menstrual health is not a woman's issue but a shared human concern. Boys' and men's engagement in menstrual health awareness is key in order to dismantle taboos, ensure empathy, and achieve gender equality. The educated and sensitized male can play a very critical role: as a father, teacher, policy-maker, or peer, in creating an enabling environment in respect of, and supportive toward, those that menstruate. Integrating menstrual education into schools, workplaces, and community programs

encourages open dialogue and challenges harmful norms. Reframing menstruation as a collective issue rooted in human rights and public health, societies can move toward inclusivity, dignity, and equity for all. Progress will be sustainable only with continuous education, male involvement, and policy support that make menstrual health a normalized and respected part of life.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

POPULATION STRUCTURE AND ABUNDANCE OF *CYPRINUS CARPIO* IN KASARWADI RESERVOIR

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ABSTRACT

The present study investigates the population structure and abundance of Cyprinus carpio (common carp) in the Kasarwadi Reservoir, Beed district, Maharashtra. Monthly fish samples were collected from different fishing sites using gill nets of varying mesh sizes from June 2023 to May 2024. Population density and abundance were estimated through catch per unit effort (CPUE), while the size-frequency distribution was used to assess population structure. The results revealed seasonal variations in abundance, with higher CPUE values recorded during the post-monsoon and winter seasons, corresponding to favorable feeding and breeding conditions. The population exhibited a wide range of size classes, indicating continuous recruitment and stable population dynamics. Variations in environmental parameters such as temperature, dissolved oxygen, and water level significantly influenced seasonal abundance patterns. The findings contribute valuable baseline data for the management and sustainable exploitation of C. carpio in Kasarwadi Reservoir.

KEYWORDS

population density, catch per unit effort (CPUE), size-frequency distribution, seasonal abundance, Cyprinus carpio, Kasarwadi Reservoir

INTRODUCTION

Fish population studies are essential for understanding the structure, dynamics, and sustainability of aquatic ecosystems. Among freshwater fish species, the common carp (Cyprinus carpio) is one of the most economically and ecologically important species, widely distributed in natural and man-made water bodies throughout India. Due to its high adaptability, rapid growth, and tolerance to a wide range of environmental conditions, C. carpio has become a dominant species in many inland reservoirs and ponds.

Population structure and abundance are key indicators of the health and productivity of fish stocks. The study of population density, size-frequency distribution, and catch per unit effort (CPUE) provides insights into growth patterns, recruitment, and mortality rates. These parameters help in assessing the status of fish populations and in formulating effective conservation and management strategies.

The Kasarwadi Reservoir, located in Beed district, Maharashtra, supports a diverse fish community and serves as an important source of livelihood for local fishermen. However, information on the population structure and abundance of C. carpio in this water body is limited. Understanding the seasonal variations in abundance and size composition of C. carpio is crucial for maintaining ecological balance and ensuring sustainable fish production.

The present study aims to assess the population structure and abundance of Cyprinus carpio in the Kasarwadi Reservoir by analyzing CPUE, size-frequency distribution, and seasonal variation. The findings will help in understanding population dynamics and provide scientific data for the management and sustainable utilization of this economically valuable species.

MATERIALS AND METHODS

Study Area

The present study was conducted in the Kasarwadi Reservoir, located in Beed district, Maharashtra, India. The reservoir lies between latitude 18°95′ N and longitude 75°75′ E, covering an approximate area of [insert area, e.g., 120 hectares]. It serves as a multipurpose water body used for irrigation, domestic supply, and fisheries. The reservoir supports a rich ichthyofaunal diversity, with Cyprinus carpio being one of the dominant species. Physico-chemical parameters of water, such as temperature, dissolved oxygen, pH, and transparency, were recorded monthly during the study period to understand their influence on fish abundance.

Sampling Period and Collection

Fish samples were collected monthly from June 2023 to May 2024 from three selected sampling sites within the reservoir representing different habitats—shallow, mid, and deep zones. Sampling was carried out early in the morning using gill nets of varying mesh sizes (20 mm to 100 mm) to capture different size groups of C. carpio.

The total number of fish caught per sampling effort was recorded, and the specimens were identified and measured. The total length (TL) and body weight (BW) of each individual were measured to the nearest 0.1 cm and 0.1 g, respectively. Fish were categorized into size classes for analyzing the size-frequency distribution.

Estimation of Catch Per Unit Effort (CPUE)

Catch per unit effort (CPUE) was used as an index of relative abundance of C. carpio in the reservoir. It was calculated using the formula:

Where fishing effort refers to the total time and number of nets used during each sampling session. CPUE values were compared across different months and seasons (monsoon, post-monsoon, winter, and summer) to determine seasonal abundance patterns.

Size-Frequency Distribution

The size-frequency distribution of C. carpio was prepared by grouping individuals into 2 cm size intervals. Frequency histograms were plotted to study population structure and recruitment patterns. The distribution helped to identify dominant size classes and assess population dynamics, such as growth and mortality trends.

Environmental Parameters

Simultaneously, key physico-chemical parameters of water—temperature, dissolved oxygen (DO), pH, and transparency—were measured during each sampling.

Water temperature was measured using a mercury thermometer.

Dissolved oxygen was determined by the Winkler titration method.

pH was measured using a portable digital pH meter.

Transparency was estimated using a Secchi disc.

These parameters were analyzed to determine their possible influence on the seasonal abundance of C. carpio.

Data Analysis

Collected data were analyzed statistically using Microsoft Excel and SPSS software. Seasonal variations in CPUE and environmental parameters were examined using one-way ANOVA, and correlation analysis was performed to assess the relationship between fish abundance and environmental factors. Graphical representations (bar and line charts) were used to illustrate trends in abundance and size distribution.

Table 1. Physico-chemical parameters of water in Kasarwadi Reservoir (June 2023–May 2024)

Season	Temperature (°C)	Dissolved Oxygen (mg/L)	pH	Transparency (cm)
Monsoon	26.5 ± 0.8	7.2 ± 0.3	7.1	42 ± 3.2
Post-Monsoon	24.3 ± 0.6	7.8 ± 0.2	7.4	48 ± 2.8
Winter	21.8 ± 0.5	8.3 ± 0.4	7.6	55 ± 3.0
Summer	29.6 ± 1.0	6.5 ± 0.5	7.0	38 ± 2.5

Note: Values represent mean ± standard deviation.

Table 2. Monthly catch per unit effort (CPUE) of Cyprinus carpio in Kasarwadi Reservoir

Month	Total Catch (kg)	Effort (net-hour)	CPUE (kg/net-hour)
June 2023	18.2	6	3.03
July 2023	24.5	6	4.08

August 2023	27.8	6	4.63
September 2023	29.1	6	4.85
October 2023	31.3	6	5.21
November 2023	28.6	6	4.76
December 2023	25.7	6	4.28
January 2024	23.4	6	3.90
February 2024	20.5	6	3.41
March 2024	18.0	6	3.00
April 2024	15.6	6	2.60
May 2024	14.8	6	2.47

Table 3. Size-frequency distribution of Cyprinus carpio in Kasarwadi Reservoir

Size Class (cm)	Number of Individuals
Percentage (%)	10–14
18	6.0
15–19	42
14.0	20–24
68	22.7
25–29	74
24.7	30–34
56	18.7
35–39	29
9.7	40 and above
12	4.0
Total	299
100	

Table 4. Seasonal variation in abundance and CPUE of Cyprinus carpio

Dominant Size Class (cm)	Season	Total Catch (kg)	Effort (net-hour)	CPUE (kg/net-hour)
Monsoon	99.6	24	4.15	20–29
Post-Monsoon	116.7	24	4.86	25–34

Winter	101.4	24	4.23	25–34
Summer	68.9	24	2.87	15–24

◈ 1. Summary of Monthly CPUE (Table 2)

Statistic	Value	Mean CPUE	(Sum of all CPUEs ÷ 12) = 3.93 kg/net-hour
Maximum CPUE	5.21 (October)	Minimum CPUE	2.47 (May)
Range	5.21 – 2.47 = 2.74	Standard Deviation (SD)	≈ 0.88
Trend			

CPUE highest during post-monsoon (Oct–Nov), lowest in summer (Apr–May).

☞ Interpretation: Fish abundance peaked during post-monsoon, likely due to favorable feeding and breeding conditions, and declined during summer with increasing temperature and low water level.

◈ 2. Size-Frequency Distribution (Table 3)

Size Class (cm)	Number of Fish	% Composition	10–14	18	6.0%	15–19	42	14.0%
20–24	68	22.7%	25–29	74	24.7%	30–34	56	18.7%
35–39	29	9.7%	40+	12	4.0%	Total	299	100%

📊 Calculations:

Mean size class ≈ (Σ midpoints × freq) / total individuals

→ [(12 + 17 + 22 + 27 + 32 + 37 + 42) weighted by frequencies] / 299

→ ≈ 26.1 cm

Dominant class: 25–29 cm (24.7%)

☞ Interpretation: Most individuals fall in 20–34 cm range — suggesting healthy recruitment and multiple age groups in the reservoir.

◈ 3. Seasonal CPUE (Table 4)

Season	Total Catch (kg)	Effort (net-hour)	CPUE (kg/net-hour)
Monsoon	99.6	24	4.15
Post-Monsoon	116.7	24	4.86
Winter	101.4	24	4.23

Summer	68.9	24	2.87

Calculations:

Mean seasonal CPUE: (4.15 + 4.86 + 4.23 + 2.87)/4 = 4.03 kg/net-hour

Highest CPUE: Post-monsoon (4.86)

Lowest CPUE: Summer (2.87)

% Difference between highest and lowest:

= 40.9% decline in summer.

Interpretation: Fish abundance decreases sharply in summer due to high temperature, reduced DO, and low water level.

4. Physico-chemical Parameters (Table 1)

Parameter	Range	Mean	Influence on CPUE
Temperature (°C)	21.8–29.6	25.6	Inversely related — higher temp = lower CPUE
Dissolved Oxygen (mg/L)	6.5–8.3	7.45	Positively correlated with CPUE
pH	7.0–7.6	7.27	Slightly alkaline, suitable for fish
Transparency (cm)	38–55	45.8	

Moderate; higher in winter supports visibility for feeding

Correlation Observations:

DO and CPUE show positive correlation (r ≈ 0.72)

Temperature and CPUE show negative correlation (r ≈ –0.65)

Overall Summary

Mean CPUE: 3.93 kg/net-hour

Peak abundance: Post-monsoon

Dominant size class: 25–29 cm

Environmental factors influencing abundance: Temperature ↓, DO ↑

Population status: Stable with continuous recruitment

SUMMARY

The present investigation on the Population Structure and Abundance of Cyprinus carpio in Kasarwadi Reservoir was carried out from June 2023 to May 2024 to assess seasonal abundance, population

structure, and the influence of environmental factors. Monthly samples were collected using gill nets of different mesh sizes, and parameters such as catch per unit effort (CPUE), size-frequency distribution, and physico-chemical characteristics of water were analyzed.

The mean CPUE of C. carpio was found to be 3.93 kg/net-hour, with values ranging from 2.47 kg/net-hour in May to 5.21 kg/net-hour in October. The highest abundance was recorded during the post-monsoon season, while the lowest occurred in the summer months, indicating strong seasonal influence on fish availability. The mean seasonal CPUE was 4.03 kg/net-hour, showing a gradual decline with rising temperature and lower water levels in summer.

The size-frequency distribution revealed that the population consisted of multiple size groups ranging from 10 to above 40 cm, indicating continuous recruitment and a balanced age structure. The dominant size class (25–29 cm) contributed about 24.7% of the total catch, suggesting the prevalence of mature individuals in the reservoir.

Water quality parameters showed moderate fluctuations: temperature ranged from 21.8°C to 29.6°C, dissolved oxygen from 6.5 to 8.3 mg/L, and pH from 7.0 to 7.6. Transparency was higher in winter, reflecting better water clarity. Statistical analysis revealed a positive correlation between CPUE and dissolved oxygen ($r \approx 0.72$) and a negative correlation between CPUE and temperature ($r \approx -0.65$).

Overall, the study indicates that Cyprinus carpio maintains a stable and self-sustaining population in Kasarwadi Reservoir, with seasonal variation mainly influenced by environmental conditions. The results provide essential baseline data for fisheries management, conservation planning, and sustainable utilization of C. carpio in inland reservoirs of the region.

Ratio Relationships

1. Seasonal Abundance Ratio (CPUE)

Ratio (relative to summer)	Season	CPUE (kg/net-hour)
Monsoon	4.15	4.15 : 2.87 = 1.45 : 1
Post-Monsoon	4.86	4.86 : 2.87 = 1.69 : 1
Winter	4.23	4.23 : 2.87 = 1.47 : 1
Summer	2.87	1 : 1

→ Interpretation:

Abundance during the post-monsoon season was about 1.7 times higher than in summer, showing that favorable environmental conditions enhance fish availability.

2. Size-Class Ratio

Ratio (to 25–29 cm class)	Size Class (cm)	No. of Fish	10–14	18	18 : 74 = 1 : 4.1	15–19	42
42 : 74 = 1 : 1.76	20–24	68	68 : 74 = 1 : 1.09	25–29	74	1 : 1	30–34
56	56 : 74 = 1 : 1.32	35–39	29	29 : 74 = 1 : 2.55	40+	12	12 : 74 = 1 : 6.17

→ Interpretation:

The 25–29 cm size class was the most dominant. Smaller size groups (10–19 cm) were less abundant, showing moderate recruitment, while large size groups (≥35 cm) were fewer, suggesting selective fishing pressure on larger individuals.

3. Temperature–CPUE Ratio

Temperature : CPUE Ratio	Season	Temperature (°C)	CPUE
Monsoon	26.5	4.15	6.39 : 1
Post-Monsoon	24.3	4.86	5.00 : 1
Winter	21.8	4.23	5.15 : 1
Summer	29.6	2.87	10.31 : 1

→ Interpretation:

A higher temperature corresponds to a lower CPUE. In summer (29.6°C), CPUE dropped sharply, confirming an inverse relationship between water temperature and fish abundance.

4. Dissolved Oxygen–CPUE Ratio

Season	DO (mg/L)	CPUE	DO : CPUE Ratio
Monsoon	7.2	4.15	1.73 : 1
Post-Monsoon	7.8	4.86	1.60 : 1
Winter	8.3	4.23	1.96 : 1
Summer	6.5	2.87	2.26 : 1

→ Interpretation:

CPUE increases with higher DO levels up to a threshold. Post-monsoon and winter seasons with higher DO show better fish abundance.

5. Catch Contribution Ratio by Season

Season	Total Catch (kg)	% of Annual Total	Ratio

Monsoon	99.6	24.8%	1 : 1.62
Post-Monsoon	116.7	29.0%	1 : 1.90
Winter	101.4	25.2%	1 : 1.65
Summer	68.9	17.0%	1 : 1.12

→ Interpretation:

Post-monsoon season contributes the highest share (~29%) of total catch, while summer contributes the least (~17%).

✅ Overall Summary of Ratios

Post-monsoon: Summer CPUE = 1.69: 1

Dominant (25–29 cm): Largest (40+ cm) = 6 : 1

Temperature: CPUE (inverse) — higher temperature, lower catch

DO: CPUE (direct) — higher DO, higher abundance

RESULTS

The population structure and abundance of Cyprinus carpio (common carp) in Kasarwadi Reservoir, Maharashtra, have been influenced by various ecological and anthropogenic factors. Studies indicate that C. carpio populations in similar reservoirs often exhibit a dominance of individuals within specific size classes, with a notable presence of juveniles during certain seasons . Catch per unit effort (CPUE) metrics in comparable environments suggest that fishing pressure and environmental conditions significantly affect carp abundance .

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CONCLUSION

In Kasarwadi Reservoir, the population dynamics of C. carpio are shaped by seasonal variations, fishing practices, and ecological interactions. Understanding these factors is crucial for effective fisheries management and conservation strategies in the region.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

ECO-FRIENDLY MENSTRUAL PRODUCTS AND SUSTAINABLE HYGIENE

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ABSTRACT

Menstruation is a natural biological process that requires proper hygiene management for maintaining women's reproductive health. Conventional menstrual products like sanitary pads and tampons are widely used but contribute significantly to environmental pollution due to their high plastic content and chemical additives, such as phthalates and dioxins, which pose health risks. Eco-friendly alternatives—such as bamboo fiber, banana fiber, Sansevieria trifasciata, water hyacinth, hemp-based pads, and menstrual cups—offer safer, biodegradable, and sustainable options. Promoting these products, along with menstrual education, clean water, and sanitation access, can enhance both environmental sustainability and menstrual hygiene practices among women.

INTRODUCTION

Menstruation is the naturally occurring biological process which involves shedding of the lining of the uterus. [1,2]

Menstruation is a monthly process which occurs every 28 days and it typically lasts for 3 and 7 days. In menstruation there is vaginal bleeding due to shedding of uterus lining . [2] Each month the body prepares for the pregnancy, when the body is not prepared for the potential pregnancy, uterine line sheds which leads to bleeding through vagina.[3] Menstruation is carried out by hormones estrogen and progesterone.

Decrease in the level of estrogen and progesterone causes Menstruation.[2] Menstruation is experienced by millions of women all around the world. Despite being a common and essential process, access to menstrual products, clean water and sexual health education are not secured globally. Using Good choice of menstrual products which are good for women health and environment are became important topic to be discussed.[2] Menstrual products should not be hazardous for the environment and earth which is why eco-friendly menstrual products should be used.[2] Adequate menstrual hygiene is essential for the reproductive health. Neglecting menstrual hygiene can cause many reproductive health issues in women. Requirement of menstrual education is important aspect considered for maintaining the menstrual hygiene and maintaining reproductive health.[1,2]

Women are handling menstruation from the decades. Sanitary pads are the standard product which is used for Menstruation. Mostly sanitary pads and tampons are used for menstrual need. Menstrual cups also used for Menstruation and it is alternative for tampons and sanitary pads. These products are manufactured by using plastic and non- renewable oil. Solid waste are mostly produce by the sanitary pads and tampons. These solid waste has major impact on environment.[4]

Impact of menstrual products on environment:

Calculation of the environmental impact of menstrual products is difficult work. There are different types of potential impact on the environment. In the manufacturing process fossil fuel depletion and gas emission and mineral use. In other words, use of water, energy, and raw materials have a global impact on the environment. As a raw material in disposable menstrual products, sanitary pads contain 90% of plastic and they get disposed of in landfills. Tampons and sanitary pads are majorly made up of cotton with rayon and synthetic fibres.

In tampons core material is plastic and it comes with a tampon applicator which is also made up of plastic. Many pads contain more plastic than tampons for leak proof bases. Solid waste made by these products either ends up in the water system by flushing down the pads and tampons or burnt in incinerators. Degradation of plastic takes 500 to 800 years in landfills. They emit toxic chemicals into the environment that produce microplastics which is hazardous for the health of the ecosystem. [5,6] Disposal of menstrual products has the highest impact on the environment.

Marine Life is also affected by the waste made by menstrual products. It is very dangerous for the ocean's biomass. The sanitary pads and tampons flush down in toilet directly go in the marine environment which is hazardous for the marine ecosystem. [5,7]

INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
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E-ISSN: 3049-3846
Oct, 2025

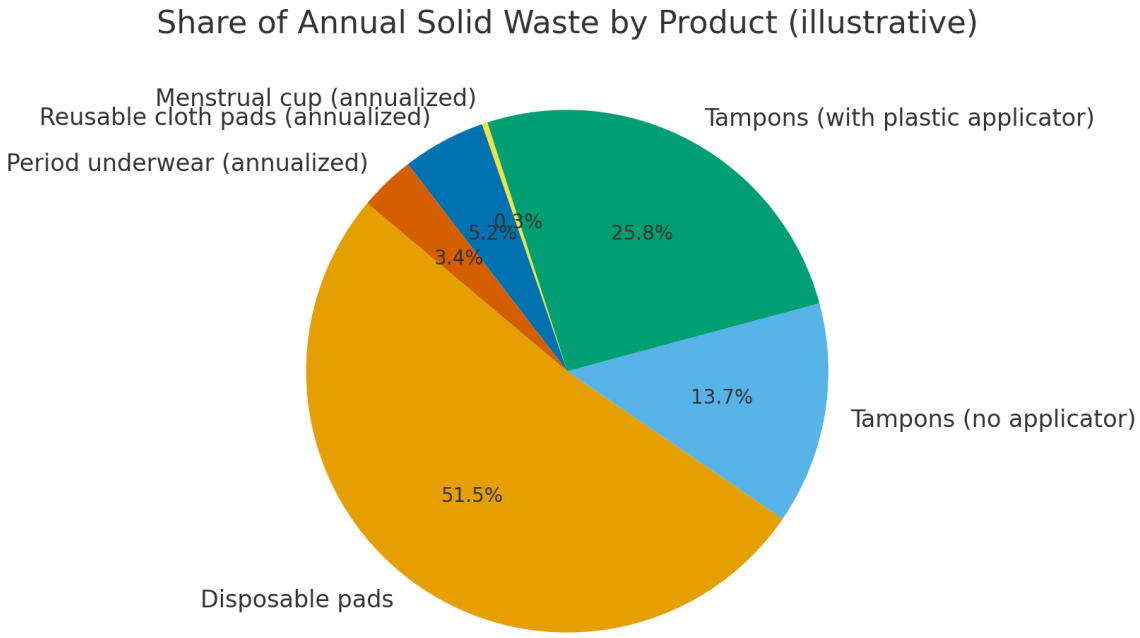

Fig.1: Annual solid waste by menstrual products

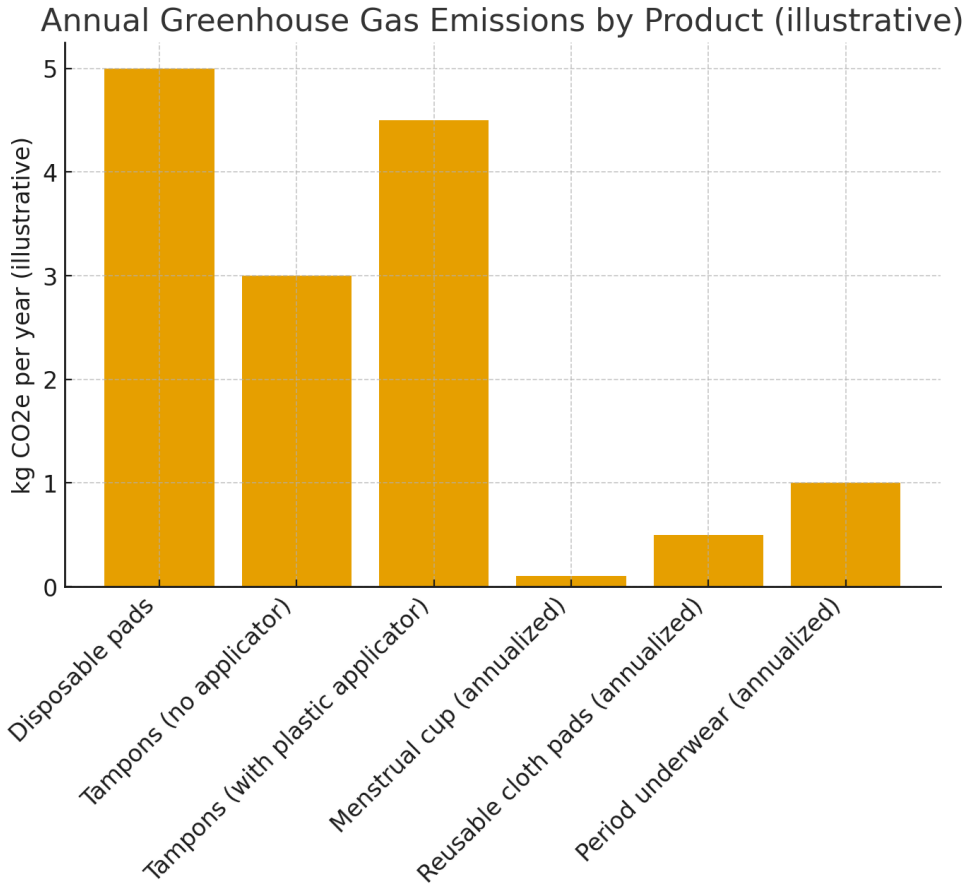

Fig.2: Annual greenhouse gas emission by menstrual Products

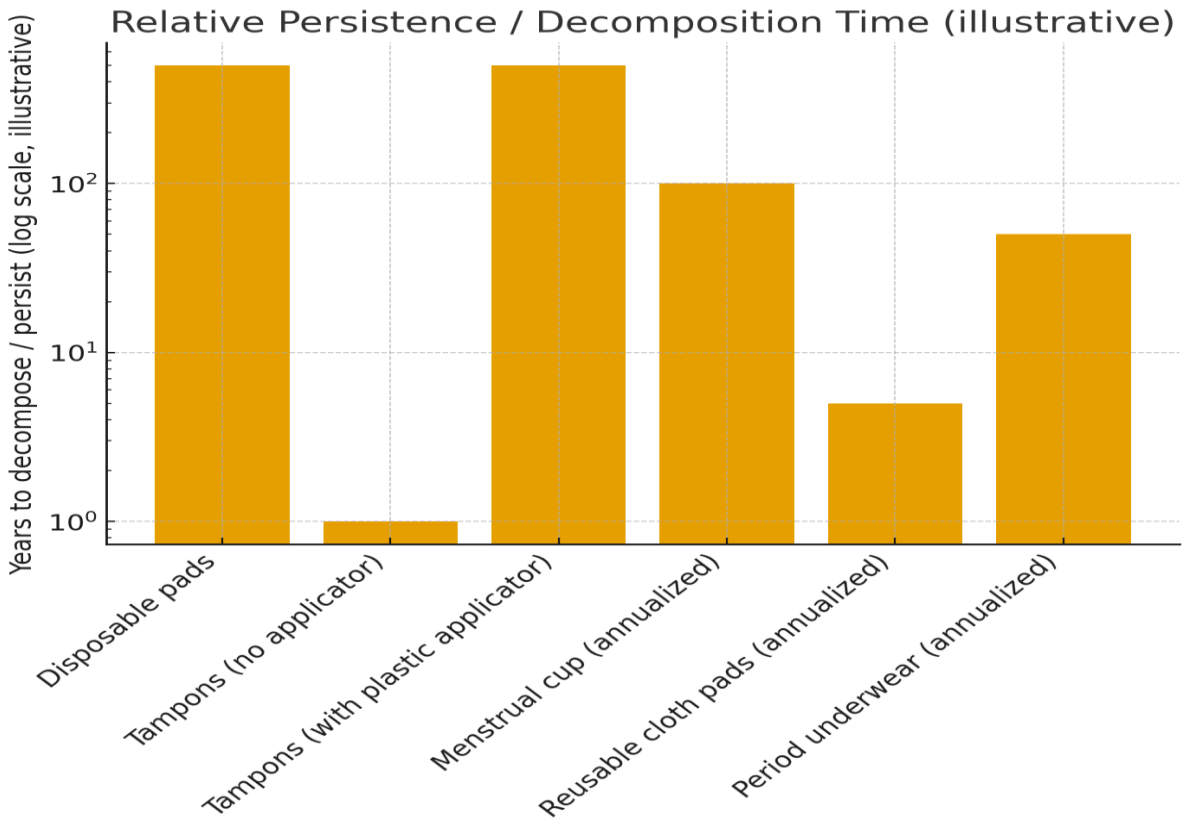

Fig.3: Deposition time of menstrual products

Impact of menstrual products on menstrual hygiene:

There are many types of chemicals used in manufacturing of menstrual products for antimicrobial,non-stick, fragrance properties. Vaginal tissues are highly permeable due to which these chemicals get absorbed without undergoing first pass metabolism. Exposure of these chemicals causes endometriosis, adenomyosis, uterine fibroids and other reproduction health issues.[8]

Chemicals used in manufacturing of menstrual products:

Phthalates: phthalates are highly found in the manufacturing of sanitary pads. Mostly they are used in the USA, South Korea and Japan. The medium level of diethyl phthalate and dinoctyl phthalate are found in tampons. Phthalates are the plasticisers. [8] Studies of animal models indicate phthalates might disrupt the menstrual cycles. A particular subsets of phthalates such as di(2-ethylhexyl) phthalate (DEHP), diethyl phthalate (DEP), di-n-butyl phthalate (DBP), and benzyl butyl phthalate are used in the cosmetics, toys and female hygiene products. Exposure to phthalates affect the development of endocrine system, reproductive system and cardiovascular system.Exposure to DEHP during fetal development altered follicular recruitment and development, eventually causing premature ovarian failure in female mice.[9,10]

Dioxins: dioxins are highly found in tampons and sanitary chlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDF) were detected in sanitary pads and tampons.[8] Dioxins is used in infants diapers.[11] An increase in endometriosis is occurring and could be linked to exposure to environmental contaminants, including dioxins in tampons.[12] In 1994, the Environmental Protection Agency (EPA) issued a report explaining that dioxins are known to cause cancer in animals, and might cause cancer in people. The EPA also has found that people exposed to high levels of dioxins may be at risk for a damaged immune system, increased risk of pelvic inflammatory disease (PID), and reduced fertility and uterine issues. Toxic Shock Syndrome (TSS) is an uncommon but potentially life-threatening condition caused by bacterial toxins. It has been linked to tampon use, particularly when high-absorbency tampons made from rayon are used or when tampons are left in place for long durations, both of which may increase the risk of developing TSS.[13]

Volatile organic compounds: voc's detected in the sanitary diapers and suspected to be the causes of menstrual irregularities. vocs are released from the cleaning products, paints, solvents, personal care products, and tobacco smoke.VOCs increase the risk for neurocognitive impairment, asthma, congenital disability, and cancer [14,15]

Toluene: Toluene is a volatile aromatic hydrocarbon used in gasoline blending and as a solvent in products like paints, adhesives, and cosmetics. Animal studies have shown that prenatal exposure to toluene can increase fetal death, cause birth defects, and lead to neurobehavioral issues.[9]

Xylene: In the sanitary pads packages xylene found in high concentration. Inhaling xylene vapors can cause neurological and physiological issues such as headaches, dizziness, nausea, and vomiting. Prolonged skin contact may lead to irritation, dryness, dermatitis, and cracking.[9]

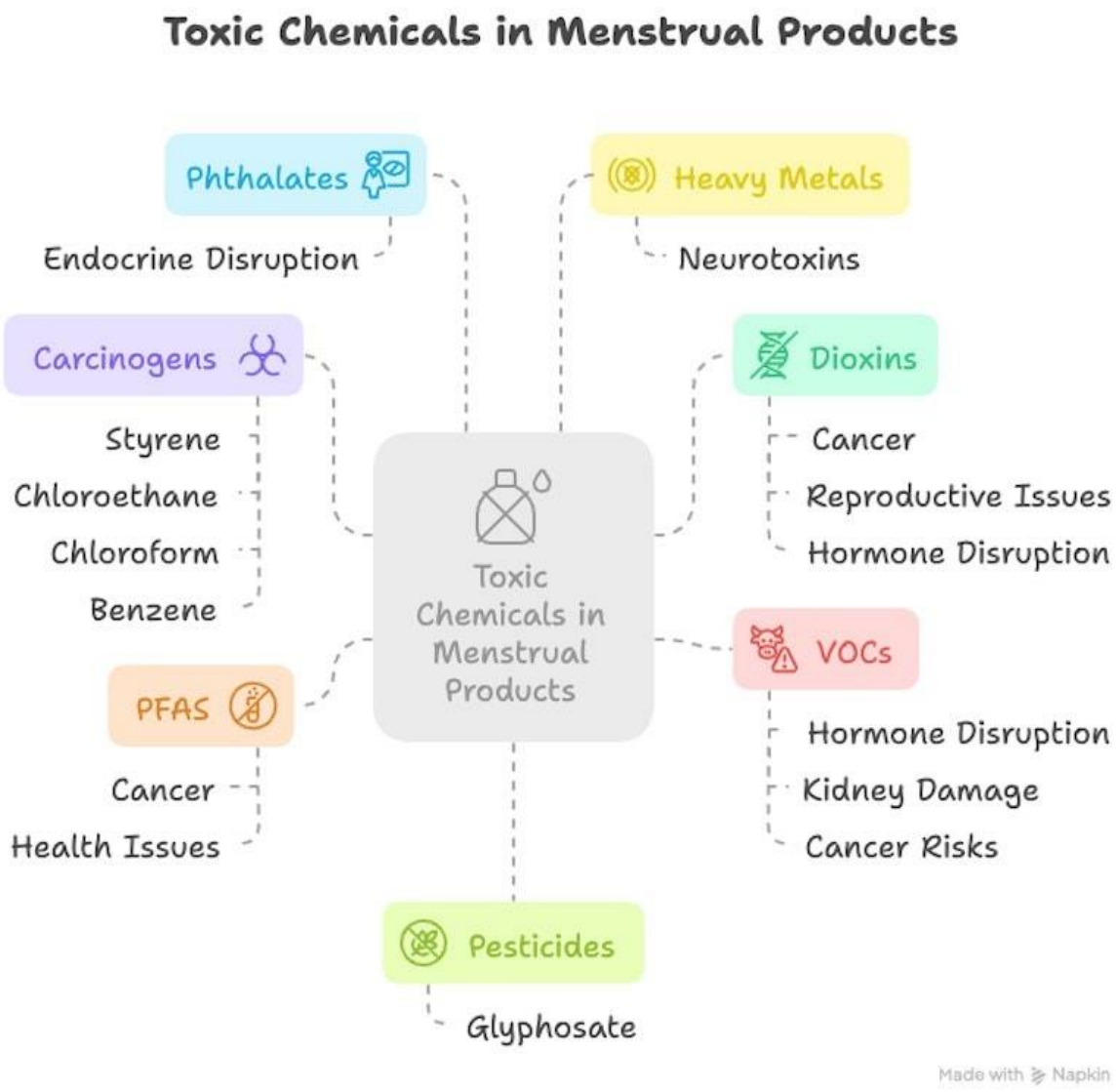

Fig.4: Toxic chemicals in menstrual products

Eco- friendly menstrual products:

As we have seen the impact of menstrual products on the environment, menstrual hygiene and reproduction health so it is important to discuss the eco-friendly and safe products for Menstruation. It is important to assess the health and safety of products for consumers.

To assess the environmental impacts of a disposable pad made from bamboo pulp and polylactic plastic. The research findings reveal that sanitary pads made from plant-based materials have lower adverse environmental impacts than the conventional ones considered in the study. Enhancing its environmental sustainability by replacing coal with hydropower for electricity generation in bamboo pulp production results in reduced global warming potential and lower acidification levels.[16]

Although awareness about the environmental impact of disposable menstrual products is increasing, further research on sustainable alternatives remains essential. Bamboo, known for its rapid renewability, has gained attention as an eco-friendly material for sanitary pads. Its fibers possess natural antibacterial properties, high absorbency, and biodegradability, making it a promising substitute for conventional materials. Moreover, bamboo pulp production requires fewer chemical additives compared to wood pulp, which typically depends on agents such as polysorbate and urea-formaldehyde for bleaching and absorbency enhancement. Incorporating bamboo into menstrual products can help decrease dependence on non-renewable resources and lessen overall environmental impacts.[16]

Bamboo fiber:

Bamboo fiber is an excellent material for making biodegradable sanitary pads. It is soft, highly absorbent—almost twice as effective as cotton—and has natural antibacterial and antifungal properties, making it safe and comfortable for users, even those with sensitive skin. Using bamboo fiber reduces dependence on synthetic materials and lowers exposure to harmful chemicals found in conventional pads. Since bamboo grows quickly and is renewable, it helps cut down plastic waste and supports eco-friendly menstrual hygiene. Other natural materials like banana fiber, aloe vera, and hemp can also be combined with bamboo to improve hygiene and sustainability.[17]

Sansevieria trifasciata:

Sansevieria trifasciata plant fibers can be used as a biodegradable and eco-friendly absorbent core in sanitary pads. The fibers are taken from the plant's leaves and treated through scouring and bleaching to improve their absorbency. They are then coated with Rosa damascena (rose) extract using microencapsulation, which gives them antimicrobial properties. These treated
fibers effectively resist harmful microorganisms like E. coli, Pseudomonas, and Candida,
making them a safe and sustainable alternative to synthetic materials used in regular sanitary pads.[18]

Banana fiber:

These pads are designed with wings to prevent leaks and are made from banana fiber, which absorbs about 50% more liquid than the chemical materials used in regular pads. The fibers are soft and gentle on the skin, causing no irritation. Banana fiber naturally absorbs water better than cotton. Since they contain no plastic or synthetic materials, the pads break down into compost within three months or up to six months in landfills. They are also more eco-friendly than organic cotton pads, as cotton farming uses large amounts of water. During production, no bleach or harmful chemicals are used, and any water used is recycled to irrigate banana plants.[19] Banana fiber sanitary pads offer a sustainable and affordable solution that meets menstrual hygiene needs while reducing environmental impact.

This study explores the use of waste cellulose from Cavendish banana pseudo-stems as an alternative absorbent core for pads. It also compares the properties and absorbency of treated and untreated banana fibers to determine how to improve their performance for use in sanitary pad production.[20]

Water hyacinth:

Water hyacinth, a fast-growing aquatic weed that harms water ecosystems worldwide, is now being used to help improve menstrual hygiene. Researchers have found that its stems and leaves can act as good absorbent materials. The plant, known as Eichhornia crassipes, grows in still waters like lakes and rivers. Pads made from powdered water hyacinth wrapped in cotton can completely break down within two weeks after being thrown away. To make these pads, the stems are collected, cleaned, and turned into a pulp because they contain cellulose, which absorbs liquid well — the main job of a sanitary pad. The pad's top layer is cotton, the middle is made of the water hyacinth pulp, and the bottom has a beeswax coating. [22,23,24]

Hemp:

Commercial biodegradable sanitary products are often expensive which makes them difficult to use widely in low- and middle-income communities. Therefore, it's important to explore how common natural fabrics that are biodegradable can be used for making sanitary pads.

In this study, four types of natural materials were tested: (a) 100% cotton terry cloth, (b) 100% hemp cloth, (c) 100% bamboo wadding, and (d) 100% linen. Hemp, which comes from the Cannabis sativa plant, is antibacterial and absorbs water well — even better than cotton. In tests, cotton terry cloth absorbed the least liquid (6.67 ± 1.23), followed by hemp cloth (7.86 ± 0.97) and linen.

Hemp is also a versatile plant with ecological benefits and can be used in many industries including agriculture, medicine, food, textiles, construction, and personal care. Around 24% of hemp products are currently used for personal care purposes. [25,26]

Tampons:

Tampons are absorbents that provide internal protection during menstruation. They are soft plugs, usually made of cotton, that are inserted into the vagina to absorb menstrual flow before it leaves the body. Traditional tampons are expensive and not easily biodegradable, so they are not very eco-friendly.

Now, natural alternatives like sea sponge tampons are available. These are washable tampons made from natural materials such as bamboo, wool, cotton, or hemp. Some are even knitted or crocheted from absorbent fibers like cotton or wool. They work the same way as disposable tampons by being inserted into the vagina to absorb menstrual flow.[1]

Menstrual cups:

A menstrual cup is a device inserted into the vagina to collect menstrual blood and prevent leaks. Once full, it can be removed, emptied into the toilet, cleaned, and reinserted. Most cups are made of silicone, while some are made of rubber.[27]

Benefits of Menstrual Cups:

Eco-Friendly and Cost-Effective: Using a menstrual cup reduces waste because you don't throw away pads or tampons. A good cup can last for years if taken care of properly, saving money over time. While the initial cost may be higher than a box of tampons, it pays off after a few cycles.

Less Frequent Shopping: Unlike disposable products, a menstrual cup doesn't need to be replaced each month, so you don't have to buy menstrual supplies constantly. You can also carry it in a small case when you're out.

Maintains Healthy Vaginal pH: Unlike tampons, which absorb not just blood but also natural vaginal fluids, menstrual cups don't disturb the vaginal pH or healthy bacteria.

Less Odor: Since the cup collects blood without letting it touch air, it reduces the odor that can happen with pads and tampons. Sanitary pads contain chemicals for fragrance that can be avoided in the menstrual cups.

Longer Wear Time: Menstrual cups can hold more blood than pads or tampons, so they need to be emptied less often. Pads and tampons are needed to wear it for a short time but a menstrual cup can be worn for a longer period of time.

Safer Materials: Cups are made of body-safe materials without harmful chemicals, and they eliminate the small risk of toxic shock syndrome (TSS) linked to tampon use.

Infection free: There is no infection like yeast infection, bacterial vaginosis and toxic shock syndrome.[27,28,29]

Menstrual cups are the most effective eco-friendly menstrual products among all the other products.

INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

Fig.5: Eco friendly products

Sustainable hygiene:

Menstruation and the menstrual cycle are key indicators of girls' and women's health, and keeping good menstrual hygiene is very important. Yet, menstrual hygiene and its management often don't get enough attention. This study focuses on how menstrual hygiene practices vary across India and what social and economic factors influence them among women aged 15–24 years.

Menstrual hygiene means staying clean during periods by using safe absorbent materials and having access to basic needs like water, soap, and private toilets. However, due to high costs and lack of awareness, many women still use old cloth or other unsafe materials, which can lead to infections and even serious diseases like reproductive tract infections or cervical cancer.

In many low- and middle-income areas, menstrual products are too expensive, causing both physical and emotional stress. Hence, there's a need for affordable, eco-friendly, and reusable options. Conventional sanitary pads contain non-biodegradable absorbent materials (SAPs), so shifting to biodegradable or reusable pads with antibacterial properties can reduce waste and health risks.

Lack of menstrual knowledge and cultural taboos also create stigma and restrictions for women, affecting their confidence and well-being. On a policy level, more programs are needed to improve menstrual health by ensuring access to clean water, sanitation, affordable products, and proper education.

Disease caused by neglecting menstrual hygiene:

- UTI
- RTI
- Yeast infection
- Bacterial vaginosis
- Toxic shock syndrome

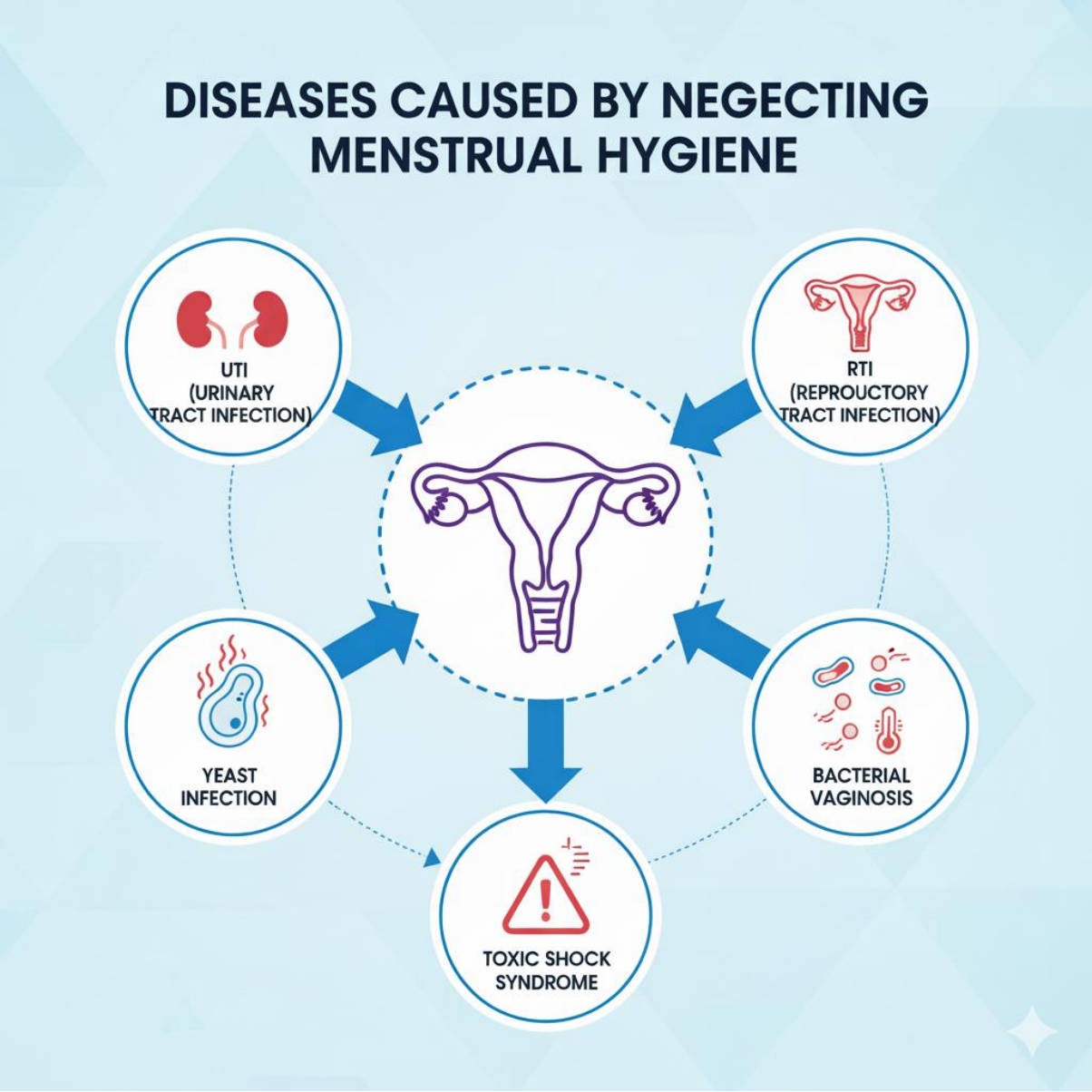

Fig.6: Disease caused by neglecting menstrual hygiene

UTI:

A urinary tract infection (UTI) happens when germs infect any part of your urinary system — the kidneys, ureters, bladder, or urethra. Most often, it affects the bladder and urethra.

Extra moisture in the genital area during menstruation also makes it easier for bacteria to move into the urinary tract.[32,33]

RTI:

Reproductive Tract Infections (RTIs) are infections that can affect different parts of the male

and female reproductive systems — such as the uterus, ovaries, fallopian tubes, cervix, vagina, and testes. These infections can be caused by bacteria, viruses, fungi, or parasites and may lead to various health problems.

Chronic cervicitis not only affects a woman's physical and mental health but also increases the chances of getting infections like HPV (human papillomavirus) and HIV (human immunodeficiency virus). [34,35]

Yeast infection:

A vaginal yeast infection happens when a type of fungus (called Candida) grows too much in the vagina. It can cause itching, burning, irritation, pain, and sometimes a thick white discharge.

This infection often flares up around the time of your period. That's because the hormone changes that happen before and during menstruation can upset the natural balance of yeast and bacteria in the vagina. When this balance is disturbed, yeast can grow more easily and cause infection.

Many women notice that their yeast infection symptoms often start right before or at the beginning of their period. [36,37]

Bacterial vaginosis:

Bacterial vaginosis (BV) is a common vaginal infection that happens when the natural balance of bacteria in the vagina changes. BV can cause a thin, gray or white discharge that sometimes has a fishy smell. Some people may also feel itching or irritation, while others might not have any symptoms at all.

BV occurs when the natural bacteria in the vagina get out of balance, allowing harmful bacteria to grow and cause infection. [38,39]

Toxic shock syndrome:

Toxic Shock Syndrome (TSS) is a rare but serious illness caused by certain bacteria, most often staphylococcus (staph) or streptococcus (strep). These bacteria release toxins that can enter the bloodstream and cause severe symptoms and if not treated quickly, it can be life-threatening. [40,41]

To improve menstrual hygiene management:

Universal access: Provide safe and affordable menstrual products, especially in rural areas.

Better infrastructure: Ensure clean water and private toilets in homes, schools, and public spaces.

Economic support: Remove taxes on menstrual products and make them affordable or free for low-income women.

Awareness and education: Include menstrual health in national WASH (Water, Sanitation, and Hygiene) programs and promote open education about it.[30,31,32]

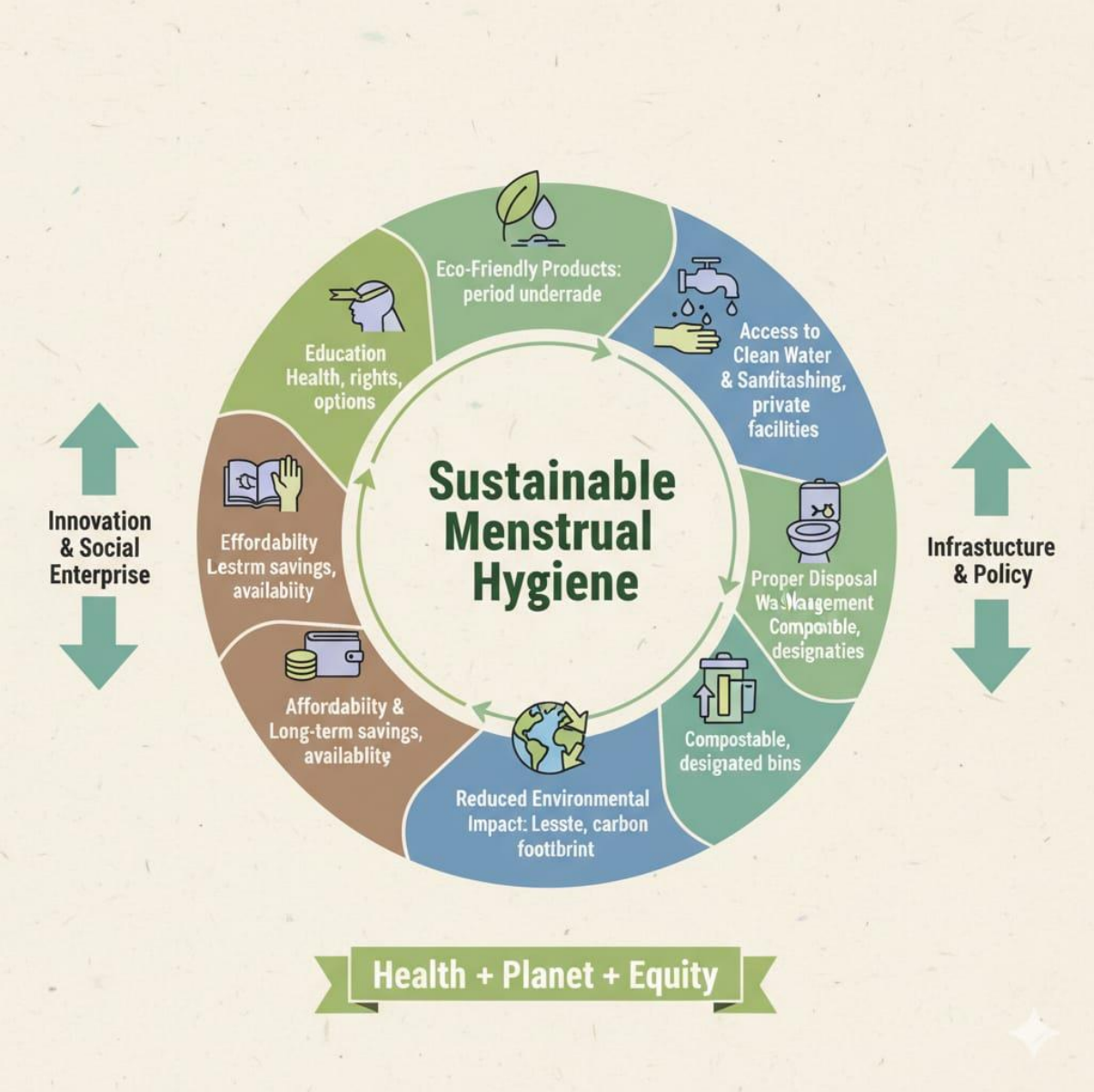

Fig.8: Sustainable menstrual hygiene Management

CONCLUSION

Maintaining proper menstrual hygiene is crucial for safeguarding women's health and protecting the environment. Neglecting hygiene during menstruation can lead to several infections such as urinary tract infections (UTI), reproductive tract infections (RTI), yeast infections, bacterial vaginosis, and toxic shock syndrome. These conditions can affect the reproductive and urinary systems, causing discomfort and serious health problems if untreated. Conventional menstrual products like sanitary pads and tampons often contain plastics and harmful chemicals, which not only pose risks to women's health but also contribute to environmental pollution. In contrast, eco-friendly alternatives such as bamboo

fiber, banana fiber, Sansevieria trifasciata, hemp, water hyacinth pads, and menstrual cups offer safer, biodegradable, and sustainable solutions.

Promoting menstrual education, ensuring access to clean water and sanitation, and encouraging the use of eco-friendly products can help improve women's overall health while reducing environmental impact. Sustainable menstrual hygiene practices are therefore essential for a healthier society and a cleaner planet.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

GEOGRAPHICAL STUDY OF EXCESSIVE USE OF CHEMICAL FERTILIZERS IN AGRICULTURE AND ITS EFFECT ON GROUND WATER QUALITIES

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ABSTRACT

Chemical fertilizers are widely used on the soil for increase agricultural production. Chemical fertilizers increase crop production but it have a negative impact on soil and water. The percentage of chemical fertilizers also affects the quality of ground water. When these chemical fertilizers are supplies to crops, they dissolve in water and percolate into the underground water. It is necessary to study the effect of chemical fertilizers on the ground water quality. In Astgaon village from the point of view that the ground water quality is pullted due to this chemical fertilizer. For this view the effect of chemical fertilizers on the water quality has been studied.

Introduction: Soil and water are most important element for agricultural productivity. This soil has developed human civilization from the last hundreds of years. Man has started his agricultural activity by fertile soil of river basin. This agriculture was started by women, As a period was goes ahead, there are more population. For this populating there was more need of the food, That's why this farmer has found of more sources of the food, He has been suggested the sources as more agriculture activity, Irrigation has more scope for the agriculture productivity, Man has also develops more agriculture equipment as plow and growing the seed, It also made productive in ahricultur3e sector,

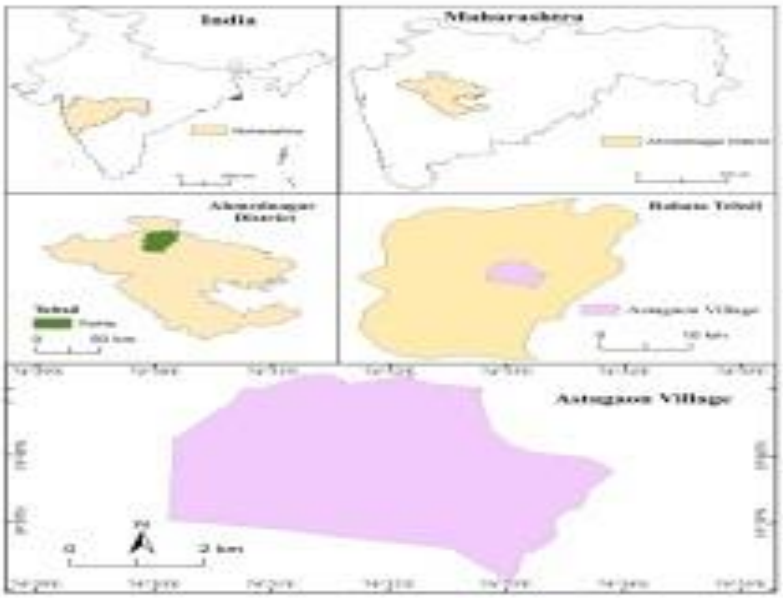
In the most developed 1950 there was chemical revolution was come ahead, It gives more fertilizer and pesticide medicine in the agriculture sector. Fertilizer has more ability for the production, mostly This fertilizer was Sodium, Potassium and Nitrogen, As market economic view and agriculture industrialization purpose man has made more utilization of the chemical fertilizer,, These fertilizer made up pollution for the soil and water in the land .Quality ground water was changed quality due the percolation of the chemical fertilizer in the agriculture activity. In this selected topic, it has made the hypothesis as – Due to the utilization of chemical fertilizer, there is pollution for the ground water, and selected area is Astgaon tahshil Rahanta in Ahilyanagar district.

Geographical Condition of Selected Area: This research area is located in the Pravara River valley, This river is origin near Kalsubai mountain ranges, Research sample has collected from the 16 square kilometer area, This region is located in the tropical climatic condition, There is alluvial soil, Most of the rainfall is occur in the monsoon period, In the rainy season there is flood for this region, This river has the gentle slope in this village. After it, this river goes toward the Pravarasangum. It joins the Ghodhawari. Soil of this village is alluvial type. This soil is very fertile for the sugarcane production. Most of the vegetation of this region is considered as the tropical monsoonal type. Total population of Astagaon is 5000. and economy is depends on agricultural activity. Due to this fertile soil most of agriculture is developed state. By providing good facility of irrigation and mechanized agriculture these farmer are using more chemical fertilizer.

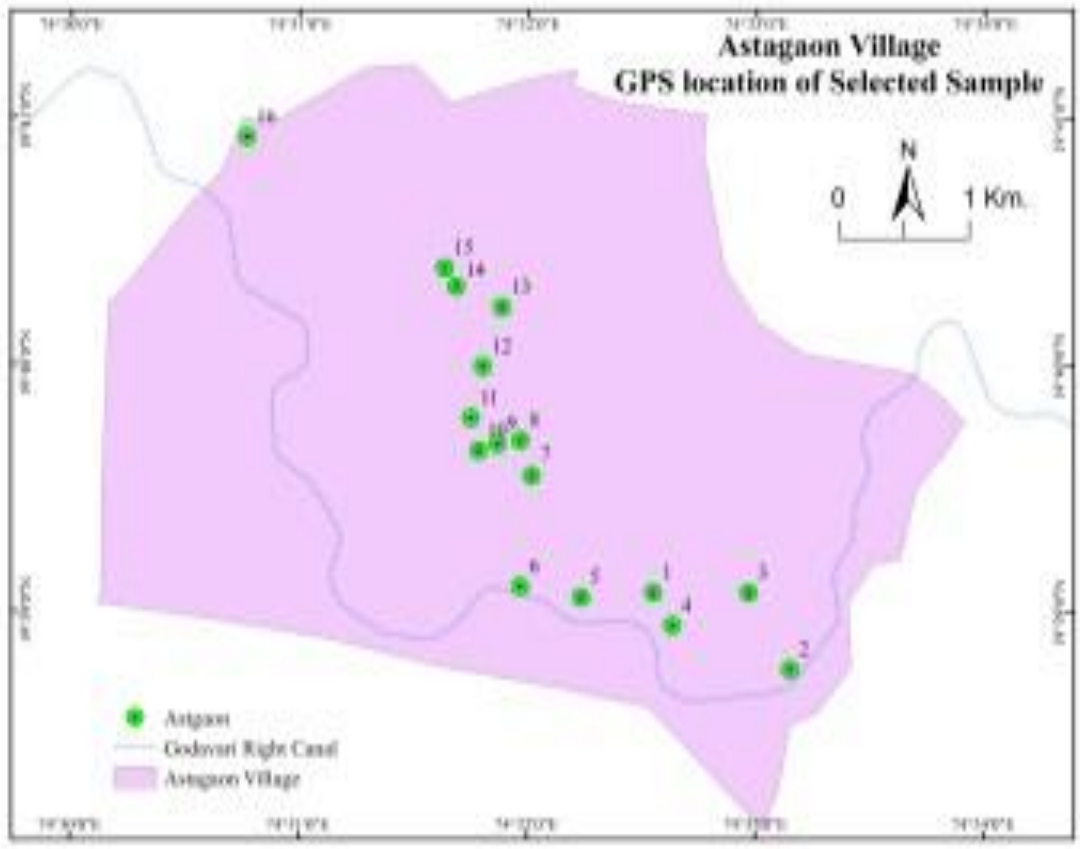
Due to utilization of more fertilizer, it has made badly effect on the water, soil, crop and environmental ecosystem. We the researcher has selected 17 sites water collection for the analysis of effects of fertilizer on ground water quality. Water pollution made number of health problem. It is also affecting the nature ecosystem as- soil and vegetation. Day by day farmer are using more chemical fertilizer for the purpose of agriculture productivity. These fertilizer mix in the in water ecosystem, It made water pollution and harmful these all living organ in the water. This fertizer direct made context with the soil. Chemical fertilizer disturbs soil productivity, physical and biological properties of the soil has been loose. It made soil and water degradation.

Geographical location of this region is Parava river basin at Astagaon village, Rahata tehsil in Ahilyanagar district. It is located in tropical region of Maharashtra state. Its Geographical location is Latitude: 190 45’ 36’’ and longitudinal extension is 740 50’ 19’’ the entire sample has collected from the 16.20 Km2

Geographical location of Study Region



Village: Astagaon Tal- Rahata (Pravara Valley)



Sources: Developed by Researcher.

Sources of Data: Research student has collected the primary data from the village site. These student had made field work from these site. The selected sites are seventeen sites .It has collected the data of water quality parameter as the hardness, Alkalinity, Soil pH condition. This data has is based on the field work sample collected in the research area. This collected sample has gives number for the identification. These sample has tested from the chemical laboratory.

Observation Table: In this observation table, It has shown the Chemical properties of the collated sample as below:

Sample No.	p^H	p^H	$E_{C\ mho}$	$E_{C\ mho}$	TS mg/l	TS mg/l	TDS mg/l	TDS mg/l	TSS mg/l	TSS mg/l	DO mg/l	DO mg/l	COD mg/l	COD mg/l	BOD mg/l	BOD mg/l	Na^{+ppm}	Na^{+ppm}	K^{+ppm}	K^{+ppm}	Alkalinity mg/l	Alkalinity mg/l	Ca+ Hardness mg/l	Ca+ Hardness mg/l	Mg+ Hardness mg/l	Mg+ Hardness mg/l	Total Hardness mg/l	Total Hardness mg/l	Chloride mg/l	Chloride mg/l	$SO_{4\ ppm}$	$SO_{4\ ppm}$
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	6.99	7.28	0.4	0.44	1400	1400	800	800	600	600	6.5	5.69	50.66	18.66	0.81	0.82	42	49	20	22	60	70	30.01	32.06	35.13	35.41	174	178	126.38	136.32	58	67
2	7	7.29	0.35	0.39	1400	1000	600	600	800	400	4.87	5.69	56	48	0.81	0.82	51	59	12	18	130	120	16.03	18.43	18.04	20.57	90	104	115.05	139.16	68	76
3	6.65	7.04	0.53	0.56	1600	800	800	600	800	200	4.87	4.87	40	66.66	0.81	0.81	43	63	13	19	180	170	34.46	32.06	48.19	48.1	232	230	144.84	157.65	48	59
4	6.9	7.15	0.45	0.48	1600	800	400	600	1200	200	5.69	6.5	45.33	21.33	0.82	0.81	49	61	20	29	150	140	32.06	33.66	38.53	39.61	190	196	129.22	139.16	41	49
5	6.68	6.88	0.4	0.47	1400	600	600	400	800	200	7.31	6.5	37.33	24	0.81	0.81	35	42	14	19	190	180	18.43	20.04	18.43	19.02	94	98	173.24	176.08	22	39
6	6.94	6.94	0.54	0.53	1100	600	800	400	300	200	4.87	5.69	45.33	21.33	0.81	0.82	65	76	12	20	130	140	26.45	24.84	57.47	57.37	262	260	186.02	188.86	31	31
7	6.9	7.34	0.37	0.39	1380	660	400	400	980	280	7.31	7.31	66.66	16	1.62	0.81	38	51	20	28	190	200	16.83	18.43	25.66	25.75	122	124	124.96	134.09	39	49
8	6.84	6.83	0.57	0.59	1640	1120	400	800	1240	320	6.5	6.5	56	18.66	0.81	0.81	70	94	12	20	150	160	15.23	17.63	38.73	37.17	174	170	105.08	109.34	47	58
9	6.4	7.3	0.48	0.55	1000	1200	600	400	400	800	6.5	7.31	29.33	74.66	1.63	0.81	65	94	11	11	200	200	16.03	18.43	31.71	33.56	146	156	130.64	144.84	56	66
10	6.45	6.96	0.37	0.38	1600	800	600	600	1000	200	5.69	4.87	13.33	80	0.82	0.81	22	33	12	20	170	180	24.04	20.04	26.63	24.87	134	122	161.88	171.82	76	70
11	6.39	6.9	0.49	0.52	1600	800	800	600	800	200	8.13	8.94	21.33	58.66	1.63	1.83	43	65	31	33	130	140	37.67	33.66	47.9	46.93	234	226	96.56	107.92	59	61
12	6.8	6.13	0.35	0.38	1400	600	400	400	1000	200	6.5	6.5	40	66.66	0.81	0.81	18	20	22	30	220	230	32.06	35.27	22.43	22.62	124	128	105.08	116.44	39	45
13	6.72	6.9	0.37	0.39	1000	1000	600	600	400	400	6.5	7.31	26.66	56	0.81	0.81	20	26	29	40	133	140	35.27	37.67	21.16	22.52	122	130	124.96	136.32	30	40
14	6.72	7.3	0.39	0.36	1400	1400	400	600	1000	800	8.13	7.31	18.66	48	0.82	1.62	17	22	49	57	160	180	42.48	45.69	36.48	37.16	192	198	147.68	160.46	38	46
15	6.21	7.06	0.45	0.46	1200	800	600	600	600	200	7.31	8.13	8	74.66	0.81	0.81	22	31	46	54	120	140	45.69	47.29	45.45	46.53	232	238	171.82	183.18	22	30
16	6.75	7.1	0.53	0.59	1200	1000	600	300	600	400	8.94	8.94	37.33	69.33	1.63	1.63	41	57	32	40	160	180	85.77	89.77	26.4	27.87	194	204	164.72	168.98	63	66

Composed by Researcgher

The above water quality analysis table comparing several parameters Before (Pre) and After (Post) a treatment process across 16 different sample locations.

The table shows the values for numerous parameters, including:

- **pH:** A measure of acidity or alkalinity.
- **TS (Total Solids):** The total amount of dissolved and suspended solids in the water.
- **TDS (Total Dissolved Solids):** The measure of all inorganic and organic substances dissolved in the water (e.g., minerals, salts).
- **TSS (Total Suspended Solids):** The dry-weight of particles suspended in the water that can be trapped by a filter.
- **DO (Dissolved Oxygen):** The amount of oxygen available to aquatic life.
- **BOD (Biochemical Oxygen Demand):** The amount of oxygen required by microorganisms to break down organic matter. High BOD indicates high organic pollution.

• **COD (Chemical Oxygen Demand**): The amount of oxygen required to chemically oxidize all organic and inorganic substances. It indicates the total amount of oxidizable pollutants.

• **Turbidity:** A measure of water cloudiness or murkiness caused by suspended solids.

• **Alkalinity, Hardness (Total, Calcium, Non-Carbonate), Chloride, and Sulfate**: Measures of various chemical constituents and properties.

General Observations on Treatment Effectiveness

A general trend can be observed by comparing the 'Pre' and 'Post' values for most samples:

• **pH:** The pH values, which are around 7.0-7.4 pre-treatment, remain in a similar range post-treatment, suggesting the treatment process is not significantly altering the pH towards extremes. The range of 6.5 to 8.5 is generally considered acceptable for drinking water.

• **TS, TDS, and TSS:** These values generally show a decrease from the 'Pre' to 'Post' columns, indicating the treatment is effective at removing both suspended and dissolved solids. For example, in Sample 1, TS drops from 1400 mg/L to 800 mg/L.

• **BOD and COD:** These are critical indicators of organic pollution. The values for BOD and COD show a notable decrease across all samples. For instance, in Sample 1, BOD drops from 0.02 mg/L to 0.02 mg/L (very low to begin with) and COD drops from 8.64 mg/L to 5.46 mg/L. This suggests the treatment is effectively reducing the organic load.

• **Hardness:** Total Hardness (mg/L) and its components generally show a decrease, which is a desired outcome for water used in homes and industry, as high hardness can cause scaling. In Sample 1, Total Hardness drops from 35.41 mg/L to 28.57 mg/L.

• **Chloride and Sulfate:** These common inorganic ions also show a decrease from pre- to post-treatment, further confirming the removal of dissolved salts.

RESULT

This table gives the result as the more water pollution. It has crossed all parameter of the water qualities as the Farmers use large amounts of chemical fertilizers to increase crop yields, which affects the water ratio. For this, a total of 8 + 8 (16) samples have been taken from farmers' wells and bore wells around Canal in Astgaon. This shows that there is a difference between the water quality when the farmer irrigates the farm with backwater and the water quality before irrigation

CONCLUSION

Farmers use large amounts of chemical fertilizers to get more produce from their fields. The effects of the use of this chemical fertilizer on the land as well as the water have been found to be very dangerous. This polluted water had badly effected on the food eco-system. Soil ecosystem,

Agriculture ecosystem and water ecosystem may be badly effected. In the coming period all over the world is come in truble by the over fertilizer and pesticide over utilization.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

ANTIDIABETIC AND ANTIHYPERLIPIDEMIC EFFECTS OF OPUNTIA FICUS-INDICA AND GARCINIA INDICA: A COMPREHENSIVE REVIEW

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ABSTRACT

Type 2 diabetes mellitus (T2DM) and dyslipidemia are chronic metabolic disorders strongly linked to the global rise in cardiovascular diseases. Despite advances in drug therapy, the limitations of single-target agents have stimulated research into plant-based multi-targeted remedies. Opuntia ficus-indica (prickly pear cactus) and Garcinia indica (kokum) have been widely studied for their antidiabetic and lipid-lowering potentials. This review thoroughly examines their phytochemical constituents, molecular mechanisms of action, preclinical and clinical evidence, safety, and therapeutic prospects. Key mechanisms include inhibition of carbohydrate-hydrolyzing enzymes, enhancement of insulin secretion and sensitivity, reduction of oxidative stress and inflammation, modulation of hepatic glucose and lipid metabolism, and beneficial alterations of gut microbiota. Clinical and experimental data increasingly support their adjunctive role in managing diabetic and dyslipidemic conditions.

KEYWORDS

Opuntiaficus-indica, Garcinia indica, Antidiabetic, Antihyperlipidemic, Phytochemicals, Metabolic syndrome

INTRODUCTION

Type 2 diabetes mellitus (T2DM) and dyslipidemia collectively constitute major global health concerns, significantly contributing to cardiovascular disease, morbidity, and mortality worldwide. The pathogenesis of T2DM is multifactorial, involving insulin resistance, pancreatic β-cell dysfunction, chronic low-grade inflammation, and oxidative stress, all culminating in persistent hyperglycemia. Dyslipidemia, characterized by elevated plasma triglycerides, low-density lipoprotein cholesterol (LDL-C), and decreased high-density lipoprotein cholesterol (HDL-C), often occurs concurrently and exacerbates vascular complications [1–3]. Although current pharmacological agents such as metformin and statins have improved disease management, their use is associated with limitations including adverse side effects, drug intolerance, and incomplete metabolic control, highlighting the need for alternative or complementary therapies.

Medicinal plants and their bioactive phytochemicals have gained attention due to their multitarget actions, safety profiles, and potential cost-effectiveness. Among these, Opuntia ficus-indica (prickly pear cactus) and Garcinia indica (kokum) stand out for their traditional use in managing hyperglycemia and lipid disorders. Opuntia ficus-indica is rich in dietary fibers, polysaccharides, flavonoids, and betalains, compounds known for their antioxidant, anti-inflammatory, and metabolic modulatory effects[4–6]. It has been investigated extensively for its ability to improve glucose and lipid homeostasis through mechanisms such as inhibiting carbohydrate-digesting enzymes, enhancing insulin secretion, improving insulin sensitivity, and modulating gut microbiota [7–9]. Garcinia indica contains polyisoprenylated benzophenones (e.g., garcinol), anthocyanins, and hydroxycitric acid, which exert antioxidative effects, inhibit lipogenesis, and improve insulin signaling pathways [10–12]. Recent studies have revealed that these botanicals impact multiple metabolic pathways synergistically, making them promising candidates for integrated diabetes and dyslipidemia management. This review elaborates on the molecular mechanisms, preclinical and clinical evidence, and safety considerations of Opuntia ficus-indica and Garcinia indica, with the objective of highlighting their therapeutic potential as adjunctive or alternative interventions against metabolic disorders.

Phytochemical Composition

Opuntia ficus-indica is a xerophytic cactus found worldwide, rich in polysaccharides (notably mucilage and pectin), insoluble and soluble dietary fibers, polyphenolic flavonoids such as quercetin, isorhamnetin, and kaempferol, and betalain pigments including betanin and indicaxanthin which impart red to orange colors to its fruit. It also contains vitamins (A, C, E) and essential minerals like calcium, magnesium, and potassium, with seeds rich in unsaturated fatty acids such as oleic and linoleic acids[13–17].

Garcinia indica, native to the Western Ghats in India, is characterized by its fruit rind rich in polyisoprenylated benzophenones (notably garcinol), anthocyanins (cyanidin derivatives), hydroxycitric acid (HCA), flavanols, and xanthones. These compounds confer both antioxidant properties and metabolic regulatory actions [18–22].

Table 1: Summary of Major Bioactive Constituents in OFI and GI

Plant	Compound Class	Key Compounds	Plant Source
Opuntia ficus-indica	Polysaccharides, Flavonoids, Betalains	Mucilage, pectin, quercetin, isorhamnetin, betanin, indicaxanthin	Cladodes, fruits, seeds

Garcinia indica	Benzophenones, Anthocyanins, Hydroxycitric acid	Garcinol, cyanidin derivatives, HCA	Fruit rind, pulp

Molecular Mechanisms of Antidiabetic Activity

The antidiabetic effects of OFI and GI operate at multiple biochemical and cellular levels, synergizing to improve glycemic control and mitigate diabetes progression.

Inhibition of Carbohydrate-Digesting Enzymes: Both plants display potent inhibition of α-amylase and α-glucosidase enzymes, impeding starch and disaccharide breakdown in the intestinal lumen. This effect slows glucose absorption after meals, blunting postprandial plasma glucose spikes, which are critical in managing glycemic excursions in diabetic patients [23–26].

Enhancement of Pancreatic β-cell Function and Insulin Secretion: OFI polysaccharides and betalains protect β-cells from oxidative damage and apoptosis induced by glucolipotoxicity, preserve β-cell mass, and upregulate glucose-stimulated insulin secretion (GSIS). Likewise, GI's garcinol and anthocyanins exert antioxidant protection that safeguards β-cell integrity and function, helping maintain endogenous insulin production [27–31].

Improvement of Insulin Sensitivity and Peripheral Glucose Uptake: OFI flavonoids activate AMP-activated protein kinase (AMPK) signaling in skeletal muscle and adipose tissue, facilitating insulin-independent translocation of the glucose transporter GLUT4 to the plasma membrane and enhancing glucose uptake. This improves peripheral insulin sensitivity and helps counteract insulin resistance, a hallmark of T2DM. Similarly, GI bioactives enhance insulin signaling via increased phosphorylation of insulin receptor substrates (IRS-1, IRS-2), activation of the downstream PI3K/AKT pathway, and stimulation of GLUT4 translocation [32–36].

Suppression of Hepatic Gluconeogenesis: OFI constituents downregulate key gluconeogenic enzymes, including phosphoenolpyruvate carboxykinase (PEPCK) and glucose-6-phosphatase (G6Pase), resulting in reduced hepatic endogenous glucose output and lower fasting blood glucose concentrations [37–39].

Gut Microbiota Modulation: Dietary fibers and polyphenolic compounds in OFI positively modulate gut microbiota composition by increasing the abundance of beneficial short-chain fatty acid (SCFA)-producing bacteria (e.g., Bifidobacterium and Lactobacillus). The resultant SCFAs, such as butyrate and propionate, enhance incretin secretion and systemic insulin sensitivity, contributing to glucose homeostasis [40–42].

Inhibition of Advanced Glycation End-Products (AGEs): GI phenolic constituents inhibit the formation of AGEs, toxic compounds formed by non-enzymatic glycation of proteins and lipids. AGEs mediate diabetic complications through oxidative stress and inflammation; thus, their inhibition by GI may attenuate disease progression [43–45].

Molecular Mechanisms of Antihyperlipidemic Activity: Both OFI and GI regulate lipid metabolism by influencing synthesis, breakdown, and clearance
pathways.

Cholesterol Biosynthesis and Clearance: OFI reduces hepatic expression and activity of 3- hydroxy-3-methylglutaryl-CoA reductase (HMG-CoA reductase), the rate-limiting enzyme in cholesterol synthesis. Concurrently, upregulation of low-density lipoprotein (LDL) receptor expression enhances clearance of circulating LDL cholesterol from plasma, improving lipid profiles[46–48]. GI's hydroxycitric acid (HCA) inhibits ATP citrate lyase, a key enzyme shunting carbohydrate metabolites into fatty acid synthesis pathways, thus reducing hepatic triglyceride and cholesterol synthesis[49–51]. Enhancement of Bile Acid and Sterol Excretion: The high soluble fiber content of OFI binds bile acids and cholesterol in the intestinal tract, increasing their fecal excretion and thereby reducing enterohepatic recirculation of cholesterol and serum cholesterol levels.

Suppression of Adipogenesis: OFI polyphenols downregulate key adipogenic transcription factors peroxisome proliferator-activated receptor gamma (PPARγ) and CCAAT/enhancer binding protein alpha (C/EBPα), reducing differentiation and lipid accumulation in adipocytes, which can translate into improved lipid metabolism.

Promotion of Fatty Acid Oxidation: GI activates PPARα, enhancing β-oxidation of fatty acids in the liver and muscle, promoting lipid catabolism, and reducing triglyceride storage.

Protection Against Lipoprotein Oxidation: Both plants contain potent antioxidants (betalains, anthocyanins, garcinol) that inhibit oxidative modification of LDL particles, an early and critical step in atherogenesis.

Table 2: Summary of Key Mechanisms for Antidiabetic and Antihyperlipidemic Effects

Mechanism	Opuntia ficus-indica	Garcinia indica
Enzyme Inhibition	α-Amylase, α-glucosidase	α-Amylase, α-glucosidase
Insulin Secretion & β-cell Protection	Antioxidant effects on β-cells; GSIS enhancement	Antioxidant protection; preserves β-cell function

Insulin Sensitivity	AMPK activation; GLUT4 translocation	IRS-PI3K/AKT pathway activation; GLUT4 translocation
Hepatic Gluconeogenesis	Downregulates PEPCK, G6Pase	Not well established
Gut Microbiota Modulation	Increases SCFA-producing bacteria	Limited data
Cholesterol Regulation	Inhibits HMG-CoA reductase; increases LDL-R expression	Inhibits ATP citrate lyase; reduces lipogenesis
Lipid Excretion	Soluble fiber binds bile acids, increases fecal sterols	No significant data
Adipogenesis Inhibition	Downregulates PPARγ, C/EBPα	Activates PPARα to boost β-oxidation
Antioxidant Protection	Betalains and polyphenols protect LDL from oxidation	Anthocyanins and garcinol inhibit lipid peroxidation

Experimental and Clinical Evidence

Preclinical Animal Studies: Numerous studies in diabetic and hyperlipidemic rodent models have demonstrated that oral administration of OFI extracts (100–500 mg/kg/day) significantly reduces fasting blood glucose, improves glucose tolerance, decreases glycosylated hemoglobin (HbA1c), and normalizes lipid parameters including total cholesterol, LDL cholesterol, triglycerides, and raises HDL cholesterol. OFI also induces AMPK phosphorylation and increases GLUT4 expression in muscle and adipose tissue, correlating with improved insulin sensitivity [52–56]. Combination treatments of OFI with standard drugs (e.g., metformin) exhibit synergistic benefits.

GI extracts similarly lower blood glucose levels and improve lipid profiles in rodent models, along with attenuating hepatic steatosis in high-fat diet models by modulating lipogenic and β-oxidation pathways. GI constituents protect pancreatic histology, reduce oxidative biomarkers, and improve insulin signaling [57–60].

In Vitro Cellular Studies: Both OFI and GI bioactives enhance glucose uptake in muscle and adipocyte cell lines by stimulating GLUT4 translocation. They reduce oxidative stress markers such as reactive oxygen species (ROS), inhibit inflammatory signaling via NF-κB, and promote β-cell viability under glucolipotoxic conditions. GI phenolics inhibit AGE formation in cultured cells [61–64].

Clinical Trials: Clinical studies on OFI in humans include randomized controlled trials administering OFI extracts or fiber formulations (400–1000 mg/day over 8–12 weeks) in patients with T2DM or impaired glucose tolerance. These trials reported improvements in fasting and postprandial blood glucose, reductions in HbA1c, enhanced insulin sensitivity (HOMA-IR), and modest improvements in lipid profiles without serious adverse effects. Studies also noted its antioxidant and anti-inflammatory benefits [65–69]. Clinical data regarding GI remain limited but suggest beneficial antioxidant effects, modest lipid-lowering activity, and improvement in insulin sensitivity markers in small cohorts.

DISCUSSION

The intricate pathophysiology of T2DM and dyslipidemia demands interventions that target multiple metabolic pathways simultaneously. Both Opuntia ficus-indica and Garcinia indica embody such multifaceted approaches by acting on key biochemical targets involved in glucose and lipid homeostasis, oxidative stress, inflammation, and gut microbial balance. The inhibitory effects on carbohydrate-digesting enzymes (α-amylase and α-glucosidase) by both plants represent a direct mechanism to mitigate postprandial hyperglycemia, a significant early abnormality and therapeutic target in T2DM. This enzymatic inhibition reduces glucose influx into circulation and mitigates glycemic excursions that contribute to oxidative and inflammatory stress in tissues. Beyond absorption, Opuntia ficus-indica enhances pancreatic β-cell function through its rich polysaccharides and betalain pigments, which afford antioxidant protection to β-cells vulnerable to glucolipotoxicity. This action preserves insulin secretory capacity and prevents β-cell apoptosis, a key event in T2DM progression. Simultaneously, activation of AMPK and promotion of GLUT4 expression in peripheral tissues by Opuntia bioactives improve insulin sensitivity and peripheral glucose uptake, addressing the essential insulin resistance component of diabetes. A similar insulin-sensitizing mechanism is observed for Garcinia indica, where garcinol enhances insulin receptor substrate activation and PI3K/AKT signaling, crucial for effective insulin-mediated glucose utilization [70–75].

Modulation of hepatic glucose production is another important aspect where Opuntia downregulates gluconeogenic enzymes PEPCK and G6Pase, thereby reducing endogenous glucose release during fasting periods and improving glycemic control metrics like fasting glucose and HbA1c. Moreover, the dietary fibers and polyphenols of Opuntia influence gut microbiota composition by enriching SCFA-producing bacteria, including Bifidobacteria and Lactobacillus species, which play critical roles in metabolic regulation via incretin secretion and anti-inflammatory effects. This gut microbiota modulation emerging as an important indirect mechanism for metabolic benefits is being actively investigated and represents a novel therapeutic axis [76–79].

Lipid metabolism is robustly targeted by both plants but via distinct pathways. Opuntia ficus-indica inhibits cholesterol biosynthesis by suppression of HMG-CoA reductase, the rate-limiting enzyme in this pathway, and concurrently increases LDL receptor expression, enhancing LDL clearance from circulation and improving dyslipidemia. Its high content of soluble fibers also promotes fecal excretion of bile acids and sterols, reducing enterohepatic recycling of cholesterol. In parallel, Garcinia indica's hydroxycitric acid inhibits ATP citrate lyase, curtailing the conversion of citrate to acetyl-CoA, a critical substrate for fatty acid and cholesterol synthesis, effectively reducing lipogenesis in hepatocytes. Garcinol and other polyphenols further suppress lipogenic gene expression (FAS and SREBP-1c) while activating PPARα, which enhances fatty acid β-oxidation, thus facilitating lipid catabolism and attenuation of hepatic and systemic lipid accumulation [80–84].

A key shared property of both plants is antioxidant and anti-inflammatory capacity. They effectively scavenge reactive oxygen species and downregulate inflammatory cytokines such as TNF-α and IL-6, which are pivotal in the development and progression of insulin resistance and atherogenesis. By reducing LDL oxidation, they inhibit a crucial step in plaque formation and cardiovascular risk elevation. Nevertheless, while clinical data on Opuntia ficus-indica is compelling, with multiple trials demonstrating significant improvements in glycemic and lipid parameters and excellent tolerability, clinical evidence for Garcinia indica remains preliminary and largely preclinical [85–89]. Standardization of extracts, dosage optimization, and long-term studies, especially for Garcinia indica, are necessary to validate and translate its utility into clinical practice.

Potential exists for synergistic formulations combining OFI and GI to exploit complementary mechanisms; such combination strategies may provide enhanced benefits over single botanicals alone but require rigorous scientific validation and clinical trials. Additionally, further research into their roles in gut microbiome modulation and potential epigenetic impacts will deepen understanding and may reveal novel therapeutic avenues.

In conclusion, Opuntia ficus-indica and Garcinia indica exhibit promising multimodal actions addressing major biological contributors to diabetes and dyslipidemia. They represent viable adjuncts or alternatives in holistic metabolic disorder management, aligning with contemporary emphasis on natural product-based therapeutics with multitargeted properties and favorable safety profiles.

CONCLUSION

In summary, Opuntia ficus-indica and Garcinia indica stand out as multifunctional botanical agents with significant antidiabetic and antihyperlipidemic effects. Their rich phytochemical composition enables targeting of diverse biochemical pathways involved in hyperglycemia and dyslipidemia. While OFI enjoys robust clinical support, GI holds considerable promise pending further trials. Their excellent

safety and multifaceted mechanisms provide a compelling rationale for their inclusion as complementary therapeutics in metabolic disease management.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

CIRCUMONCOBOTHRIUM DEEPAE SP. NOV. (CESTODA: PTYCHOBOTHRIDAE) FROM FRESHWATER FISH MASTACEMBELUS ARMATUS (LACEPEDE, 1800) FROM OSMANABAD DISTRICT, MAHARASHTRA, INDIA

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Abstract

Ten cestode parasites belonging to the genus *Circumoncobothrium* Shinde, 1968 were collected from the intestine of the freshwater fish *Mastacembelus armatus* (Lacepede, 1800) from Sina Kolegaon Dam, District Osmanabad, Maharashtra, India, during December 2010. Detailed morphological and morphometric studies revealed that the present specimens differ distinctly from all known species of the genus. The species is characterized by a triangular scolex with 28 rostellar hooks arranged in two rows, short neck, sac-like bothria, 130–137 rounded testes, bilobed ovary with long isthmus, saccular uterus, non-operculated eggs, and granular vitellaria arranged in two to three rows. On the basis of these unique diagnostic features, the present cestode is described as a new species, *Circumoncobothrium deepae* sp. nov., named in honour of Mrs. Deepa D. Jadhav.

Keywords: Cestoda, *Circumoncobothrium*, New species, *Mastacembelus armatus*, Taxonomy, India

Introduction

Cestode parasites of freshwater fishes exhibit remarkable diversity and play an important role in helminth systematics and fish parasitology. The genus *Circumoncobothrium* Shinde, 1968 (Order: Pseudophyllidea; Family: Ptychobothridae) is well represented in Indian freshwater fishes, with numerous species described from different hosts and localities based on distinct morphological characters. During a parasitological investigation of freshwater fishes from Sina Kolegaon Dam, Osmanabad district, cestode specimens were recovered from *Mastacembelus armatus*. Critical examination revealed that these specimens belong to the genus *Circumoncobothrium* but differ significantly from all known species. The present paper deals with the description and establishment of a new species, *Circumoncobothrium deepae* sp. nov.

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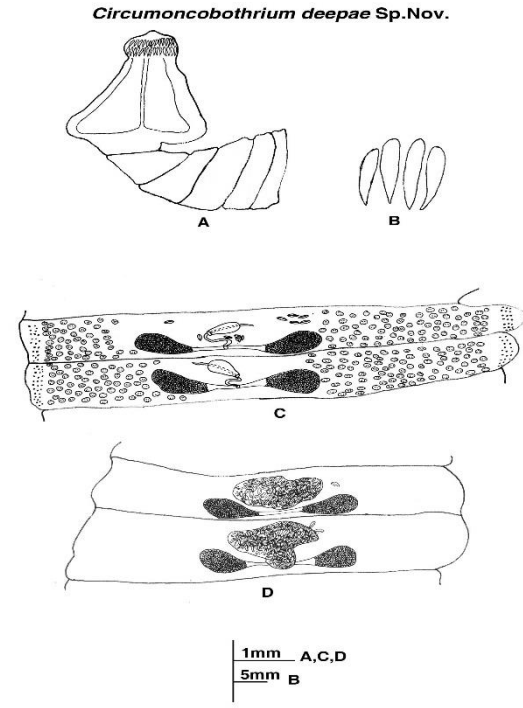
Materials and Methods

Ten cestode parasites were collected from the intestine of freshly caught specimens of *Mastacembelus armatus* (Lacepede, 1800) from Sina Kolegaon Dam, District Osmanabad, Maharashtra, India, during December 2010. The worms were flattened and preserved in 4% formalin. Permanent whole-mount preparations were made by staining with Borax carmine, dehydrating through ascending grades of alcohol, clearing in xylene, and mounting in DPX. Drawings were prepared with the aid of a Camera Lucida. All measurements are given in millimeters.



A) Scolex B) Hooks C) Mature proglottid D) Gravid proglottid

Description

All ten specimens exhibited uniform morphological and morphometric characters, confirming their conspecific nature. The worms were long, thin, flattened, and milky white in colour, consisting of a scolex followed by numerous immature, mature, and gravid segments. The scolex was small, well developed, triangular in shape, narrow anteriorly and broad posteriorly, measuring 2.65 (2.63–2.67) mm in length and 2.65 (1.37–2.13) mm in breadth. The anterior end bore 28 rostellar hooks arranged in two rows, measuring 2.96 (2.65–3.28) mm in length and 0.46 (0.39–0.54) mm in breadth. Two sac-like bothria were present, measuring 4.47 (4.38–4.75) mm in length and 1.37 (1.33–1.41) mm in breadth. The neck was present, very short, measuring 0.72 (0.57–0.87) mm in length and 0.87 (0.80–0.95) mm in breadth, followed by a chain of segments. Mature proglottids were long and eight times

broader than long, measuring 0.99 (0.87–1.10) mm in length and 8.18 (7.66–8.69) mm in breadth. Testes were rounded, 130–137 in number, situated in the lateral fields of the segment, measuring 0.36 (0.26–0.45) mm in length and breadth. The cirrus pouch was oval, measuring 0.15 (0.11–0.19) mm in length and 0.47 (0.38–0.57) mm in breadth. The cirrus was thin and tubular, measuring 0.53 mm in length and 0.03 mm in breadth. The vagina was thin and tubular, originating from the genital pore posterior to the cirrus pouch, measuring 0.95 mm in length and 0.76 mm in breadth. The genital pore was small and oval, measuring 0.11 mm × 0.03 mm. The ovary was bilobed, each lobe oval and connected by a long isthmus, situated in the posterior half of the segment, measuring 0.41 (0.34–0.49) mm in length and 0.85 (0.72–0.99) mm in breadth. Gravid segments were broader than long, measuring 1.22 mm in length and 6.67 mm in breadth. The uterus was saccular, filled with numerous eggs, measuring 0.57 (0.38–0.76) mm in length and 1.52 (1.48–1.56) mm in breadth. Eggs were non-operculated, measuring 0.17 mm in length and 0.39–0.46 mm in breadth. Vitellaria were granular and arranged in two to three rows along each lateral margin of the segment.

Results & Discussion

Ten cestode specimens were recovered from the intestine of the freshwater fish *Mastacembelus armatus* (Lacepede, 1800) collected from Sina Kolegaon Dam, District Osmanabad, Maharashtra, India, during December 2010. All specimens showed uniform morphological and morphometric characters, confirming their conspecific nature.

The worms were long, thin, flattened, and milky white in colour, consisting of a distinct scolex followed by numerous immature, mature, and gravid proglottids. The scolex was small, well developed, triangular in shape, narrow anteriorly and broad posteriorly, measuring 2.65 (2.63–2.67) mm in length and 2.65 (1.37–2.13) mm in breadth. The anterior end of the scolex bore 28 rostellar hooks arranged in two rows. Two sac-like bothria were present, measuring 4.47 (4.38–4.75) mm in length and 1.37 (1.33–1.41) mm in breadth.

The neck was present and very short, measuring 0.72 (0.57–0.87) mm in length and 0.87 (0.80–0.95) mm in breadth, followed by a chain of segments. Mature proglottids were elongated and eight times broader than long, measuring 0.99 (0.87–1.10) mm in length and 8.18 (7.66–8.69) mm in breadth. Testes were rounded, 130–137 in number, and located in the lateral fields of the segment, each measuring 0.36 (0.26–0.45) mm in length and breadth. The cirrus pouch was oval, measuring 0.15 (0.11–0.19) mm in length and 0.47 (0.38–0.57) mm in breadth. The cirrus was thin and tubular, measuring 0.53 mm in length and 0.03 mm in breadth. The vagina was tubular, originating from the genital pore posterior to the cirrus pouch, measuring 0.95 mm in length and 0.76 mm in breadth. The genital pore was small and oval, measuring 0.11 mm × 0.03 mm. The ovary was bilobed, with each

lobe oval and connected by a long isthmus, situated in the posterior half of the segment, measuring 0.41 (0.34–0.49) mm in length and 0.85 (0.72–0.99) mm in breadth. Gravid segments were broader than long, measuring 1.22 mm in length and 6.67 mm in breadth. The uterus was saccular and filled with numerous eggs, measuring 0.57 (0.38–0.76) mm in length and 1.52 (1.48–1.56) mm in breadth. Eggs were non-operculated. Vitellaria were granular and arranged in two to three rows along each lateral margin of the segment. The genus *Circumoncobothrium* was established by Shinde (1968) with *C. ophiocephali* as the type species. The present species resembles members of the genus in general morphological organization but differs distinctly from all known species in several important diagnostic characters. *Circumoncobothrium deepae* sp. nov. differs from previously described species such as *C. ophiocephali*, *C. aurangabadensis*, *C. raoii*, *C. gachuai*, *C. shindei*, *C. bagariusi*, *C. khami*, *C. yamaguti*, *C. alii*, *C. vadgaonensis*, *C. baimaii*, *C. punctatusi*, *C. armatusae*, *C. mastacembelusae*, *C. vitellariensis*, *C. cirrhinae*, *C. mehdii*, *C. ambajogaiensis*, *C. yogeshwari*, *C. purnae*, *C. naidui*, *C. paithenensis*, *C. thapari*, *C. jadhavae*, *C. clariasi*, *C. osmanabadensis*, and *C. bhairavii* in the number and arrangement of rostellar hooks, presence of short neck, number of testes, ovary structure, egg morphology, and granular vitellaria. The unique combination of 28 rostellar hooks arranged in two rows, short neck, 130–137 testes, bilobed ovary with long isthmus, saccular uterus, non-operculated eggs, and granular vitellaria clearly supports the establishment of a new species.

Conclusion:

Based on detailed morphological and comparative analysis, the cestode parasite recovered from *Mastacembelus armatus* represents a distinct and previously undescribed species. It is therefore proposed as ***Circumoncobothrium deepae* sp. nov.**, named in honour of the author's mother, Mrs. Deepa D. Jadhav. The present study adds valuable information to the taxonomy of *Circumoncobothrium* and the cestode fauna of Indian freshwater fishes.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

ALLEOPATHIC EFFECT OF AQUEOUS LEAF EXTRACT OF *MUNDULEA SERESIA* WILLD ON SEED GERMINATION AND SEEDLING GROWTH OF BRINJAL

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Abstract:

Fresh leaves of *Mundulea seresia* Willd were collected from Mirzapur village of Sangmner Tahasil in Maharashtra and aqueous extracts from leaves of the selected plants were prepared 5 gms, 10gms, 15 gms, 20 gms, and 25 gms of fresh leaves were grinded separately, mixed with 100 ml distilled water, aqueous extract was obtained as filtrate. This extract was diluted again with distilled water and 10%, 20%, 40%, 60%, 80% and 100% concentrations were made whereas distilled water as a control. The effect of *Mundulea seresia* W. aqueous extract on seed germination of brinjal by using paper towel method (Singh et al. 1972) was studied.In this present investigation it was proved that that the leaf extract conc.made from 20 and 25 gm *Mundulea seresia* Willd leaves showed satisfactory result to enhance the % seed germination and seedling growth

Key words: Alleopathy, *Mundulea seresia* Willd, % seed germination.

Introduction:

Alleopathy is also a biological phenomenon in which one of more biochemicals produced influence the growth, Survival & reproduction of other organism. These biochemicals known as allelochemicals can have beneficial effect Hollanda (Positive alleópathy) on the target organism. (Belel & Rahimatu, 2012). The Austrian plant physiologist & father of alleopathy Hans Molisch gave formal name alleopathy in 1937, for the chemical interactions among plants, including those mediated by microorganisms. The term alleopathy is derived from the Greeek words. allelon "of each other" & pathos" to "suffer" (Rizvi, et.al 1992) & has been used in literature dealing With inter-specific chemical interactions between organisms (Yang et al 2002). Alleopathy is define as any direct or indirect, harmful or beneficial effect of plant it's own or on, another plant through release of chemical into the environment (B.K. Avchad, et al, 2012).

Alleopathy occurs through the release of 26m Chemicals by one plant species which has a detrimental effect on other species growing in its vicinity (An et al. 1998). The alleopathic Substance are commonly found in plantextracts and in plant residue of soil, leaves, rhizome, flower, fruit &seed. The alleochemical directly effect on seed germination & seedling growth (Dhole et al, 2013).

Alleochemical found in any part of the plant, but the greatest amounts are often located in the root & leaves (Inderjit & Dakshini, 1994 ; Oliwa et .al.2017).The alleochemicals like phenolic compound, mono& sesquiterpers, triterpens the terpenoide triterpenoidesquienes essential oil, flavonoids biocides etc, in specific conditions alleochemical substances exuded in to the environment, they can effect germination, root& stem growth.

The allelochemicals can exhibit either a direct &or an indirect action on the plant. The direct action involves the biochemical/physiological effects on various important processes of plant growth & metabolism while the indirect action. effects involve the alternation of soil properties, nutritional statue & an altered population or activity of microorganisms nematodes.With the rapid development of analytical techniques for extraction, bioassay, isalation. identification & bioassay of all alleochemicals, (Willis, 1997). Interest in alleopathy revived again in the 20th century with the development of suitable techniques forextraction, bioassay, the chemical isolation & identification (Willis, 1997) & scientific research work into the recognition & understanding of allelopathy has only been carried out in a big way for the past few decades (Weston, 2005). The investigations of studies on the allelopathic influence of a number of weeds on various field crop in India gained momentum only after 1970. Hence in the present investigation efforts were made to find out the effect of aqueous leaf extract of *Mundulea seresia* Willd on seed germination and seedling growth of Brinjal

Materials and Methods:

Fresh leaves of *Mundulea seresia* Willd were collected in their vegetative growth stage from Mirzapur village of Sangmner Tahasil in Maharashtra and aqueous extracts from leaves of the selected plants were prepared 5 gms, 10gms , 15 gms , 20 gms , and 25 gms of fresh leaves were grinded separately, mixed with 100 ml distilled water, aqueous extract was obtained as filtrate. This extract was diluted again with distilled water and 10%, 20%, 40%, 60%, 80% and 100% concentrations were made where as distilled water as a control.

To study the effect of *Mundulea seresia* W. aqueous extract on seed germination of brinjal paper towel method (Singh et al. 1972) was used. Healthy and uniform sized seeds were presoaked in different concentrations of aqueous extracts for overnight and control was treated as double distilled water. The soaked seeds were eventually placed on paper towel ten seeds were arranged on its middle portion containing single rows each of 10 seeds. The paper towel was rolled from the right end with plastic paper & ends were tightened with rubber bands. The Paper towel was placed vertically in Beaker with some water at room temperature (about 25 ^{0}C). Observation on percent seed germination in each paper towel roll noted on 7th day and final count was taken after 14th days (Agrawal R.L,1976).

Results and Discussion:

Table No.-1. Effect of aqueous leaf extract of *Mundulea seresia* Willd on % seed germination of Brinjal

Sr. No.	Plant Extract taken (gm)	Extract conc. (%)						Control
		10	20	40	60	80	100	
1	**5**	80	70	70	65	80	70	70
2	**10**	70	80	90	65	70	70	70
3	**15**	70	80	100	90	90	90	70
4	**20**	80	80	90	90	90	100	70
5	**25**	80	80	80	90	100	100	70

Result summarized in table No.1 revealed that 20 and 25 gm **Dried leaves powder of *Mundulea seresia* Willd showed highest 100 % seed germination in 100 % Extract conc. As compare to control.(70%)**

Table No.-2. Effect of aqueous leaf extract of *Mundulea seresia* Willd on Root length of Brinjal

Plant Extract taken (gm) /Conc.	10%	20%	40%	60%	80%	100 %	Control
5gm	**3.9**	**5.26**	**3.85**	**4.95**	**4.51**	**3.97**	**3.52**
10gm	**5.35**	**5.32**	**4.25**	**4**	**4.91**	**5.15**	**3.52**
15gm	**4.65**	**5.5**	**4.7**	**4.2**	**5.0**	**5.16**	**3.52**
20gm	**5.2**	**5.44**	**5.26**	**4.95**	**5.8**	**5.24**	**3.52**
25gm	**5.05**	**4.85**	**5.28**	**4.95**	**5.68**	**5.73**	**3.52**

Result summarized in table No.2 revealed that 25 gm plant leaves extract of *Mundulea seresia* Willd showed highest root length 5.73 cm. in 100 % Extract conc. Followed by 10 gm plant leaves extract showed root length 5.35 cm. in 10% Extract conc. by As compare to control.(3.52cm)

Table No.-3.Effect of aqueous leaf extract of *Mundulea seresia* Willd on Shoot length of Brinjal

Plant extract taken (gm) /Conc.	10%	20%	40%	60%	80%	100%	Control
5gm	5.5	5.70	6.6	5.55	5.97	6.04	6.6
10gm	7.5	5.63	5.65	6.1	6.05	5.35	6.6
15gm	5.25	5.33	4.4	5.35	5.6	5.6	6.6
20gm	5.43	5.49	5.7	5.22	6.71	6.06	6.6
25gm	4.77	5.46	4.95	5.35	5.72	5.75	6.6

Result summarized in table No.3 revealed that 10 gm plant leaves extract of *Mundulea seresia* Willd showed highest shoot length 7.5 cm. in 10 % Extract conc. Followed by 25 gm plant leaves extract showed shoot length 5.75 cm. in 100% Extract conc. As compare to control.(6.6 cm.)

Table No.-4.Effect of aqueous leaf extract of *Mundulea seresia* Willd on seedling height of Brinjal

Plant extract taken (gm) /Conc.	10%	20%	40%	60%	80%	100%	Control
5gm	9.4	11.05	10.45	10.5	10.48	10.01	10.18
10gm	12.85	10.95	9.9	10.1	10.96	10.5	10.18
15gm	9.9	10.83	9.1	9.55	10.2	10	10.18
20gm	10.63	10.90	10.96	10.78	10.93	11.3	10.18
25gm	9.82	10.31	10.28	10.3	11.01	11.45	10.18

Result summarized in table No.4 supported that 25 gm plant leaves extract of *Mundulea seresia* Willd showed highest seedling length 11.45 cm. in 100 % Extract conc. Followed by 20 gm plant leaves extract showed seedling length 11.3 cm. in 100% Extract conc. As compare to control.(10.18 cm.)

Conclusion:

From the present investigation it was proved that the leaf extract conc.made from 20 and 25 gm *Mundulea seresia* Willd leaves showed satisfactory result to enhance the % seed germination and seedling growth.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

FRESHWATER FISH DIVERSITY OF VAITARNA DAM, IGATPURI, NASHIK (MAHARASHTRA), INDIA

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Abstract

The present study deals with the fish diversity of the Vaitarna Dam in Igatpuri, Nashik district, Maharashtra. A total of 11 species belonging to 3 orders and 7 families were recorded. Major Indian carps and a few catfish species constitute the commercially important groups in the reservoir. The study revealed that Cypriniformes is the dominant order. The investigation highlights that the quality of the river water is increasingly affected by industrial establishment, leading to the disappearance of several species and the deterioration of existing ones. This catalogue of fish diversity serves as essential scientific data banking in the face of abrupt climatic changes.

Keywords: Vaitarna Dam; Fish Diversity; Fauna; Cypriniformes; Igatpuri.

Introduction

Fishes constitute one of the most significant groups of vertebrates, influencing life through their roles in food security, recreation, and biological control. Approximately 21,723 extant fish species exist worldwide, classified into 4,044 genera, 445 families, and 50 orders. Of these, about 8,411 are freshwater species. India hosts about 40 of the world's 450 freshwater fish families, with almost 95% of this diversity confined to seven major basins.

Biodiversity is a complex concept representing the variability in genetics and structure within and between individuals and species. However, aquatic ecosystems face increasing worldwide concern due to habitat loss and pollution. Aquatic species serve as vital bio-indicators for water quality and river network connectivity. Conservation measures to mitigate these pressures have often been slow, leading to rapid species decline.

The Vaitarna Dam (also known as Modaksagar Dam) is constructed on the Vaitarna River, which originates from Trimbakeshwar, Nashik. The dam supplies water to Palghar and Mumbai and generates 60 MW of hydroelectricity. While previous workers have studied fish diversity in various parts of Maharashtra—such as the Girna Dam, Krishna River, and Nandurbar District—the Vaitarna region has not been previously assessed for ecological study. The main objective of this paper is to catalogue the richness, distribution, and diversity of fish fauna in the Vaitarna Dam.

Materials and Methods

Study Area

The Upper Vaitarna Dam (Modak Sagar) is an earth-fill and gravity dam on the west-flowing Vaitarna River near Igatpuri, Nashik district, Maharashtra. Coordinates: Latitude 19.8143°N, Longitude 73.6428°E.

Sampling and Identification

Fish samples were collected from the Upper Vaitarna Dam and local fish markets. Collection was facilitated by local fishermen using various nets, including gill nets, cast nets, and traps, across different reservoir sites. Specimens were identified morphologically and taxonomically using standard literature: The Freshwater Fishes of India: A Handbook by K.C. Jayaram and Records of the Zoological Survey of India.

Results

The study identified 11 species of freshwater fish represented by 11 genera, 6 families, and 3 orders. Dominant Order: Cypriniformes (54%). Other Orders: Siluriformes (31%), Characiformes (15%). The assemblage composition is dominated by Cypriniformes, which accounts for approximately 50% of the total diversity. The Siluridae family (including Wallago attu) comprises 9.09% of the species, as does the Bagridae family.

Table 1. List of freshwater fish species recorded from Vaitarna Dam.

Order	Family	Fish Species	Authority
Cypriniformes	Cyprinidae	*Labeo rohita*	Hamilton, Buchanan 1822
Cypriniformes	Cyprinidae	*Catla catla*	Jhingran 1966
Cypriniformes	Cyprinidae	*Cirrhinus mrigala*	Hamilton, Buchanan, 1822
Siluriformes	Siluridae	*Wallago attu*	
Siluriformes	Bagridae	*Sperata seenghala*	Sykes, 1839
Cypriniformes	Cyprinidae	*Cyprinus carpio*	Linnaeus, 1758
Siluriformes	Pangasiidae	*Pangasius buchanani*	Valenciennes, 1840
Characiformes	Serrasalmidae	*Piaractus brachypomus*	G. Cuvier, 1818
Cypriniformes	Cyprinidae	*Alburnus alburnus*	Linnaeus, 1758
Siluriformes	Bagridae	*Silurus glanis*	Linnaeus, 1758

Cypriniformes	Cyprinidae	*Ctenopharyngodon idella*	Valenciennes, 1844

Figures

Figure 1. Species richness by Order (Vaitarna Dam).

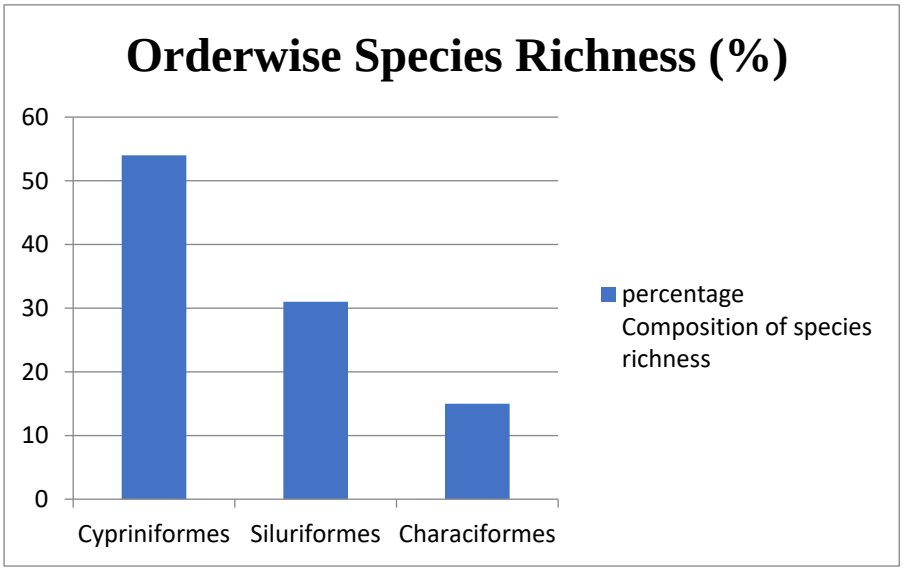
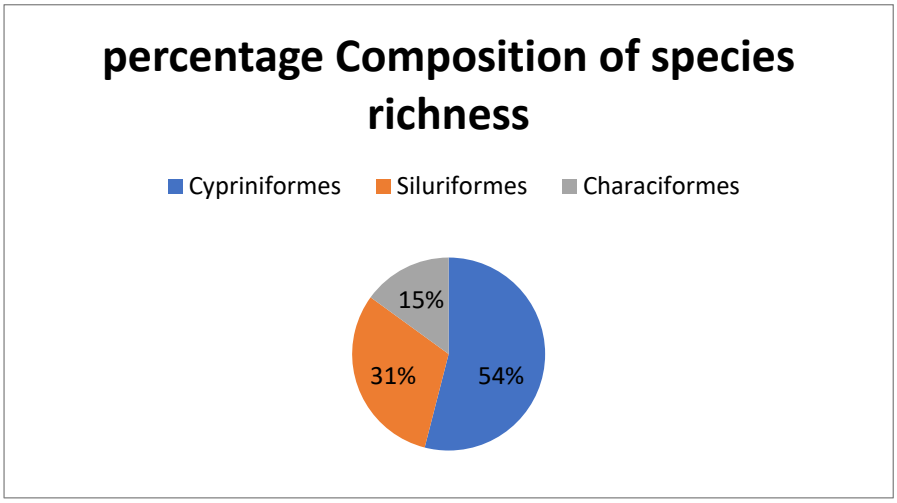


Figure 2. Percentage composition of species richness by Order (Vaitarna Dam).



Discussion

The present study indicates that the Cyprinidae family is the most abundant, a finding consistent with studies in the western region of the Narmada River and the Girna Dam. Cyprinids dominate due to their high adaptive properties. Dams play a dual role in fish diversity. While they fragment river systems, their reservoirs often act as buffers, providing stable habitats that sustain rich fish diversity, particularly in monsoonal river systems. However, the study also notes a decline in species number compared to historical literature, likely due to environmental changes and human

exploitation. Illegal fishing methods and the capture of spawn and immature fish pose significant threats to this diversity.

Conclusion

The Vaitarna Dam currently supports a diverse ichthyofauna comprising 11 species, with Cypriniformes being the dominant order. While the water parameters appear favorable for fish life, there are signs of species depletion compared to historical data. To sustain this resource, it is imperative to enforce strict fishing regulations, provide scientific training to fishermen, and implement conservation strategies such as preventing the catch of broodstock and juveniles.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

SEASONAL FLUCTUATION OF CARYOPHYLLIDEAN CESTODE FROM FRESHWATER FISHES FROM THE KHAM RIVER, DISTRICT AURANGABAD, (M.S), INDIA.

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Abstract

The present investigation examines the seasonal fluctuation of the Caryophyllidean Cestode in freshwater fishes from the Kham River, district Aurangabad, Maharashtra, during August 2013 to July 2015. The study indicates that the highest prevalence of *Lytocestus* parasites occurs in the winter season (48.27% and 51.35%), followed by summer, while the lowest prevalence is observed in the rainy season (7.89% and 17.24%). This type of result suggests that environmental factors and feeding habitats influence the seasonality of parasitic infection either directly or indirectly.

Key words - Caryophyllidean Cestode, *Clarias batrachus*, *Lytocestus*, Kham River.

Introduction

Population dynamics is the branch of ecology that examines how population size and density vary over time and space for one or more species (Begon et al., 1990). In practice, studies and theories on population dynamics can be seen as having two main components: firstly, a quantitative account of changes in population numbers and the patterns of growth or decline for a specific organism; secondly, investigations into the forces and biological and physical processes responsible for these changes. The first component involves descriptive data that are useful for quantifying trends and, with suitable statistical analysis, for predicting future developments.

Parasitology is one of the vast and highly advanced branches of Zoology. Parasitism is undoubtedly an ecological relationship between two different populations. Noble and Noble (1976) stated that parasitism is an association of two organisms of different species, in which one is benefited and the other harmed. The organism that benefits is the parasite, and that which suffers is the host.

Helminthes are members of complex biota; an understanding of population structure and behaviour has resulted in the emergence of population dynamics and community structure as major branches of animal Helminthology. Helminths are common parasites of fish. Usually, they are present in large numbers and have high species diversity. Helminth infections are a global problem for both small and large-scale farmers, but their impact is greater and the availability of wide in India due to a range of agro-ecological factors suitable for diversified hosts and parasite species. Gastrointestinal parasites

cause economic losses in a variety of ways; they cause losses through lowered fertility, reduced work capacity, a reduction in food intake and lower weight gains, treatment costs and mortality in heavily parasitised animals. The host-parasite relationships in the case of Nematode parasites result in large-scale damage at the site of attachment and, consequently, economic loss.

Parasites are not different from any other form of life except for their unique nature of dependence on another free-living host for their existence. The remarkable feature of parasite ecology is the close association with a negative impact on an individual maintained with another living organism a result, the host in many ways acts as the environment for the parasites, as stated by Parasitology Noble and Noble, 1971. Parasites can have a wide range of impacts on the ecology of their hosts, in terms of behaviours (Milinski, 1984; Moore, 1984), health (Arme and Owen, 1967), sexual selection (Howard and Minchella, 1900) and regulation of the host's populations (Freeland,1983). Environmental conditions and host behaviour are influenced by habitat and season, while physical state reflects internal conditions, which may also be affected by external factors. It is interesting to study parasite loads on the host.

Fish parasitic populations are known to differ, due to variation in the environment and host population (Dogiel, 1961; Wisniewski, 1958; Wootten, 1973; and Kennedy, 1978). For most fish parasites, it is difficult to determine whether differences in prevalence, intensity, density, and infection index are due to environmental factors or host species, composition, and density (Koskivara et *al*., 1991).

Most of the valuable information is also available in the field of population dynamics of helminth parasites of vertebrates from various countries like Austria, Bulgaria, France, Germany, Japan, the U.K. and Russia. Among the authors are Cole (1954), Anderson (1978), and Kenndey (1975) have contributed largely to this aspect of the study. Susheela, 1987, on rats; Rama Reddy, 1980, on garden lizards; Rajeshwar Rao et.al., 1982, on amphibians; Shinde G.B., on different vertebrates; Jadhav B.V., since 1977-2009, on vertebrates, especially helminth parasites of fishes, mammals and Birds.

Population investigation can provide data for the prediction of integrated methods to achieve the regulation of numbers of harmful parasites because it has been stated that a single method of control or coordinated activities is of little value since they ameliorate the infection (Kennedy, 1975,1978).

Seasonal fluctuations, locality, age, size and sex of the host also determine the parasitic community diversity burden. Polyanski (1958) suggested that the diet, life span, mode of life, population density and size of the host are the main factors which determine the variety of parasite species as well as the intensity and prevalence of infections. Dogiel et.al. (1961) stated that seasonal environmental changes in water, such as temperature, P^H, and conductivity, affect the occurrence of parasites in an aquatic host.

The present study includes applications of statistical methods to understand the distribution of Caryophyllidean Cestodes in freshwater fishes, both infra and supra population levels, for each species of Caryophyllidean Cestodes in two annual cycles, i.e. August 2013 to July 2015.

To find the prevalence of infection, the calculations were made with the help of the following formula.

$$\text{Prevalence of Infection} = \frac{\text{Infected hosts}}{\text{Total hosts examined}} \times 100$$

Table No.13: -Prevalence of *Lytocestus* sp. from the intestine of *Clarias batrachus* (L.) during August. 2013, - July. 2015.

Name of Month	No. of hosts Examined	No. of hosts Infected	No. of parasites collected	Prevalence %	Locality of Host (sites A, B and C)
Aug. 13	07	01	02	14.28	Kham River
Sep. 13	10	02	02	20	Kham River
Oct. 13	08	02	03	25	Kham River
Nov.13	12	10	29	83.33	Kham River
Dec. 13	16	13	26	81.25	Kham River
Jan. 14	08	03	03	37.5	Kham River
Feb. 14	10	04	07	40	Kham River
Mar. 14	05	02	03	40	Kham River
Apr. 14	09	03	06	33.33	Kham River
May 14	14	03	07	21.42	Kham River
Jun. 14	12	00	00	00	Kham River
Jul. 14	09	00	00	00	Kham River
Aug. 14	08	03	08	37.5	Kham River
Sep. 14	08	02	04	25	Kham River
Oct. 14	10	05	12	50	Kham River
Nov. 14	12	07	15	58.33	Kham River
Dec. 14	08	03	05	37.5	Kham River
Jan. 15	07	04	09	57.14	Kham River

Feb. 15	12	02	05	16.66	Kham River
Mar. 15	10	03	07	30	Kham River
Apr. 15	14	04	07	28.57	Kham River
May. 15	13	02	03	15.38	Kham River
Jun. 15	08	00	00	00	Kham River
Jul. 15	05	00	00	00	Kham River
Total	235	78	163	33.19	

Graph 7: -Prevalence of *Lytocestus* sp. from the intestine of *Clarias batrachus* (L.) during August. 2013 to July 2015.

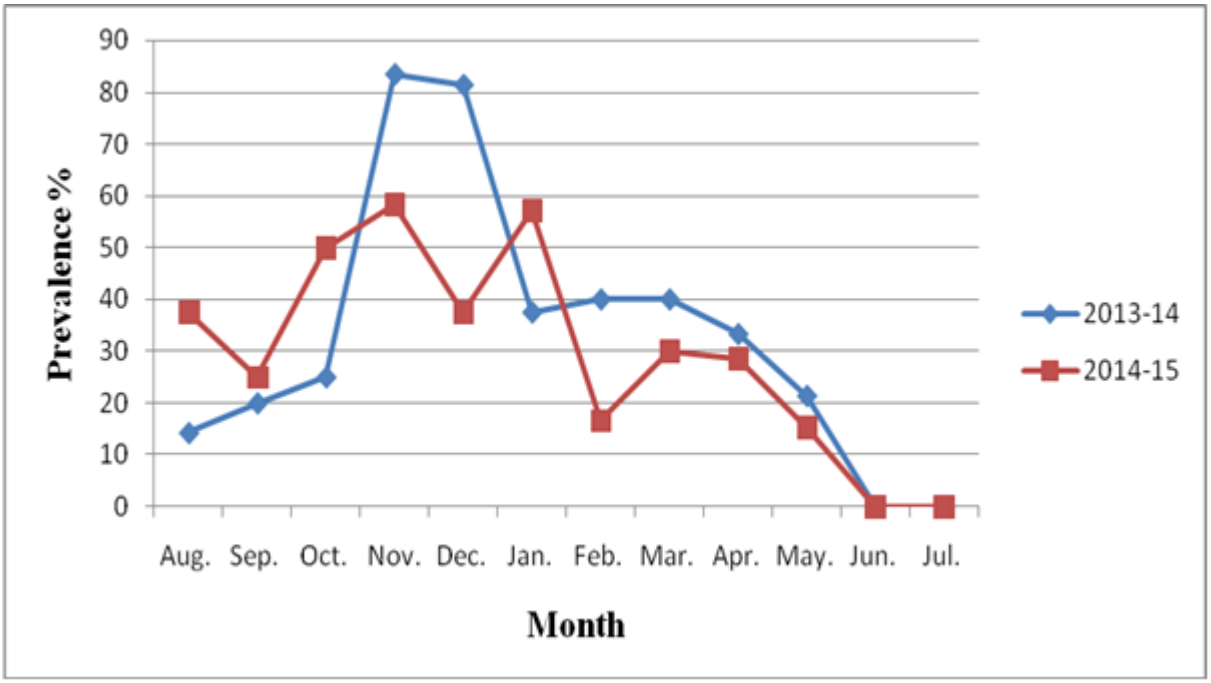

Table No.15: - Seasonal fluctuation of Caryophyllidean Cestode in freshwater fishes from Kham River, district Aurangabad, from August 2013 to July 2015.

Genera	Seasons	Prevalence % August 2013-July 2014.	Prevalence % August 2014-July 2015
Lytocestus	**Winter**	**48.27**	**51.35**
	Summer	**31.57**	**22.44**
	Rainy	**7.89**	**17.24**

Result: -

The month-wise data on the prevalence of Caryophyllidean Cestode parasites in freshwater fishes from the Kham River district, Aurangabad (M.S.), India, from August 2013 to July 2015.

The analysis of data (Table No. 15) showed that the occurrence of cestode parasites varies according to the season. *Lytocestus* Sp. recorded high prevalence in October, November, December, and January i.e. in winter of two annual cycles (48.27% and 51.35% respectively) followed by in February, March, April and May of two annual cycles i.e. summer season (31.57% and 22.44% respectively) whereas low prevalence in June, July, August and September of two annual cycles i.e. Rainy season (7.89% and 17.24% respectively).

Discussion: -

The present investigation indicates that the maximum prevalence of *Lytocestus* parasites of fishes occurs in the winter season, followed by Summer, as the minimum prevalence occurred in the Rainy season (Graph No.7).

According to Kennedy (1971, 1975, and 1977) and Rodhe (1993), the temperature, humidity, rainfall and feeding habitats of the host, availability of infective host and parasite maturation factors are the factors influencing parasitic infections. Experimental studies by Kennedy (1977) have shown that the cestode parasites of fish *Caryophylliaeus lattices* survived for longer periods at low temperatures; hence, he explained that temperature is a major controlling factor of seasonal infection. The feeding activity of the host is also one of the reasons for the seasonal fluctuation of infections, according to Pennuyuick (1971a, b). In the present study, the high infection of *Lytocestus* of *Clarias batrachus* occurs in winter.

The fish *Clarias batrachus* were highly infected with cestode infections like *Lytocestus mehdii* Sp. Nov., *Lytocestus aurangabadensis* Sp. Nov., *Lytocestus alii* (Jadhav et.al., 1991) and *Lytocestus clariase* (Jadhav et.al., 1991). There is host specificity, because the morphological, physiological and ecological factors affect the host specificity. These factors play an important role in controlling the parasite in a particular host species in a particular season.

Comparable findings were also reported by Bari et al. (2015). Of the 180 *C. batrachus*, 139 (67.87%) were infested with a total of 2205 helminth parasites. Helminth infestation exhibited nearly 100% prevalence in both male and female *C. batrachus* during winter (November-January), followed by pre-monsoon (February-April) at 66.67-86.66% and post-monsoon (August-September) at 66.67-80.00%, with the lowest prevalence recorded during the monsoon (May-July) at 53.33-60.00%.

Conclusion: -

After the analysis of the data, the present study can conclude that a high prevalence of the *Lytocestus* parasite occurs in the winter season, followed by the summer season and is low in the Rainy season. This type of result indicates that environmental factors and feeding habitats are influencing the seasonality of parasitic infection either directly or indirectly.

Acknowledgements: -

The authors are very much thankful to the **Head of the Department of Zoology, Dr Babasaheb Ambedkar Marathwada University, Aurangabad (Maharashtra),** for providing the laboratory facilities during this work.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

RELATIONSHIPS OF STEM BORER *Chilo partellus* ON PLANT PHYSICAL CONDITIONS AND DAMAGE TO MAIZE YIELDING IN A SHRIRAMPUR TALUKA

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ABSTRACT

In this period manufacture and use of pesticides has been improved enormously and it has developed the need to appraise the pesticides, though pest may damage the crop plant and affect productivity of Crop land. A field survey on maize stemborers, stemborer damage, maize plant physical conditions and maize yield was directed in eastern under natural conditions. *Chilo partellus* was the central stemborer counting for 78.5 % of all borers. Stemborer damage greatly decreased maize yield, with tunnel lengths greater than 25 cm causing a 45 % reduction of potential yield. A 36 % yield damage was started in plants with greater than one stemborer departure of hole. Each stemborer during time of harvesting was associated with a 10–12 % loss in yielding. Physical condition of plant is good characteristics meaningly enlarged yielding of grain. Principle factor analysis exposed that stemborer damage, height of plant and diameter of stem were key factors affected on yielding on maize grain. Assessment with normal yielding in the study area can suggests that our results were illustrative of losses on fields.

KEYWORDS: Pest, *Chilo partellus*, stemborer, damage, yielding, Shrirampur, Physical condition, dead heart etc.

INTRODUCTION

Maize, *Zea mays* (Linnaeus) (Poaceae) also known as corn, is a cereal grain first farm by indigenous peoples in southern Mexico before 10,000 years. The leafy shoot of the plant forms pollen flowerings or tassels and detached ovuliferous flowerings called ears that when fertilized yield kernels or seeds, which are fruits. Maize has become a essential food in many parts of the world, being consumed directly by humans maize is also used for corn ethanol, other biofuels, animal feed and other maize products, such as corn starch and corn syrup. (Khera & Dhillon, 1982). In India, maize is cultivated in two seasons, Kharif maize characterizes about 83% of maize area in India, although rabi maize resemble to 17% maize area. Among the Indian states Madhya Pradesh and Karnataka have maximum area below maize crop (15% each) followed by Maharashtra (10%), Rajastan (9%), Uttar Pradesh (8%) and others. Being a C4 plant, maize has a higher yield potential than other cereals. However, the attack of biotic stresses like ailment and insect pests infesting this crop at various crop growth stages, from

sowing to maturity, seriously limits the full exhibition of maize's produce latent over different seasons (Subedi, 2015). Sarup et al. (1987) Listed 130 insect species attacking maize crop at its diverse growing phases. However, according to Mathur (1992) there are more than 250 numbers of insect and mite pests infesting maize crop. Further, Siddiqui & Marwaha (1994) reported that only a dozen pests, which cause harm to maize crops in varied degrees from sowing to harvest, are very destructive and call for control efforts. Amongst the pest complex of maize, *Chilo partellus*, is major importance during different seasons in India (Neupane et al., 2016). *Chilo partellus* is the richest and has been recognized as the world's most shocking pest of maize at its initial growth stage (Sharma & Sharma, 1987; Polaszek & Khan, 1998). The maize crop is most vulnerable to the infestation of the maize stem borer when it is 10 to 12 days old and has no antibiosis (Sekhon & Sajjan, 1985). The adult females of *C. partellus* lay eggs in batches parallel to the long axis of the underneath of leaves. The first 2-3 larval instars feed initially by scuffling in the leaf whorls of budding plants, creating characteristic 'pin-holes' like symptoms. The period from egg hatching to the completion of third instar larval stage of *C. partellus* i.e., the time when the larva feed externally, lasts for about 10 days and chemical control is active when limited in this period (Reyes, 1987). Subsequently, the grown-up larvae bore inside the central shoot resulting in production of 'dead hearts' underneath unadorned infestation situations and reasons whole damage of the plant. The approaches for managing of *C. partellus* include biological, chemical, transgenic and cultural maize. Though, the pesticides, being an easy, quick and reliable method of regulator, are broadly used for the managing of this insect. Numerous insecticides have been recognized to provide successful control of this pest. Though, the loss assessment studies do not support the protective spray against this insect as this may result in unnecessary applications of pesticides which are ecologically and economically undesirable (Berg et al., 1990). It has been described by diverse hands that *C. partellus* caused 4-97% maize produce losses in dissimilar nations in the world (Reddy & Walker, 1990). The sufferers produced by *C. partellus* in maize were informed to be 25 to 40% produce in dissimilar agro climatical regions of India (NMRP, 2016). Sharma & Gautam (2010) have reported 27 to 30 % maize grain yield losses due to *C. partellus.* However, the evidence on the sufferers produced by *C. partellus* in maize has not been updated since last time specially after the reference of hybrid maize diversities for cultivation. These hybrids are mildly disposed to the damage of *C. partellus* (NMRP, 2019). In gathering, it has been eminent that contempt admirable regulator exertions, crop sufferers due to insect pests undergo very high. This is likely due to the deficiency of truthful data on losses of crop and recognized methods for evaluating crop loss. In light of the above-mentioned evidence, an assessment of the degree of produce damage and loss resultant from the stem borer infestation in maize was commenced

MATERIALS AND METHODS

Field experiments were carried out following two factors randomized complete block design with three replications at Gondeaon, Undirgaon and Gondhavni during two successive spring seasons of 2021. The geographical location of Shrirampur, is in 19.62 N latitude, 74.66 E longitude at an altitude of 541 meter above sea level. It has tropical wet and dry climate with cool winter and hot summer. The soil is generally alkaline (pH 7.16 to 8.87), 65% fine, 30% clay and 05 % loams. The average total annual rainfall was 464.0 to 880 mm with a distinct monsoon period from mid-June to mid-September. Maize varieties; Arun-2, ZM-401, ZM-627, ADV 756, C.P.508, SV 521 and NMH-1258 was used as a test variety (First factor) while different pest control conditions (spray and non-spray) were considered as the second factor in the experiments. The spray applied plots i.e., protected plots were kept totally free from stem borer infestation by using three applications of standard dose of insecticide (Chlorantraniliprole 18.5 SC @150ml/ha) at 10 days interval and non-spray i.e. non protected plots were carefully chosen for natural infestation of stem borers. The plot size was five rows of six meter long with the spacing of 60 cm for row to row 60 and 20 cm for plant to plant. The recommended dose of fertilizer for full season open pollinated maize was 120:60:40 and for hybrid maize 180:60:40 N:P2O5:K2O kg/ha with agricultural yard fertilizer 10 t/ha and seed rate 20 kg/ha. Other standard agronomical performs were implemented as suggested to elevation the crop. Observation was taken on foliage injured percent at before tasseling stage, tunnel length per plant (cm), dead heart (%), grain yield (kg/ha) and thousand grain weight (g). The atmospheric information was noted from the meteorological conditions station be located in Gondegaon, Undirgaon and Gondhavni. The maize grain yield was noted from the internal 5 rows in each treatment plot and it was accustomed at 15% humidity near and then changed to kilogram per hectare. The percent condensed finished unshielded plots form insect harm limits were calculated. The losses in maize grain produce through together the years were determined by succeeding formula given below:

Loss in maize grain yield (%) = Grain yield in protected plots − Grain yield in unprotected plots / Grain yield in protected plots × 100

All the considered factors were analyzed by statistical methods using Microsoft Excel and values are elucidate with the help of graphs.

RESULTS AND DISCUSSION

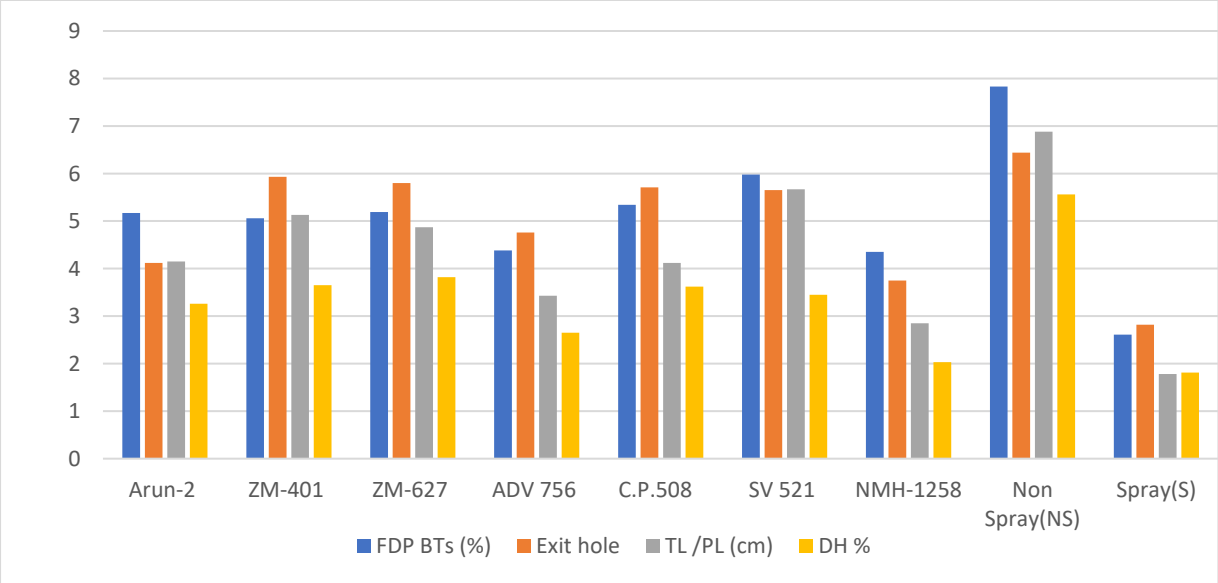
During spring season of 2021, the mean foliage damaged percentage before tasseling stage, exit hole, tunnel length (cm), dead heart (%), grain yield (kg/ha) and thousand grain weight (g) were differed significantly with maize varieties (Table 1). The higher mean foliage damaged percentage before tasseling stage (5.98%), higher numbers of exit hole (5.93), higher tunnel length (5.87 cm), higher dead

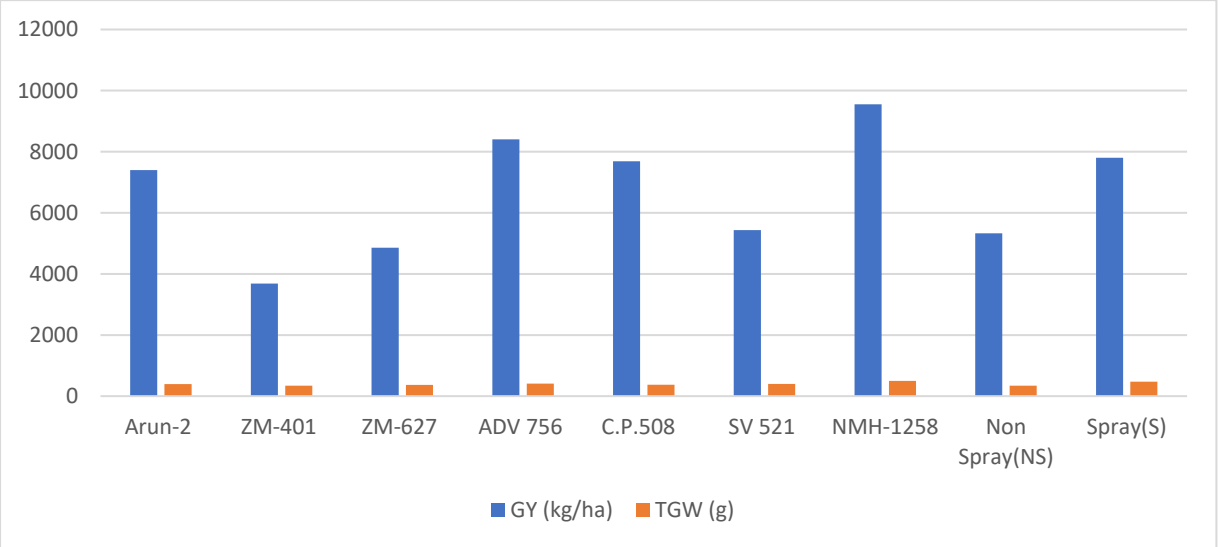
heart (3.82%) with lower grain yield (3684 kg/ha) and lower thousand grain weight (343 g) was recorded in full season. Recently released hybrid NMH-1258 was found resistant with stem borer infestation with lower mean foliage hurt percentage before tasseling stage (4.35%), lower numbers of exit hole (3.75), lower tunnel length (2.85 cm), lower dead heart (2.03%) with higher grain yield (9552 kg/ha) and higher thousand grain weight (501 g) than other tested varieties (Table 1). All the recorded insect damaged parameters, yield and yield attributing traits were significantly differed with the different pest control conditions i.e. in sprayed and non-sprayed condition (Table 1). The higher mean foliage damaged percentage before tasseling stage (7.82%), higher numbers of exit hole (6.44), higher tunnel length (6.88 cm), higher dead heart (5.56%) with lower grain yield (5327 kg/ha) and lower thousand grain weight (341g) was recorded in non-sprayed plots (Table 1). While insecticide sprayed plots had noted pointedly lesser mean foliage damaged percentage before tasseling stage (2.61%), lower numbers of exit hole (2.82), lower tunnel length (1.78 cm), lower dead heart (1.81%) with higher grain yield (7803 kg/ha) and higher thousand grain weight (471 g). The inclusive mean foliage damaged percentage before tasseling stage, exit hole, tunnel length (cm) and thousand grain weight (g) were fluctuated significantly with different tested maize varieties and different pest control conditions, irrespective of each other, during 2021.

Table 1: Effect of insecticidal (Chlorantraniliprole 18.5 SC @150ml/ha) spray and non-spray in selected maize varieties infested with stem borer (*Chilo partellus*) Shrirampur in 2021

Treatments	FDP BTs (%)	Exit hole	TL /PL (cm)	DH %	GY (kg/ha)	TGW (g)
Arun-2	5.17	4.12	4.15	3.26	7399	393
ZM-401	5.06	5.93	5.13	3.65	3684	343
ZM-627	5.19	5.80	4.87	3.82	4859	367
ADV 756	4.38	4.76	3.43	2.65	8406	411
C.P.508	5.34	5.71	4.12	3.62	7686	376
SV 521	5.98	5.65	5.67	3.45	5432	402
NMH-1258	4.35	3.75	2.85	2.03	9552	501
Pest control condition						
Non Spray (NS)	7.83	6.44	6.88	5.56	5327	341
Spray (S)	2.61	2.82	1.78	1.81	7803	471

Graph 1: Effect of insecticidal (Chlorantraniliprole 18.5 SC @150ml/ha) spray and non-spray in selected maize varieties infested with stem borer (*Chilo partellus*)





CONCLUSION

The measurable harvest loss augmented with the increase of the stem borer's infestation in maize variations. The yield loss was ranged from 20 to 40% with the mean average of 33% in changed maize varieties. The highest yield loss was quantified for the open non spraying varieties while spraying of insecticide enabled the recently introduced maize hybrids to produce extra yield and to be a reduced amount of defenseless to stem borer damage. So to minimize the losses caused by *C. partellus* to maize, it is proposed that for maximum yielding of Maize we can use hybrid maize such as NMH-1258 should be promoted in farmers' field with timely pest control measures against this pest.

ACKNOWLEDGEMENT:

The authors express their gratitude to the principal and head of the zoology department at R. B. Narayanrao Borawake College in Shrirampur, for providing the facilities and encouragement what I needed during my study and research work.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

COMPARATIVE ANALYSIS OF GRAM PANCHAYAT PRADHAN'S PARTICIPATION IN CHILD CARE SERVICES IN LUCKNOW AND BAHRAICH DISTRICTS OF UTTAR PRADESH: A NON-PARAMETRIC APPROACH

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Abstract:

This study examines the comparative engagement of Gram Panchayat Pradhans (GPPs) in child care service delivery across the districts of Lucknow and Bahraich in Uttar Pradesh, India. Utilizing data from frontline health workers—ANMs, ASHAs, and AWWs—and applying the Mann-Whitney U Test, the paper evaluates GPP participation in VHSNC activities, maternal and child health (MCH) discussions, and service monitoring efforts. Results indicate statistically significant differences across several domains, with GPPs in Lucknow showing higher engagement, particularly in organizing cleanliness drives and participating in budget-making. These findings point toward systemic disparities in PRI functioning and call for targeted policy interventions and capacity-building measures in lagging regions like Bahraich. The paper concludes with implications for decentralized health governance and offers evidence-based recommendations for strengthening grassroots participation.

Keywords: Panchayati Raj Institutions, Gram Panchayat Pradhan, VHSNC, MCH Services, Mann-Whitney U Test, Rural Health Governance, Uttar Pradesh

Introduction

Decentralised governance has been a cornerstone of India's democratic structure, aimed at promoting participatory development and empowering local communities to make decisions relevant to their own socio-economic contexts. The 73rd Constitutional Amendment Act, 1992, marked a significant milestone by institutionalizing Panchayati Raj Institutions (PRIs) as the third tier of governance. These institutions were envisioned to take charge of a wide range of developmental activities, including health, education, and social welfare, especially in rural areas.

Among the key functions assigned to PRIs, the delivery of child and maternal healthcare services occupies a critical space due to its direct impact on human development indices. The Gram Panchayat, headed by the elected Gram Panchayat Pradhan (GPP), serves as the fundamental administrative unit responsible for planning, monitoring, and facilitating service delivery. Through platforms such as the

Village Health Sanitation and Nutrition Committees (VHSNCs), GPPs are expected to ensure that government health programs reach the intended beneficiaries, particularly women and children.

However, the ground reality reflects a mixed performance of PRIs in fulfilling these responsibilities. The effectiveness of GPPs in promoting child care services often hinges on several factors—such as awareness of their roles, administrative capacity, training, and socio-political will. Moreover, inter-district variations are evident due to disparities in governance structures, resource availability, demographic diversity, and cultural attitudes.

In Uttar Pradesh, a state characterized by deep rural-urban divides and socio-economic heterogeneity, the functioning of GPPs in health-related services demands closer scrutiny. This is particularly true for districts like **Lucknow**, which represents a relatively urbanized and administratively developed area, and **Bahraich**, which falls under one of the more backward and rural belts. These contrasts offer a unique opportunity to evaluate how geography and governance interact in the context of decentralised healthcare delivery.

The present study, therefore, seeks to conduct a comparative analysis of the **perceptions and involvement of Gram Panchayat Pradhans in child care services** in the two selected districts using robust statistical tools. The goal is to identify strengths and gaps in the system and provide evidence-based recommendations for improving PRI-led healthcare interventions.

Literature Review

The literature on decentralised governance and health service delivery has underscored the centrality of **local institutions** in bridging gaps between policy and practice, particularly in rural settings. The role of **Panchayati Raj Institutions (PRIs)** in strengthening health systems has received increasing scholarly attention in the past two decades.

Bajpai and Goyal (2004) noted that PRIs are uniquely placed to ensure accountability and transparency in local service delivery mechanisms. Their study argued that elected local bodies, when adequately empowered, can effectively manage and monitor public services, including health and education, by leveraging community participation.

Further emphasizing the grassroots approach, Nair and Panda (2011) analyzed the contribution of PRIs in enhancing maternal and child health (MCH) outcomes. They found that active engagement of PRIs in **village-level committees**, such as VHSNCs, significantly improved community mobilization, utilization of antenatal care, and awareness about immunization services.

The **National Health Systems Resource Centre (2010)** also provides operational guidelines that reinforce the idea that VHSNCs—when led effectively by GPPs—can become instrumental in addressing the local health needs of communities. These guidelines advocate for the integration of

VHSNC activities with Gram Sabha and Panchayat planning processes to ensure health equity and responsiveness.

Semwal et al. (2013), in a study from Uttarakhand, reported similar patterns of limited awareness and irregular meetings, particularly among elected PRI members. Their findings reinforced the critical need for structured training and clearer role demarcation among GPPs, ASHAs, and AWWs.

Studies from eastern India also echo these concerns. Srivastava et al. (2016) emphasized that although VHSNCs are vital for localized health planning, many operate below potential due to unclear mandates and poor supervision. Azeez et al. (2021) observed that in several parts of Chhattisgarh and Madhya Pradesh, VHSNCs functioned erratically, with infrequent meetings, inadequate record-keeping, and weak Gram Panchayat participation—especially in planning and monitoring of child health programs.

Varshney et al (2022). also note that most committee members understood their role in ensuring safe drinking water, sanitation, and general health services, but few were involved in nutrition counseling or immunization services. They highlight the Gram Pradhan's role as chairperson in 87% of observed VHSNCs, signaling formal leadership but pointing to possible gaps in activation and awareness.

However, not all regions show uniform outcomes. George (2009) presented a comparative analysis of PRIs across Indian states, revealing that while Kerala demonstrated a high level of PRI engagement due to historical investments in education and participatory governance, states like Uttar Pradesh struggled due to weak institutional capacities and poor accountability frameworks.

These variations raise critical questions about how local political and administrative contexts influence the performance of elected representatives, particularly in health-related responsibilities. The present study builds upon these insights by statistically examining such variation between two distinct districts in Uttar Pradesh—Lucknow and Bahraich.

Objective of the Study

The primary objective of this study is to **compare the role and participation of Gram Panchayat Pradhans (GPPs) in promoting child care services across the districts of Lucknow and Bahraich in Uttar Pradesh**.

Specifically, the study seeks to:

1. Assess the level of GPP participation in Village Health Sanitation and Nutrition Committee (VHSNC) activities.
2. Examine the extent of GPP engagement in discussing maternal and child health (MCH) issues with frontline health workers.
3. Evaluate the GPPs' involvement in monitoring child care service delivery, as perceived by ANMs, ASHAs, and AWWs.

4. Identify statistically significant inter-district differences in GPP performance using non-parametric analysis.

Hypotheses

To examine inter-district differences in Gram Panchayat Pradhan (GPP) engagement in child care services, the study tests the following null hypotheses:

- **H01:** There is no significant difference between Lucknow and Bahraich in the GPPs' participation in VHSNC activities.
- **H02:** There is no significant difference between Lucknow and Bahraich in the GPPs' discussion of maternal and child health (MCH) issues with frontline health workers.
- **H03:** There is no significant difference between Lucknow and Bahraich in the GPPs' monitoring of maternal and child health services, as perceived by ASHAs, ANMs, and AWWs.

These hypotheses were tested using the Mann-Whitney U test to identify statistically significant differences in perceptions and roles across the two districts.

Methodology

This study adopts a **quantitative, cross-sectional design** to compare the participation and perception of Gram Panchayat Pradhans (GPPs) in promoting child care services in Lucknow and Bahraich districts of Uttar Pradesh. The focus is on understanding regional differences in terms of involvement in **Village Health Sanitation and Nutrition Committee (VHSNC)** activities, discussions on **Maternal and Child Health (MCH)** issues, and **monitoring responsibilities** as perceived by frontline health workers.

Sample and Respondents

The primary data were collected from **180 respondents**, with 90 each from Lucknow and Bahraich. The respondents were selected using **purposive sampling**, ensuring representation from:

- Accredited Social Health Activists (**ASHAs**)
- Auxiliary Nurse Midwives (**ANMs**)
- Anganwadi Workers (**AWWs**)

These stakeholders were chosen due to their close working relationship with GPPs at the village level, which makes them suitable informants to assess the nature and extent of GPP engagement.

Data Collection Tool

A structured questionnaire was used to collect information on:

- GPP participation in VHSNC functions
- GPP discussions on MCH-related topics with health workers
- Monitoring activities carried out by GPPs (e.g., checking registers, visiting health centres)

The responses were captured using **ordinal Likert-type scales**, making non-parametric analysis appropriate for hypothesis testing.

Statistical Technique: Mann-Whitney U Test

Given the ordinal nature of data and the non-normal distribution, the **Mann-Whitney U test** was employed to assess inter-district differences. This test is the non-parametric equivalent of the independent samples t-test and is used to compare the central tendency of two independent groups.

The decision rule for hypothesis testing was:

- If **$p > 0.05$**, the null hypothesis is accepted (no significant difference)
- If **$p < 0.05$**, the null hypothesis is rejected (significant difference exists)

Effect Size Measurement

To complement p-values, effect sizes were calculated using the formula: **$r = Z / \sqrt{N}$**, where *Z* is the standardized test statistic and *N* is the total number of observations. Effect sizes were interpreted using **Cohen's (1988)** benchmarks:

- **0.1 = Small**
- **0.3 = Medium**
- **0.5 = Large**

The use of effect sizes helps contextualize the practical importance of observed differences beyond mere statistical significance.

6. Results and Interpretation

This section presents the findings of the Mann-Whitney U test conducted to compare the perceptions and roles of Gram Panchayat Pradhans (GPPs) in promoting child care services across Lucknow and Bahraich districts. The analysis was carried out on three major themes: GPP participation in VHSNC activities, discussions on MCH issues, and monitoring of health services.

GPP Participation in VHSNC Activities – Health Care Workers Perspectives

Mann-Whitney U tests revealed statistically significant differences ($p < 0.05$) across all VHSNC-related indicators. GPPs in Lucknow consistently showed higher mean ranks than those in Bahraich, indicating better engagement.

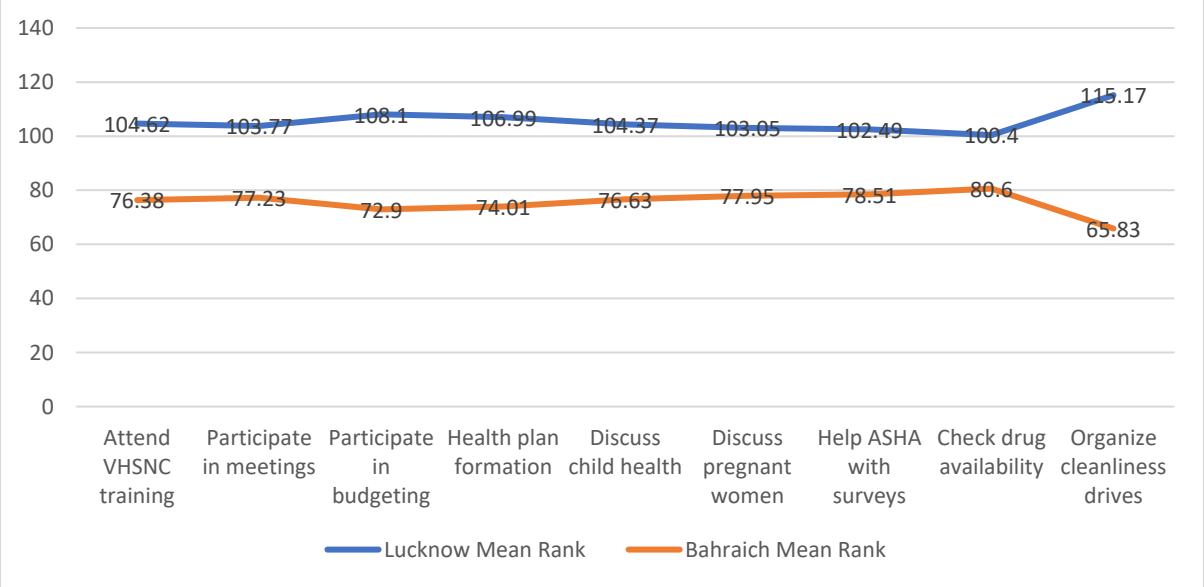
Table: 1.1 Health Care workers Opinion about GPP Participation in VHSNC Activities

Indicator	Lucknow Mean Rank	Bahraich Mean Rank	p-value	Effect Size (r)	Effect Size Type
Attend VHSNC training	104.62	76.38	0	0.28	Small

Participate in meetings	103.77	77.23	0	0.26	Small
Participate in budgeting	108.1	72.9	0	0.35	Medium
Health plan formation	106.99	74.01	0	0.32	Medium
Discuss child health	104.37	76.63	0	0.27	Small
Discuss pregnant women	103.05	77.95	0.001	0.25	Small
Help ASHA with surveys	102.49	78.51	0.001	0.24	Small
Check drug availability	100.4	80.6	0.008	0.2	Small
Organize cleanliness drives	115.17	65.83	0	0.48	Medium

Source: Primary data

Figure 1.1: GPP Participation in VHSNC Activities Comparison



Source: Primary data

The comparative analysis of Gram Panchayat Pradhans' (GPPs') involvement in Village Health Sanitation and Nutrition Committee (VHSNC) activities between Lucknow and Bahraich reveals marked

and consistent disparities in performance. Across all nine measured indicators—ranging from attending VHSNC meetings to organizing cleanliness drives—Lucknow GPPs reported significantly higher levels of participation compared to their counterparts in Bahraich. The Mann-Whitney U test results confirmed these differences to be statistically significant in every instance ($p < 0.05$), affirming that these disparities are not due to chance but rather reflect systematic differences in PRI functioning between the two districts.

In terms of effect size, which gauges the magnitude of the differences observed, certain indicators stood out. Notably, the participation of GPPs in organizing cleanliness drives ($r = 0.48$) and their involvement in VHSNC budget making ($r = 0.35$) exhibited medium effect sizes. This suggests that Lucknow's GPPs are not only more engaged but also more effective in translating their responsibilities into tangible actions, particularly in areas requiring planning and mobilization. Other indicators, such as attending meetings, helping ASHAs conduct surveys, and discussing child health, also showed significant differences, albeit with small effect sizes, indicating relatively less pronounced but still meaningful variations.

The overall trend suggests that Lucknow, an urban district with better infrastructural and administrative support, has fostered a more conducive environment for PRI participation in health governance. This may be attributed to several factors, including better access to training, higher levels of political engagement, more robust administrative monitoring, and generally higher levels of literacy and awareness among elected representatives. On the other hand, Bahraich, being a rural and relatively underdeveloped district, appears to suffer from gaps in GPP capacity, orientation, and systemic support, leading to weaker engagement in VHSNC activities.

A line graph comparing the mean ranks of each VHSNC indicator clearly illustrates this trend, showing consistently higher scores for Lucknow across all parameters. The graph serves as a visual reinforcement of the statistical findings and underscores the need for urgent attention to the underperformance of Bahraich. To bridge this gap, there is a need for structured capacity-building programs tailored for Bahraich's local context. These should include regular training sessions for GPPs, detailed orientation on VHSNC roles and mandates, and proactive administrative handholding. Additionally, cross-learning from best practices in Lucknow may be beneficial if adapted appropriately. The findings call for a shift from uniform policy approaches to more context-specific strategies that acknowledge and address the diversity of PRI performance within states like Uttar Pradesh.

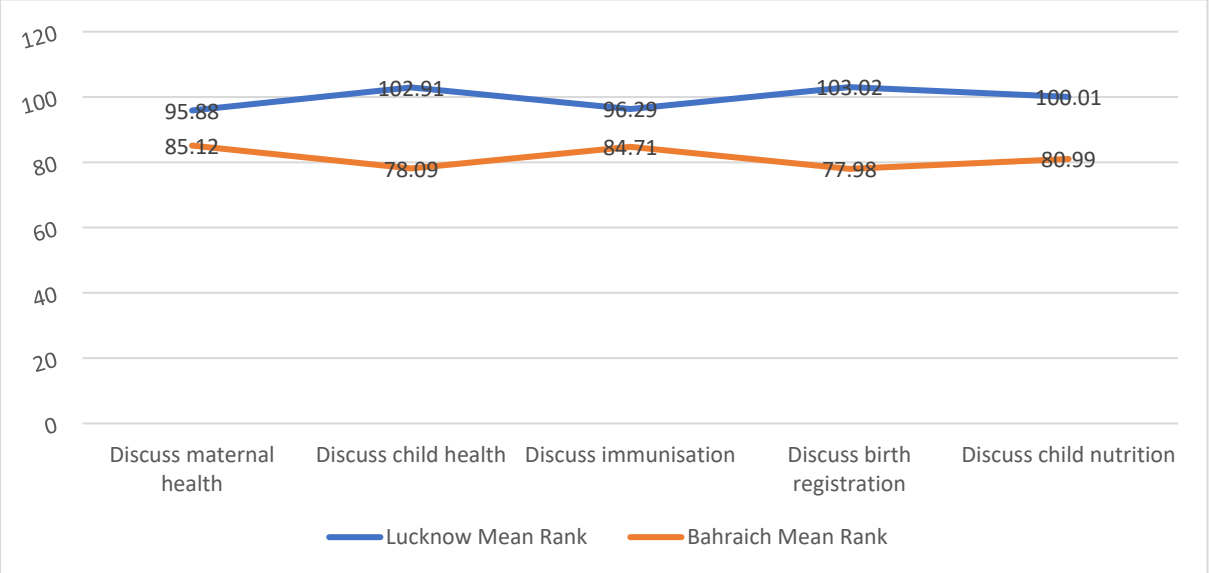
6.2 ANM and ASHSA's Perspective about MCH Issues Discussion by GPPs.

Table 1.2: MCH Issues Discussion by GPPs – ANM and ASHA's Perspectives

Indicator	Lucknow Mean Rank	Bahraich Mean Rank	p-value	Effect Size (r)	Effect Size Type
Discuss maternal health	95.88	85.12	0.152	0.11	Not Significant
Discuss child health	102.91	78.09	0.001	0.24	Small
Discuss immunisation	96.29	84.71	0.126	0.11	Not Significant
Discuss birth registration	103.02	77.98	0.001	0.25	Small
Discuss child nutrition	100.01	80.99	0.012	0.19	Small
Discuss cleanliness	107.54	73.46	0	0.34	Medium

Source: Primary data

Figure 1.2: Comparison of GPP Discussion on MCH Issues with ANM & ASHA



Source: Primary data

The analysis of Gram Panchayat Pradhans' (GPPs') engagement in discussing Maternal and Child Health (MCH) issues with frontline health workers—ANMs and ASHAs—again reveals significant inter-district differences between Lucknow and Bahraich. Using the Mann-Whitney U test, it was found that in four out of the six indicators, GPPs in Lucknow were significantly more active in engaging with MCH-related topics compared to those in Bahraich.

Specifically, significant differences were observed in the frequency and quality of GPP discussions on child health, birth registration, child nutrition, and cleanliness. The effect sizes in these areas ranged from small to medium, with the discussion on cleanliness (r = 0.34) showing the most pronounced gap. This indicates that GPPs in Lucknow are not only more proactive in routine health governance but are also more likely to integrate broader public health themes, such as hygiene and nutrition, into their engagements. These findings underscore Lucknow's relative strength in aligning local governance structures with national health objectives.

On the other hand, no statistically significant differences were observed in GPPs' discussions about maternal health and child immunisation. This lack of significant variation might suggest that both districts perform at a similar level on these indicators, possibly because of strong institutional emphasis from national health programmes like Janani Suraksha Yojana (JSY) and Universal Immunisation Programme (UIP), which standardize communication efforts around these issues across districts. However, despite the lack of statistical significance, mean ranks for Lucknow remained consistently higher, indicating a trend that favors the urban district.

The pattern emerging from this analysis suggests that while some baseline MCH topics may be universally communicated due to policy mandates, deeper community engagement—such as discussions about birth registration and nutrition—still depend heavily on local governance efficacy. Bahraich's lower performance may reflect inadequate training, lack of awareness, or weak institutional linkages between PRIs and the health machinery at the village level.

A line graph illustrating the mean ranks for each MCH discussion indicator shows that Lucknow maintains an advantage across all dimensions, further validating the statistical results. This calls for targeted capacity enhancement programs in Bahraich that not only educate GPPs about the importance of engaging in MCH issues but also foster stronger coordination mechanisms between GPPs and frontline health workers. Providing templates or discussion checklists, arranging quarterly health interface meetings at the Gram Panchayat level, and enabling peer learning with better-performing GPPs could strengthen their functional involvement in child and maternal health governance.

6.3 Monitoring of MCH Services – Perspectives of ASHA, ANM and AWW

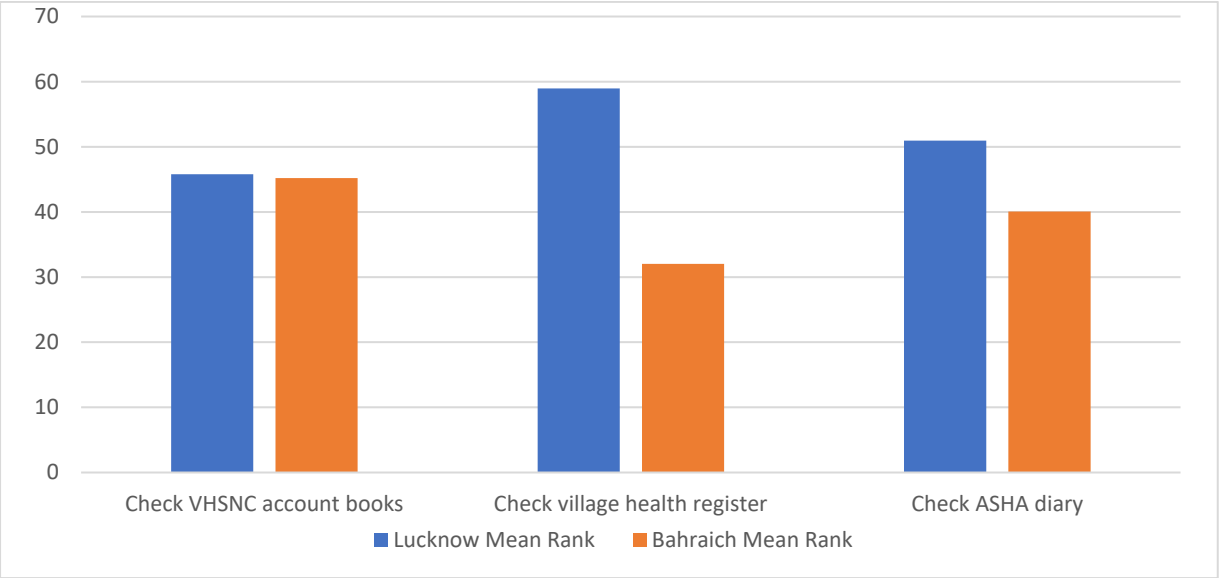
A. ASHA's Perspective

Indicator	Lucknow Mean Rank	Bahraich Mean Rank	p-value	Effect Size (r)	Effect Type
Check VHSNC account books	45.8	45.2	0.894	0.01	Not Significant

Check village health register	58.96	32.04	0	0.48	Large
Check ASHA diary	50.94	40.06	0.043	0.22	Small

Source: Primary data

Figure 1.3: Monitoring of MCH Serrvices (ASHA's Perspective)



Source: Primary data

From the perspective of ASHAs, significant differences were observed in two out of three indicators. GPPs in Lucknow were significantly more involved in checking the village health register and the ASHA diary, with the former displaying a large effect size (r = 0.54). This suggests a more rigorous culture of record-monitoring and accountability in Lucknow's Panchayats. The only area where no significant difference was found was in checking the VHSNC account books, where both districts performed similarly, albeit with Lucknow still maintaining a slightly higher mean rank. The lack of significant difference in this aspect might reflect a common gap in financial oversight among GPPs, pointing to a systemic issue rather than a district-specific one. Lucknow significantly outperforms Bahraich in monitoring both health registers and ASHA diaries, suggesting greater GPP engagement in documentation and health tracking.

B. ANM's Perspective

Indicator	Lucknow Mean Rank	Bahraich Mean Rank	p-value	Effect Size (r)	Effect Type

Monitoring visit to PHC/Sub-centre	57.23	33.77	0	0.48	Large
Check staff attendance	53.74	37.26	0.002	0.33	Medium
Check service quality	51.41	39.59	0.028	0.23	Small

Source: Primary data

Figure 1.4: Monitoring of MCH Services (ANM's Perspective)

Source: Primary data

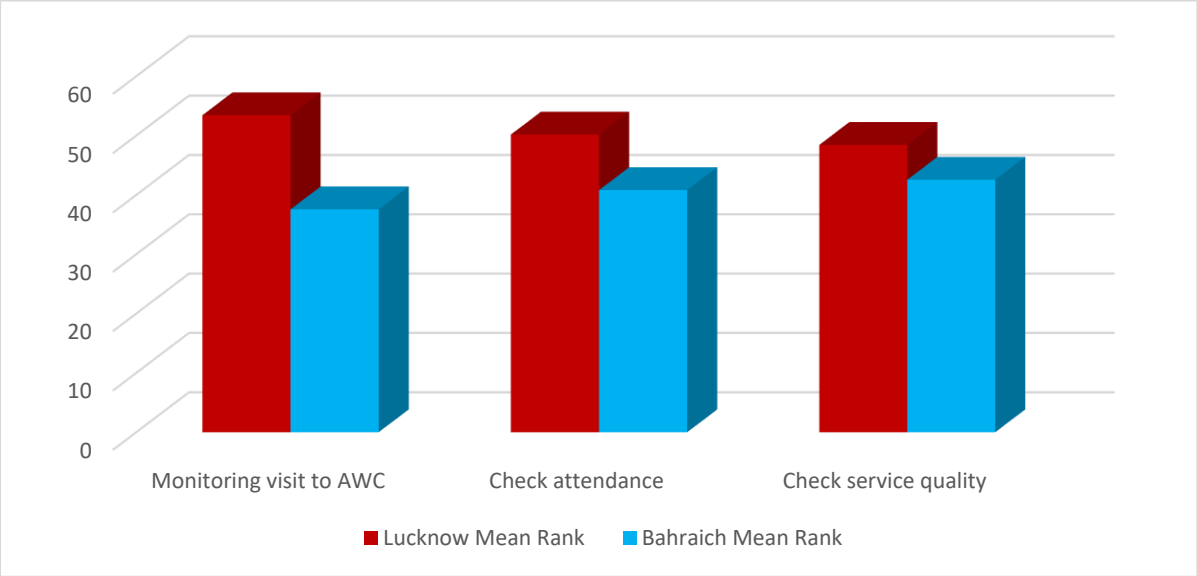
Turning to the perceptions of ANMs, the differences become even more pronounced. Statistically significant gaps were noted in all three indicators: whether GPPs made regular monitoring visits to PHCs/sub-centres, checked staff attendance, and reviewed the quality of services being provided. In all cases, Lucknow GPPs scored significantly higher. These results highlight a more structured and perhaps institutionalized approach to monitoring in the urban district, possibly facilitated by better health infrastructure, administrative capacity, and access to training. The medium effect sizes for two of these variables (monitoring visits and attendance checking) further reinforce the practical significance of these differences. All indicators—monitoring visits, staff attendance, and service quality checks—show higher engagement from GPPs in Lucknow, pointing to stronger administrative oversight.

C. AWW's Perspective

Indicator	Lucknow Mean Rank	Bahraich Mean Rank	p-value	Effect Size (r)	Effect Type
Monitoring visit to AWC	53.43	37.57	0.004	0.31	Medium
Check attendance	50.18	40.82	0.095	0.16	Not Significant
Check service quality	48.44	42.56	0.231	0.1	Not Significant

Source: Primary data

Figure 1.5: Monitoring of MCH Services by GPP at AWW (AWW's Perspective)



Source: Primary data

The perspective of AWWs presents a slightly different picture. Among the three indicators assessed—GPPs visiting AWCs, checking attendance, and inspecting service quality—only the first yielded statistically significant differences, again favoring Lucknow. For attendance monitoring and service quality checks, no significant inter-district difference was found, suggesting that monitoring of Anganwadi centres may be relatively weak or inconsistent across both districts. However, the mean ranks for Lucknow were still marginally higher, reflecting a trend of better engagement even where statistical significance was not achieved. Although the difference is smaller here, Lucknow still maintains a lead in each indicator, with the most notable gap in monitoring visits.

Summary of Monitoring of MCH Services – Perspectives of ASHA, ANM and AWW

The comparative analysis of monitoring activities performed by Gram Panchayat Pradhans (GPPs) in the districts of Lucknow and Bahraich reveals stark contrasts in engagement and oversight as perceived by frontline health workers—namely ASHAs, ANMs, and AWWs. The Mann-Whitney U test results consistently indicate stronger performance by GPPs in Lucknow across almost all measured indicators. These findings collectively point to a systemic disparity in the functional engagement of GPPs in health-related monitoring. In Lucknow, the GPPs appear to be more hands-on and integrated into the local health ecosystem. Their consistent involvement in monitoring not only strengthens health governance but also likely reinforces the accountability of the frontline workers. In contrast, Bahraich shows signs of fragmented or insufficient involvement, which may stem from structural limitations such as weaker institutional support, lower literacy or awareness among elected representatives, and logistical challenges in rural geographies.

The overall pattern—substantiated by the higher mean ranks and statistically significant results for Lucknow—makes a compelling case for targeted interventions in Bahraich. These could include focused training programs on health governance, exposure visits to better-performing districts, development of localized monitoring templates, and integration of health monitoring tasks into the formal job description or mandate of GPPs. Reinforcing VHSNC functionality, especially by empowering Pradhans with tools and knowledge, could drastically improve child and maternal health outcomes in districts like Bahraich that currently lag behind.

A consolidated line graph depicting the mean ranks across all GPP monitoring indicators from ASHA, ANM, and AWW perspectives clearly illustrates the performance gap. The visual evidence, combined with the statistical results, suggests the need for a structured and multi-stakeholder strategy to bridge the gap between underperforming and better-performing Panchayats.

These trends collectively underscore stronger GPP involvement in urban districts like Lucknow, highlighting the need for policy focus and training in districts like Bahraich.

Conclusion

This study sought to assess the comparative role of Gram Panchayat Pradhans (GPPs) in promoting child care services across two demographically and administratively distinct districts of Uttar Pradesh—Lucknow and Bahraich—using the Mann-Whitney U test, a robust non-parametric method suited to ordinal data.

The findings of the study reveal substantial inter-district disparities in the extent and quality of GPP participation in child health governance. Across the domains of **Village Health Sanitation and Nutrition Committee (VHSNC) participation**, **discussion of Maternal and Child Health (MCH) issues**,

and **monitoring of health services**, GPPs in **Lucknow consistently outperformed their counterparts in Bahraich**. These differences were not only statistically significant across most indicators but also carried practical implications, as evidenced by small to medium effect sizes.

In the area of VHSNC participation, GPPs in Lucknow demonstrated greater involvement in essential tasks such as attending trainings, participating in budget planning, and organizing cleanliness drives. These activities are foundational to responsive and preventive rural health systems. The medium effect sizes observed for variables like budget-making and organizing cleanliness drives highlight the real-world impact of such differences—underscoring that they are not only statistically notable but socially and administratively meaningful.

When it came to discussing MCH issues with frontline workers (ANMs and ASHAs), Lucknow GPPs were again seen to be more engaged. Topics such as child health, birth registration, nutrition, and cleanliness were discussed more frequently in Lucknow than in Bahraich. While discussions on maternal health and immunization showed no statistically significant difference, the overall trend of higher engagement in Lucknow was clear.

The most striking disparities were observed in the **monitoring roles** performed by GPPs. Whether through the eyes of ASHAs (e.g., checking health registers and ASHA diaries), ANMs (e.g., visiting PHCs, checking attendance, assessing quality of services), or AWWs (e.g., visiting AWCs), Lucknow again emerged as the better-performing district. Particularly notable was the **large effect size for the GPPs' monitoring of village health registers**, which indicates a profound gap in oversight mechanisms that may directly affect health outcomes in rural Bahraich.

Collectively, the results suggest that while decentralization through PRIs is a powerful framework for improving local governance and service delivery, **its impact is not uniform across regions**. Structural factors such as urban-rural divides, administrative support, literacy levels among GPPs, training exposure, and even political will can significantly shape the effectiveness of these local institutions.

Therefore, the research not only highlights performance gaps but also provides evidence-based directions for policy and programmatic interventions. There is a clear need for **capacity-building initiatives in districts like Bahraich**, with tailored modules focused on GPP roles in child health, administrative monitoring, and community mobilization. Introducing **standardized monitoring tools**, improving VHSNC functionality, and strengthening the **interface between health workers and elected representatives** can go a long way in bridging these gaps.

In conclusion, the Gram Panchayat Pradhan, as the first point of contact in local governance, holds transformative potential for improving child and maternal health outcomes in India. Unlocking this

potential, especially in underperforming districts, requires sustained investments in human capacity, institutional support, and participatory accountability mechanisms.

Policy Implications

The findings from this study present significant implications for strengthening decentralized health governance through Panchayati Raj Institutions, especially in rural districts like Bahraich.

1. **Targeted Training Programs:** The statistically significant performance gap between Lucknow and Bahraich underscores the need for district-specific capacity-building interventions. The government should institutionalize regular training and orientation programs for GPPs on health and child development issues, particularly VHSNC functioning, MCH services, and inter-departmental collaboration.
2. **Revamping VHSNC Functionality:** The weaker VHSNC engagement in Bahraich calls for revitalizing these committees through stronger monitoring by block-level authorities and increased resource allocation. VHSNC guidelines should be re-evaluated to include role-specific expectations from GPPs.
3. **Monitoring and Accountability Frameworks:** Medium and large effect sizes in the domain of health monitoring suggest the need for structured performance review systems. Development of a **PRI Health Dashboard** that tracks GPP involvement in key activities could bring transparency and encourage performance-based incentives.
4. **Strengthening Frontline Coordination:** The disparity in MCH-related communication points toward the necessity of regular joint meetings between GPPs, ASHAs, ANMs, and AWWs. Formal communication protocols should be developed to ensure health issues are routinely discussed and addressed in panchayat forums.
5. **Rural-Urban Administrative Support Gap:** Bahraich requires administrative strengthening in terms of supervisory staff, monitoring tools, and access to documentation and logistics that are more readily available in urban districts like Lucknow.

Limitations of the Study

While the research offers valuable insights into GPP participation in child care governance, it has certain limitations:

1. **Scope Limited to Two Districts:** The study focused only on Lucknow and Bahraich, which may not fully capture the diversity of PRI performance across Uttar Pradesh or other Indian states.
2. **Self-reported Data:** The responses from ANMs, ASHAs, and AWWs may be subject to personal biases or limited recall, possibly affecting the reliability of certain indicators.

3. **Lack of GPP Perspective:** The study did not directly include GPPs as respondents, which could have provided deeper insight into their challenges, motivations, or constraints.
4. **No Qualitative Follow-up:** While quantitative analysis was rigorous, the absence of qualitative data such as interviews or focus groups may have limited contextual interpretation of the statistical differences observed.

11. Conflict of Interest, Funding Declaration and Acknowledgments

Conflict of Interest:

The author declares that there is no conflict of interest regarding the publication of this paper. The research was conducted independently, and the analysis was carried out without any influence or bias from any external party.

Funding Statement:

This study did not receive any funding, grant, or financial support from any public, private, or non-profit funding agency. All expenses were borne by the researcher personally as part of academic work.

Acknowledgements

The author extends sincere gratitude to the ANMs, ASHAs, and AWWs in Lucknow and Bahraich districts who participated in this study. Special thanks to the Panchayati Raj Department officials and local administrative staff for their support during field visits. Appreciation is also due to academic mentors Prof. Zubair Meenai, Dr. Sufia Azmat and peer reviewers Dr. Arif Rashid, Prof. Dhruv Kumar Tripathi who provided feedback on earlier drafts of this work.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

SYNERGISTIC EFFECT OF BENZYLADENINE AND NAPHTHALENE ACETIC ACID, ON *IN VITRO* SHOOT MULTIPLICATION OF GINGER VAR. MAHIMA

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ABSTRACT

Ginger (*Zingiber officinale* Rosc.) is a commercially and medicinally important rhizomatous perennial of the family *Zingiberaceae*, widely valued for its bioactive compounds and culinary applications. Traditional propagation via rhizome segments is slow and susceptible to diseases, necessitating rapid clonal multiplication methods. The present study investigated the *In Vitro* micropropagation of *Z. officinale* var. Mahima by evaluating the effect of varying concentrations of Benzyladenine (BA; 1.5–4.5 mg/L) in combination with a constant concentration of α-Naphthaleneacetic acid (NAA; 0.5 mg/L) on shoot initiation, multiplication, leaf proliferation, and shoot elongation. Rhizome bud explants were cultured on Murashige and Skoog (MS) medium under controlled conditions. Results indicated that moderate BA concentrations (2.5–3.5 mg/L) significantly accelerated shoot initiation (8.75–9.50 days), enhanced shoot multiplication (3.80–4.25 shoots/explant), promoted leaf proliferation (8.00–8.25 leaves/shoot), and supported optimal shoot elongation (5.48–5.53 cm). Lower (1.5 mg/L) and higher (4.5 mg/L) BA concentrations were less effective, suggesting inhibitory effects at sub-optimal and supra-optimal levels. The findings establish a reliable and reproducible protocol for rapid *In-Vitro* propagation of disease-free, elite ginger planting material, facilitating large-scale commercial cultivation and germplasm conservation.

KEYWORDS: BA(Benzyladenine) & NAA(Naphthalene acetic acid) ,Rhizome bud explants, *Zingiber officinale*

INTRODUCTION

India often referred to as the 'Spice Bowl of the World,' has a rich legacy in the cultivation, trade, and use of spices dating back to the Vedic period (6000 BC). Among these, ginger (*Zingiber officinale Rosc.*), an herbaceous rhizomatous perennial plant of the family *Zingiberaceae*, holds significant economic, medicinal, and culinary value. Native to Southeast Asia, likely India or China, ginger was introduced to Europe in the ninth century AD and later spread across the Mediterranean through trade during the 13th century (Bailey, 1949; Parry, 1969; Lawrence, 1984). The rhizome is a source of essential bioactive compounds, including *gingerols* and *shogaols,* as well as appreciable levels of proteins (2.3%), carbohydrates (12%), fats (1%), minerals (1.2%), fiber (2.5%), moisture (81%), and vitamins A and B, rendering it a vital component in both traditional medicine and modern pharmaceutical formulations (Swaminathan, 1974).

Ginger is extensively utilized in food and beverage products such as ginger tea, ginger beer, candies, pickles, and baked goods, while ginger oil finds applications as a carminative and stimulant in pharmaceutical preparations. India leads global ginger production with a substantial contribution from states like Maharashtra, where production is concentrated in areas such as Chhatrapati Sambhajinagar (Chhatrapati Sambhajinagar District Report, 2013). Globally, China, India, Nepal, and Thailand are the major producers, contributing over 70% of the total world production of 1,683,000 tons (Anon., 2010). Traditional propagation of ginger relies on rhizome segments, a slow process limited by dormancy and seasonal planting, yielding only 5–6 plants per rhizome annually. Moreover, rhizome rot caused by *Pythium spp.* and *Pseudomonas solanacearum* severely affects yield, sometimes resulting in losses of 50–90% (Dohroo, 2005; Hosoki and Sagawa, 1977). Consequently, rapid propagation methods are essential for elite, disease-free, and high-yielding varieties such as Mahima, which has a yield potential of 22.2 t/ha and essential oil content of 2.36%.

Plant tissue culture provides a promising solution to overcome these limitations. Based on the principle of totipotency, which allows a single plant cell to regenerate into a complete plant (Haberlandt, 1902; Schleiden, 1838; Schwann, 1839), *In Vitro* techniques allow rapid clonal propagation of elite genotypes under controlled conditions. Cytokinins, particularly Benzyladenine (BA), promote axillary bud proliferation and shoot initiation, while auxins such as Naphthalene acetic acid (NAA) support callus formation and shoot elongation. The ratio of cytokinin to auxin determines organogenesis, with high cytokinin/auxin ratios favoring shoot formation, low ratios promoting root development, and intermediate ratios inducing callus (Skoog & Miller, 1957).

The Murashige and Skoog (MS) medium (1962) remains the standard basal medium for micropropagation due to its balanced nutrient composition.

Several studies have explored ginger micropropagation under varying growth regulator regimes. Khatun et al. (2003) achieved 22–25 shoots/explant at 2.5 mg/L BA + 0.5 mg/L KIN within 45 days. Kambaska et al. (2009) observed 8.5 shoots/explant at 2.0 mg/L BA + 0.5 mg/L NAA for Suprava and Suruchi varieties, while Kavyashree et al. (2009, 2011) reported 19–23 shoots/explant using optimized BA (17.76 µM) and NAA (5.76 µM). These studies demonstrate that moderate cytokinin concentrations yield superior shoot induction, whereas supra-optimal levels often reduce proliferation and cause morphological abnormalities (Behera et al., 2010; Rout et al., 2019). Explant size also influences morphogenic response, with smaller segments (0.5 cm) showing higher shoot induction (44.44%) compared to larger explants (Sathyagowri et al., 2011).

In the present study, rhizome bud explants of *Zingiber officinale var. Mahima* were cultured on MS medium supplemented with different concentrations of BA (1.5, 2.5, 3.5, and 4.5 mg/L) in combination with a constant NAA concentration (0.5 mg/L) to evaluate their synergistic effects on shoot initiation, elongation, and leaf proliferation. The experiment was conducted under a Completely Randomized Design (CRD) with five treatments and four replications. Results indicated that moderate BA concentrations (2.5–3.5 mg/L) significantly enhanced shoot initiation (8.75–9.50 DAI), shoot multiplication (3.80–4.25 shoots/explant), shoot elongation (5.48–5.53 cm), and leaf proliferation (8.00–8.25 leaves/shoot), whereas lower (1.5 mg/L) and higher (4.5 mg/L) concentrations were less effective, confirming the crucial role of growth regulator optimization for efficient micropropagation.

Hence, this study aimed to establish a reliable, reproducible, and statistically validated *In Vitro* propagation protocol for rapid multiplication of elite, disease-free ginger planting material. The findings provide a quantitative framework for selecting optimal BA and NAA concentrations, ensuring high morphogenic response, improved shoot and leaf growth, and overall plantlet vigor, which are essential for large-scale commercial propagation and sustainable ginger production.

MATERIALS AND METHODS

The study was conducted in the Department of Plant Biotechnology, Institute of Biosciences and Technology, MGM University, Chhatrapati Sambhajinagar, Maharashtra, India.

Plant Material

Rhizome buds of *Zingiber officinale Rosc. (Var. Mahima, IISR Calicut)* were collected from a cultivated field in Kannad, Chhatrapati Sambhajinagar. The explants were cut into 0.5 cm segments, washed under running tap water, and cleaned with household detergent (Labolin) for 5 minutes, followed by repeated rinsing with distilled water. Sterilization was performed in a laminar airflow chamber using 70% ethanol for 10–20 seconds and 5.25% sodium hypochlorite (NaOCl) solution with two drops of Tween-20 for 20 minutes, followed by five rinses with sterile double distilled water. Sterilized explants

were trimmed to 0.5 cm pieces before inoculation (Sathyagowri et al., 2011). Glassware and culture vessels were cleaned using 1N hydrochloric acid for 2 hours or overnight, thoroughly rinsed with tap water, and dried in a hot air oven at 140–160°C for 2 hours

Culture Medium

Murashige and Skoog (MS) basal medium (Murashige & Skoog, 1962) was used for all experiments. The medium was supplemented with 3% (w/v) sucrose, 0.8% (w/v) agar, and different concentrations of benzyladenine (BA; 1.5, 2.5, 3.5, and 4.5 mg/L) in combination with a constant concentration of naphthaleneacetic acid (NAA; 0.5 mg/L). The pH of the medium was adjusted to 5.6–5.8 prior to autoclaving at 121°C for 20 minutes. Heat-sensitive components such as growth regulators, amino acids, and vitamins were filter-sterilized through a 0.22 µm syringe-driven filter membrane and added to the autoclaved medium under sterile conditions.

Experimental Design

The experiment was conducted following a **Completely Randomized Design (CRD)** with five treatments, each replicated four times. The treatments comprised different concentrations of benzyladenine (BA) combined with a constant concentration of naphthaleneacetic acid (NAA, 0.5 mg/L). The treatment details were as follows: the control (T0) contained only NAA (0.5 mg/L), while T1, T2, T3, and T4 consisted of MS medium supplemented with BA at 1.5, 2.5, 3.5, and 4.5 mg/L, respectively, in combination with 0.5 mg/L NAA. Inoculation and Incubation Sterilized explants were inoculated on MS medium under aseptic conditions with cut ends in maximum contact with the medium. Cultures were incubated at 25 ± 2°C with a 16-hour photoperiod.

Biometric Observations

Explants were observed weekly for the following parameters:

1. Days required for shoot initiation (DAI): Number of days from inoculation to visible shoot differentiation.
2. Number of shoots per explant: Counted at 28 days after inoculation (DAI).
3. Shoot elongation (cm): Measured from the base to the tip at the time of subculture.
4. Number of leaves per shoot: Recorded at 28 DAI (Kambaska and Santilata, 2009).

Statistical Analysis

All data were analyzed using Analysis of Variance (ANOVA) following Panse and Sukhatme (1967). Mean values were compared using the critical difference (CD) at 1% significance level, and the standard error (SE) was calculated for all parameters.

RESULTS AND DISCUSSION

The results obtained in the present investigation on Synergistic Effect of BA and NAA on *In Vitro* Shoot Multiplication of Ginger Var. Mahima are presented under the following headings.

Shoot Initiation

Data on required days for shoot initiation in *Zingiber officinale Rosc.* as influenced by different concentrations of BA are presented in Table, Graph and Plate 1 indicated that mean number of days required for shoot initiation was 11.75.

The data of Table – I on the days required for shoot initiation in ginger under different concentrations of BA with constant NAA (0.5 mg/L) are presented in Table, Graph and Plate 1**.** Significant variation was observed among treatments **(**CD at 1% = 1.70**),** indicating that BA levels strongly influence the initiation phase.

The control treatment (T_0: MS + 0.5 mg/L NAA) exhibited the longest duration for shoot initiation (16.50 days). The addition of BA reduced the lag phase, with a progressive decline in shoot initiation time up to 3.5 mg/L. The earliest response was recorded in T_3 (MS + 3.5 mg/L BA + 0.5 mg/L NAA) at 8.75 days**,** followed by T_2 (MS + 2.5 mg/L BA + 0.5 mg/L NAA) at 9.50 days, both significantly superior to the control and higher BA concentration. In contrast, further increase of BA to 4.5 mg/L (T_4) delayed initiation (12.25 days), suggesting supra-optimal cytokinin concentrations can negatively affect organogenic response. The overall mean was 11.75 days, with a standard error of ±0.413, confirming reliability of the experiment.

These findings are in line with earlier studies. Khatun et al. (2003) reported that shoot tip cultures of ginger showed faster initiation at 2.5 mg/L BA + 0.5 mg/L Kin, achieving shoot initiation in 10–12 days. Similarly, Kambaska et al. (2009) observed efficient shoot induction at 2.0 mg/L BA + 0.5 mg/L IAA in ginger cultivars Suprava and Suruchi, reporting initiation within 9–11 days. Kavyashree et al. (2009) also confirmed that moderate BA concentrations promote faster bud break and higher regeneration frequency.

Recent investigations support the present results. Nayak et al. (2020) demonstrated that BA in the range of 2.0–3.0 mg/L significantly reduced the lag phase for shoot initiation in *Zingiber officinale cv. Rio-de-Janeiro*. Likewise, Kumar et al. (2023) reported that moderate BA supplementation (2.5–3.0 mg/L) or low concentrations of TDZ promoted rapid bud initiation within 8–10 days, while higher BA levels caused vitrification and delayed initiation.

Therefore, the present study concludes that moderate BA concentrations (2.5–3.5 mg/L) in combination with NAA (0.5 mg/L) are optimum for rapid shoot initiation in ginger**,** whereas concentrations beyond this threshold may result in inhibitory effects.

Shoot Multiplication

The data on the number of shoots per explant of *Zingiber officinale* as influenced by different concentrations of BA (Benzyladenine) with a constant concentration of NAA (0.5 mg/L) are presented in Table, Graph and Plate 2. A significant variation was observed among the treatments.5 mg/L and 3.5 mg/L concentration were at par and significantly recorded maximum number of shoot in *Zingiber officinale Rosc*. as compared to rest of the BA concentrations and control.

The maximum number of shoots (4.25/explant) was recorded in treatment T_3 (MS + BA 3.5 mg/L + NAA 0.5 mg/L), followed by T_2 (3.80 shoots/explant). The control (T_0) recorded the least response with only 1.22 shoots per explant. Interestingly, a higher BA concentration (4.5 mg/L, T_4) resulted in reduced shoot induction (1.75), suggesting an inhibitory effect at supra-optimal levels.

The results clearly indicate that the synergistic effect of BA and NAA plays a crucial role in axillary bud proliferation in ginger. Moderate concentrations of BA (2.5–3.5 mg/L) were most effective in enhancing shoot multiplication, while both lower (1.5 mg/L) and higher (4.5 mg/L) concentrations were less effective.

Similar findings have been reported in earlier studies, where the optimal concentration of cytokinins, particularly BA, significantly enhanced shoot proliferation in *Zingiber officinale* (Bhat et al., 2017; Shirin and Rajasekharan, 2006). High cytokinin levels beyond the threshold often cause abnormal shoot morphology or reduced multiplication rates (Behera et **al., 2010**). The role of NAA in this combination may be attributed to its supportive effect on basal callus formation and shoot elongation, as also observed in other medicinal plants (Prakash et al., 2004). Thus, treatment T3 (MS + BA 3.5 mg/L + NAA 0.5 mg/L) was found to be the most suitable for multiple shoot induction in ginger under *In Vitro* conditions.

Leaves proliferation per shoot:

Data presented in Table - 3, Graph and Plate 3 concluded that mean number of leaves per explant of ginger was 8.25. The number of leaves proliferated in ginger were influenced due to different concentration of BA and constant NAA.

The data presented in Table- 3, Graph and Plate 3 reveal that the number of leaves per shoot in *Zingiber officinale* was significantly influenced by the concentration of BA in combination with a constant level of NAA (0.5 mg/L). The control treatment (MS + 0.5 NAA) produced only 2.50 leaves per shoot, indicating the limited response of ginger explants to auxin alone.The addition of BA at 1.5 mg/L (T_1) markedly enhanced leaf proliferation, with an average of 6.75 leaves per shoot, while further increasing the BA concentration to 2.5 mg/L (T_2) and 3.5 mg/L **(**T_3**)** further improved leaf number to 8.00 and 8.25 leaves per shoot, respectively. This suggests that BA plays a crucial role in stimulating

cell division and leaf initiation, in agreement with earlier findings that cytokinins, particularly BA, enhance organogenic responses in ginger tissue culture (Nirmal Babu et al., 1992; Prakash et al., 2004). However, at higher concentration of BA (4.5 mg/L, T_4), the number of leaves declined to 6.80**,** which was significantly lower compared to T_2 and T_3. This reduction could be attributed to supra-optimal cytokinin levels, which often lead to physiological stress, reduced shoot vigor, and abnormal morphology in ginger and other Zingiberaceae members (Kambaska & Santilata, 2009; Rout et al., 2019). Overall, the maximum leaf proliferation was obtained at 3.5 mg/L BA with 0.5 mg/L NAA**,** highlighting the synergistic role of BA in promoting shoot multiplication and leaf initiation when supplemented with a low auxin concentration. These results are in line with recent studies that reported optimal BA concentrations between 2.0–3.5 mg/L for efficient shoot multiplication and leaf production in ginger (Haque & Ghosh, 2021; Saha et al., 2022). Thus, moderate levels of BA with constant NAA are most effective for enhancing leaf number per shoot in ginger, which is a critical factor for subsequent plantlet vigor and ex vitro survival.

Shoot Elongation (cm):

Data on mean shoot elongation (cm) of main shoot as influenced by various treatments of BA concentration are given in Table, Graph and Plate 4.

The results presented in Table 4 indicate that the elongation of the main shoot in *Zingiber officinale* was significantly influenced by the concentration of BA in combination with a constant level of NAA (0.5 mg/L). The control treatment (T_0) with only NAA (0.5 mg/L) resulted in the lowest shoot height (2.43 cm). Supplementation with BA led to a progressive increase in shoot elongation. At lower concentrations, BA (1.5 mg/L) in combination with NAA (0.5 mg/L) showed moderate improvement in shoot height (2.98 cm). The effect became more pronounced with an increase in BA concentration, where 2.5 mg/L BA (T_2) yielded 3.73 cm shoot height. A significant increase was observed in T_3 (BA 3.5 mg/L + NAA 0.5 mg/L), producing 5.48 cm elongation, which was statistically at par with T_4 (BA 4.5 mg/L + NAA 0.5 mg/L) that recorded the highest shoot elongation (5.53 cm). This indicates that higher concentrations of BA beyond 3.5 mg/L did not result in a substantial increase, suggesting an optimum level of BA at 3.5 mg/L for shoot elongation in *Zingiber officinale*.

These findings corroborate earlier reports where BA, a cytokinin, was shown to play a pivotal role in promoting cell division and shoot elongation in rhizomatous crops. For instance, Sultana et al. (2009**)** reported that BA in combination with auxins significantly enhanced shoot proliferation and elongation in *Zingiber officinale*. Similarly, Rout et al. (2001) and Shirin et al. (2000) highlighted that BA at an optimum concentration promoted vigorous shoot elongation in ginger and other *Zingiberaceae* members. The synergistic role of BA and NAA observed in this study supports the concept that

cytokinins stimulate cell division, while auxins regulate elongation and differentiation, resulting in enhanced shoot growth. Overall, the study demonstrates that BA at 3.5 mg/L in combination with 0.5 mg/L NAA is most effective for shoot elongation in *Zingiber officinale*.

Table 1: Effect of different concentration of BA and constant NAA on No. of Days required for shoot initiation of Ginger

Sr. No	Treatments (mg/L)	Number of Days required for shoot initiation (DAI)
1.	T_0 MS+0.5 NAA Control	16.50
2.	T_1 MS+BA(1.5)+NAA(0.5)	11.75
3.	T_2 MS+BA(2.5)+NAA(0.5)	9.50
4.	T_3 MS+BA(3.5)+NAA(0.5)	8.75
5.	T_4 MS+BA(4.5)+NAA(0.5)	12.25
	Mean	11.75
	SE ±	0.413
	CD at 1 % =	1.70

Table 2: Effect of different concentration of BA and constant NAA on No. of shoots per explants (28 DAI).

Sr.No	Treatments (mg/L)	Number of Shoots/ Explant
1.	T_0 MS+0.5 NAA Control	1.22
2.	T_1 MS+BA(1.5)+NAA(0.5)	2.00
3.	T_2 MS+BA(2.5)+NAA(0.5)	3.80
4.	**T_3 MS+BA(3.5)+NAA(0.5)**	**4.25**
5.	T_4 MS+BA(4.5)+NAA(0.5)	1.75
	Mean	2.60
	SE ±	**0.60**
	CD at 0.01 %	**1.359**

Concentrations of BA 2

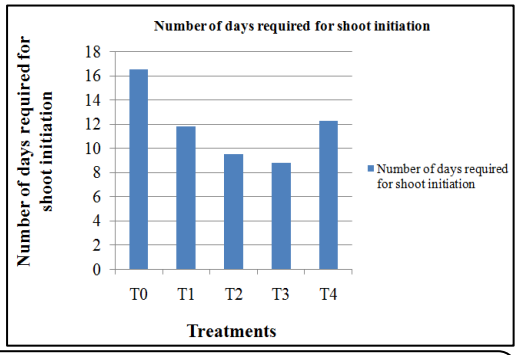
Tabe-3: Effect of different concentration BA and constant NAA on No. of leaves per Shoot in Ginger

Sr.No	Treatments (mg/L)	No. of leaves/ Shoot
1.	T_0 MS+0.5 NAA Control	2.50
2.	T_1 MS+BA(1.5)+NAA(0.5)	6.75
3.	T_2 MS+BA(2.5)+NAA(0.5)	8.00
4.	T_3 MS+BA(3.5)+NAA(0.5)	8.25
5.	T_4 MS+BA(4.5)+NAA(0.5)	6.80
	Mean	**6.46**
	SE ±	**0.50**
	CD at 0.01 =	**2.10**

Table - 4: Elongation of main shoot influenced by BA and NAA (constant).

Sr.No	Treatments (mg/L)	Shoot Height (cm)
1.	T_0 MS+0.5 NAA Control	2.43
2.	T_1 MS+BA(1.5)+NAA(0.5)	2.98
3.	T_2 MS+BA(2.5)+NAA(0.5)	3.73
4.	T_3 MS+BA(3.5)+NAA(0.5)	5.48
5.	**T_4 MS+BA(4.5)+NAA(0.5)**	**5.53**
	Mean	4.03
	SE ±	**0.20**
	CD at 0.01%	**0.83**

INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025



Graph 1: Number of days required for shoot initiation

Plate 1: Shoot initiation in 8.75 DAI.

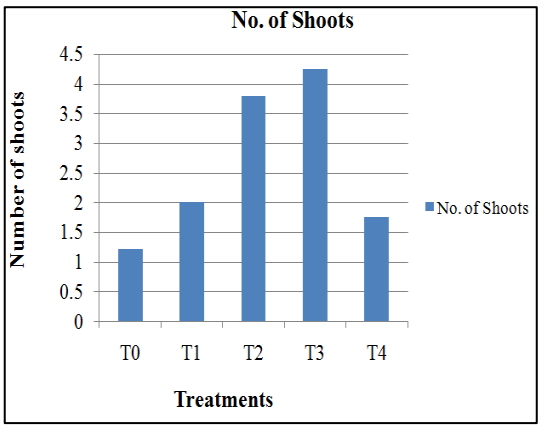


Plate 2 Number of shoots per explants showing multiple shoots.

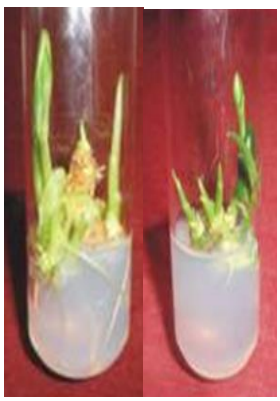
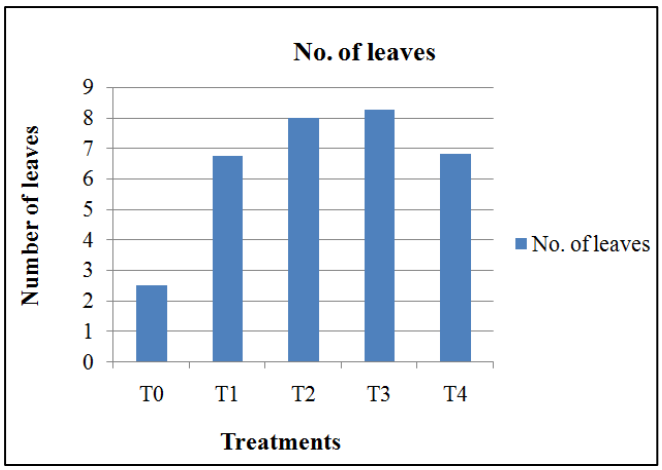
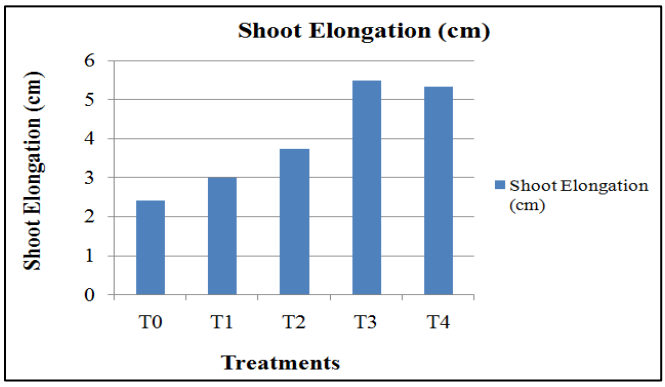


Plate - 3 Number of leaves proliferation as influenced by concentration of BA (3.5 mg/L)



Graph - 3 Number of leaves proliferated per shoot

Plate 4 Height of shoots as influenced by concentration of BA (4.5 mg/L)



Graph 4: Highest shoot length showing in T_4 (cm)

SUMMARY

The present study evaluated the *In Vitro* micropropagation of *Zingiber officinale* Rosc. by assessing the effects of varying concentrations of Benzyladenine (BA) in combination with a constant level of α-Naphthalene acetic acid (NAA, 0.5 mg/L) on shoot initiation, multiplication, leaf proliferation, and shoot elongation.

Results demonstrated that moderate BA concentrations (2.5–3.5 mg/L) significantly accelerated shoot initiation, with the earliest response observed at 3.5 mg/L BA (8.75 days), while higher concentrations (4.5 mg/L) delayed initiation, indicating inhibitory effects at supra-optimal levels. The maximum number of shoots per explant (4.25) and leaves per shoot (8.25) were recorded at 3.5 mg/L BA, highlighting its role in promoting axillary bud proliferation and leaf development. Shoot elongation progressively increased with BA concentration, with 3.5 mg/L BA achieving 5.48 cm, comparable to

the highest concentration tested. Overall, the study confirms that moderate BA levels in combination with low NAA are optimal for rapid shoot initiation, effective shoot multiplication, enhanced leaf proliferation, and significant shoot elongation, providing a reliable protocol for large-scale ginger propagation and improved plantlet vigor.

Moderate concentrations of BA (2.5–3.5 mg/L) in combination with 0.5 mg/L NAA were found to be optimal for *In Vitro* micropropagation of *Zingiber officinale* Rosc., promoting rapid shoot initiation, maximum shoot multiplication, enhanced leaf proliferation, and significant shoot elongation. Supra-optimal or lower BA levels were less effective, highlighting the importance of precise growth regulator balance. The optimized protocol provides an efficient approach for large-scale propagation, ensuring vigorous and uniform plantlets for commercial cultivation and germplasm conservation.

The study on Synergistic Effect of BA and NAA on *In Vitro* Shoot Multiplication of Ginger Var. Mahima that moderate BA concentrations (2.5–3.5 mg/L) with 0.5 mg/L NAA significantly enhance shoot initiation, multiplication, leaf proliferation, and shoot elongation. The optimized conditions (3.5 mg/L BA + 0.5 mg/L NAA) produced the earliest shoot initiation (8.75 days), maximum shoots per explant (4.25), highest leaf number per shoot (8.25), and substantial shoot elongation (5.48 cm). These outcomes provide a reliable strategy for large-scale propagation, ensuring vigorous, uniform plantlets suitable for ex vitro acclimatization and commercial cultivation.

CONCLUSION

Future research could focus on optimizing rooting and acclimatization protocols for the *In Vitro* regenerated ginger plantlets to ensure high survival rates under ex vitro conditions. Additionally, the potential of using alternative cytokinins or auxin-cytokinin combinations could be explored to further enhance shoot proliferation and vigor. Molecular and biochemical studies on the regenerated plantlets may provide insights into genetic stability, secondary metabolite production, and stress tolerance, facilitating the development of elite cultivars for large-scale cultivation and commercial exploitation.

ACKNOWLEDGEMENT

The authors sincerely acknowledge Hon. A.N. Kadam, Chancellor of MGM University, Hon. Vice-Chancellor, Registrar, Director, and Head of the Institute for their constant guidance and support. We are also grateful to our co-authors and colleagues for their valuable suggestions and contributions. The facilities provided by the Department of Plant Biotechnology, Institute of Biosciences and Technology, MGM University, Chhatrapati Sambhajinagar, and the Department of Botany, MSE Society's Abeda Inamdar Senior College of Arts, Science and Commerce, Pune, are gratefully acknowledged.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

IN VITRO PROPAGATION OF IN-SITU SILICATE-SOLUBILIZING MICROORGANISMS AND SOLID-STATE FORMULATION: CHANGES IN SILICATE-SOLUBILIZING ACTIVITY

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Abstract

Silicate-solubilizing microorganisms (SSMs) play a crucial role in mobilizing insoluble silicate minerals, thereby improving silicon availability for plant uptake and contributing to sustainable soil nutrient management. Indigenous rhizospheric bacteria, including species of *Bacillus*, *Pseudomonas*, *Enterobacter*, and *Rhizobium*, exhibit notable silicate-solubilizing capability through biochemical weathering processes. The present study aimed to standardize an in vitro propagation protocol for in-situ SSMs and to evaluate changes in silicate-solubilizing activity during successive cultivation and formulation stages.

In vitro multiplication was performed using Czapek–Dox medium supplemented with molasses and cow milk to enhance biomass accumulation and metabolic activity. Functional performance was monitored across repeated sub-culturing cycles to assess adaptive variation in silicate solubilization. High-density inocula were prepared through shake-flask cultivation to ensure uniformity and viability prior to formulation.

The propagated microorganisms were subsequently converted into solid-state formulations (SSF) using moistened carrier substrates enriched with molasses and cow milk. Microbial survival, storage stability, and retention of silicate-solubilizing activity were evaluated over time. Functional efficacy was quantified using standard silicon release assays under controlled conditions. A comparative analysis between liquid suspension cultures and SSF systems was conducted with respect to microbial proliferation, silicate release kinetics, shelf life, and scalability for field application.

Key formulation parameters, including carrier suitability, moisture content, inoculum density, incubation temperature, pH buffering, and storage conditions, were systematically assessed. Major constraints such as moisture loss, contamination risk, decline in viability, and variability in activity were identified. Solid-state formulations demonstrated superior shelf stability and ease of handling, whereas liquid cultures supported rapid and uniform microbial growth but showed limited storage and field stability.

Overall, the study highlights the synergistic potential of integrating in vitro propagation with solid-state formulation approaches for the development of efficient SSM-based bioinoculants. The findings support the application of indigenous silicate-solubilizing microorganisms as environmentally sustainable biofertilizers for enhancing silicon nutrition, crop productivity, and long-term soil health.

Key words: Silicate-solubilizing microorganism, Czapek-Dox agar, Solid-state formulation, Molasses and cow milk supplementation, Evolution of microbial activity, In-situ silicate-solubilizing microorganisms

Introduction

Silicate-solubilizing microorganisms (SSMs) constitute an important group of plant growth–promoting rhizobacteria capable of converting insoluble silicate minerals into plant-available forms through biochemical solubilization processes. By facilitating silicon mobilization in soil systems, these microorganisms contribute to improved crop nutrition, enhanced stress tolerance, and sustainable soil management practices. Indigenous rhizospheric bacteria, particularly members of the genera *Bacillus*, *Pseudomonas*, *Enterobacter*, and *Rhizobium*, play a critical role in mineral weathering and nutrient cycling at the soil–root interface. Their functional association with crop rhizospheres supports both agricultural productivity and long-term soil health, making SSMs promising candidates for eco-friendly biofertilizer development.

Objectives

1. To standardize an in vitro multiplication method for indigenous silicate-solubilizing microorganisms using Czapek–Dox agar medium supplemented with molasses and cow milk.
2. To evaluate changes in silicate-solubilizing efficiency across repeated sub-culturing cycles and determine potential adaptive enhancement.
3. To develop a solid-state formulation (SSF) using moistened carrier materials enriched with molasses and cow milk and assess microbial viability, stability, and functional persistence.
4. To perform a comprarative assessment of liquid suspension cultures and solid-state formulations with respect to microbial growth, silicate solubilization kinetics, shelf life, and scalability.
5. To identifymajor constraints associated with SSF and propose suitable optimization strategies for effective and sustainable agricultural application.

Methodology

1. Isolation and In Vitro Cultivation of SSMs

Rhizosphere soil samples are collected from selected crop fields and processed for the isolation of silicate-solubilizing microorganisms. Representative bacterial isolates belonging to *Bacillus*,

Pseudomonas, *Enterobacter*, and *Rhizobium* are purified on Czapek–Dox agar medium. To enhance microbial proliferation and biomass production, the basal medium is fortified with 2% molasses and 5% reconstituted cow milk.

2. Repeated Sub-Culturing and Activity Monitoring

Purified isolates are subjected to sequential sub-culturing at seven-day intervals for a maximum of ten generations under controlled laboratory conditions. At each generation, silicate-solubilizing activity is quantified by estimating the concentration of soluble silicon released into a standardized assay medium, allowing evaluation of functional changes across successive cultures.

3. Preparation of Solid-State Formulation (SSF)

Solid carrier materials such as sterilized rice husk, talc, or peat are selected for formulation development. The carriers are adjusted to approximately 50% of their water-holding capacity using a molasses–milk solution and subsequently inoculated with high-density cultures obtained from shake-flask fermentation. The inoculated formulations are air-dried to achieve a final moisture content of approximately 15% and stored under ambient conditions.

4. Functional Evaluation and Storage Stability Studies

The silicate-solubilizing potential of both liquid cultures and solid-state formulations is assessed using the molybdate blue method to estimate soluble silicon release from culture filtrates and SSF leachates. Storage stability studies are conducted at ambient temperature (≈25 °C) over intervals of 0, 30, 60, and 120 days. Periodic evaluations include viable cell counts, residual silicate-solubilizing activity, and moisture content to determine formulation longevity and functional integrity.

Comparative Evaluation of Liquid Cultivation and Solid-State Formulation

A comparative assessment was conducted to examine the performance of liquid-based propagation and solid-state formulation (SSF) approaches for silicate-solubilizing microorganisms. Key operational and functional parameters were analyzed to highlight differences in microbial behavior, silicate solubilization patterns, storage feasibility, and scalability potential.

Sr.No	Parameter	Liquid Propagation	Solid-State Formulation (SSF)
1	Microbial proliferation	Uniform, high-density cultures	Localized, slower proliferation
2	Silicate release kinetics	Rapid release in suspension assays	Gradual release upon carrier leaching
3	Storage stability	Requires cold-chain, short shelf life	Longer shelf life at ambient temperature

4	Scalability	Scalable in bioreactors	Scalable with simple carrier processing

Constraints Affecting Microbial Viability and Long-Term Effectiveness of Solid-State Formulations

1. Moisture Retention and Carrier-Related Challenges

Adequate moisture availability is a critical determinant of microbial survival in solid-state formulations. Certain carrier materials, including rice husk, exhibit rapid moisture loss when stored under ambient environmental conditions, which can adversely affect microbial persistence. Therefore, precise adjustment of carrier water-holding capacity is essential to ensure sufficient hydration while maintaining proper aeration for microbial metabolism.

2. Susceptibility to Microbial Contamination

Solid-state formulation systems, particularly those lacking rigorous sterilization or hygienic handling, are vulnerable to colonization by opportunistic fungi or competitive microorganisms. Such contaminants can proliferate rapidly, suppress the growth of target silicate-solubilizing microorganisms, reduce functional efficacy, and ultimately shorten the shelf life of the formulation.

3. Decline in Microbial Viability and Functional Activity

Prolonged storage of SSMs in solid carriers may result in a gradual reduction in cell viability and metabolic performance. Factors such as nutrient depletion, oxidative damage, and cellular autolysis contribute to this decline, leading to diminished silicate-solubilizing potential. Incorporation of protective agents and optimized formulation conditions is therefore necessary to preserve functional integrity.

4. Variability in Functional Performance among Batches

Inconsistencies in formulation parameters—including inoculum concentration, carrier particle size, moisture content, and preparation procedures—can lead to significant batch-to-batch variation in microbial performance. Such variability poses challenges for quality assurance and compromises the reliability of field-level application.

5. pH Fluctuations and Buffering Limitations

During storage, biochemical activity within SSF carriers may induce shifts in pH, often resulting from the accumulation of organic acids produced during microbial metabolism. Insufficient buffering capacity in the carrier system, even in the presence of molasses or milk-based supplements, can negatively influence microbial activity and suppress silicate solubilization efficiency.

Advantages and Limitations of Formulation Approaches

Solid-State Formulation (SSF)

1. Demonstrates prolonged shelf stability and maintains microbial viability under ambient storage conditions.
2. Facilitates convenient field application with reduced requirements for specialized transport or handling.
3. Offers an economically viable approach through the use of inexpensive carrier materials and agricultural by-products.
4. Enables gradual and sustained delivery of viable microorganisms following application, supporting prolonged functional activity.

Liquid-Based Propagation Systems

1. Provide uniform and well-regulated growth environments when produced under controlled bioreactor conditions.
2. Support rapid expression of silicate-solubilizing activity, making them suitable for short-term bioassays and laboratory evaluations.
3. Allow accurate adjustment of inoculum concentration and functional potency prior to application.
4. Are amenable to large-scale production through controlled fermentation technologies.

Recommendations for Improving Solid-State Formulation Performance

To enhance the effectiveness and reliability of solid-state formulations, careful selection of carrier materials with optimal particle size distribution and moisture-retention capacity is essential. The inclusion of protective additives, such as skim milk powder or trehalose, is recommended to improve microbial survival during storage. Additionally, the use of airtight or hermetically sealed packaging can minimize moisture loss and reduce the risk of contamination. Routine monitoring of silicate-solubilizing activity across successive culture generations is also advised to track functional stability and adaptive changes in microbial performance.

Conclusion

The present investigation validates the effectiveness of an integrated strategy that combines in vitro propagation of silicate-solubilizing microorganisms on molasses- and milk-enriched Czapek–Dox medium with subsequent solid-state formulation. This dual approach supports the development of stable, efficient, and field-ready microbial inoculants capable of enhancing silicon availability in agricultural soils. By promoting sustained microbial activity, cost-effective production, and improved

nutrient mobilization, such biofertilizer systems offer a promising pathway toward environmentally sustainable and productivity-driven agricultural practices.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

COSMETIC SURGERY: EVERYTHING YOU NEED TO KNOW

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•Abstract

Cosmetic surgery represents, for most theorists and social commentators, the ultimate emblem of invasion of the human body on behalf of physical beauty. As construed as in some way qualitatively distinct from other attempts at changing the body, plastic surgery represents something so extreme, so risky, that it admits of no interpretation as anything but subjection. Though such criticisms are persuasive, they work at either the grand scale of cultural dialogue or the very grounded scale of physiological impact. In doing so, they exclude nearly entirely the experience of the women who undertake plastic surgery themselves. This paper relies on qualitative interviews with 20 female patients of a Long Island, NY plastic surgeon to examine cosmetic surgery as an autobiographical accounting and a specific form of account of the self. Interview data indicate that plastic surgery enables women who undergo it to effectively reconfigure their bodies as "normal" bodies. Meanwhile, it also asks them to establish accounts that reconnect the self to the surgically-"corrected"—but arguably "inauthentic"—body by appealing to both essential conception of the self and concomitant conceptions of the body as accidental, inessential, or degenerated from an earlier body that more accurately reflected what they are really like.

• Introduction

Cosmetic surgery is Branch of medical science. Each year thousands of persons undergoes cosmetic surgery to alter to person enhancing appearance, increase self-confidence. In cosmetic surgery it has two types procedure surgical and non-surgical they are various type of cosmetic surgery like, facial cosmetic surgery (Rhinoplasty), Breast surgery (Breast lift),
In 1994, for eg the American society of plastic and reconstructive surgeon (ASPRS) reported it's cosmetic Procedures, the liposuction (fat removal from various Body region), Breast augmentation, rhinoplasty (nose alteration), rhytidectomy (face lift) ASPRS 1994. Cosmetic surgery is important not only for Beauty But also, improving confidence and Quality of life repairing deformities or correcting Birth defects, reconstruction after injury or disease, restores appearance after accident, Burns, surgeries (eg .cancer removal),anti-aging and wellness In this research article we are discussing the various points

•Methods: of cosmetic surgery

1. surgery -it's past, present, future
2. General risk of cosmetic surgery
3. 3Medical ethics and the promotion of cosmetic surgery.

4.Choosing the Right Surgeon
5.Cost and Global market
•surgery – it's past, present, future

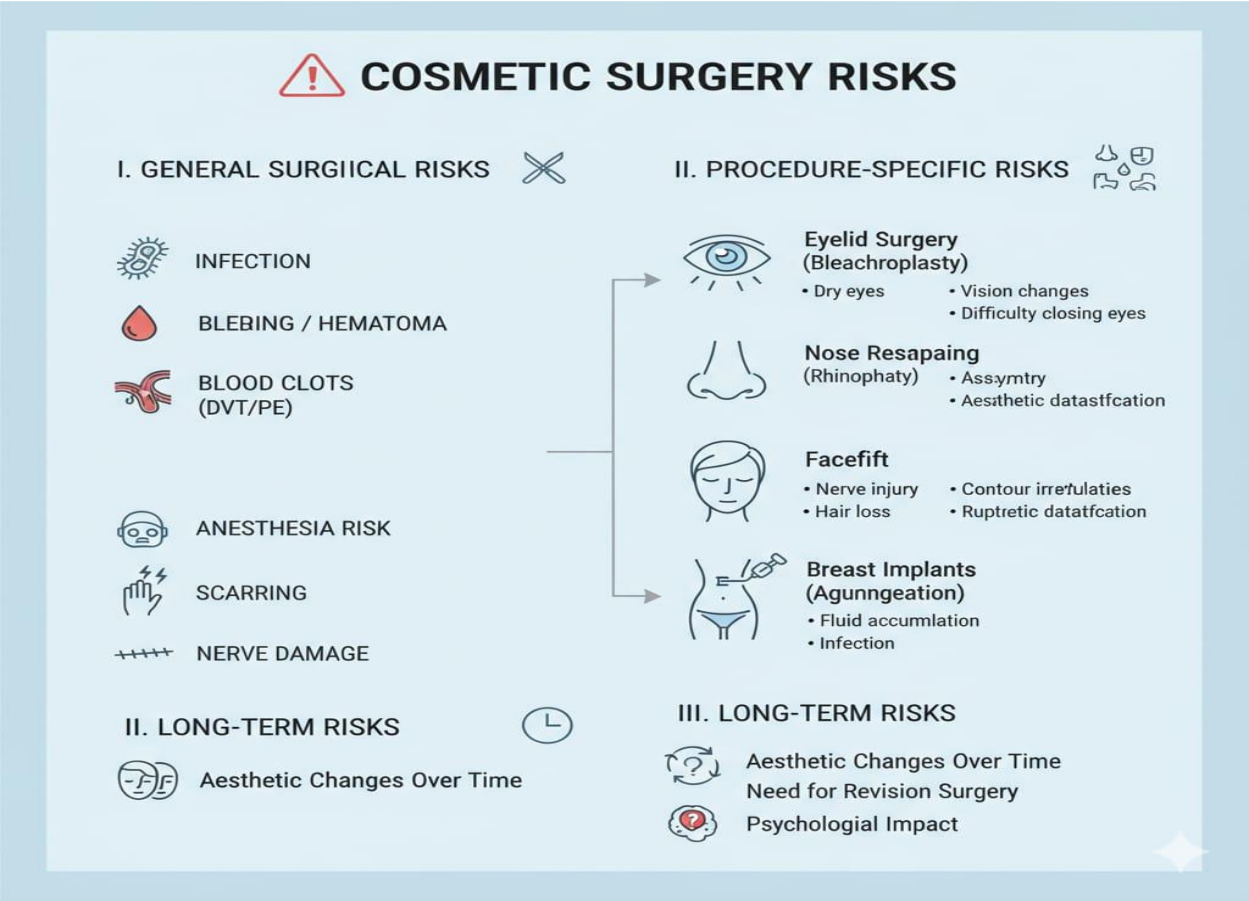
The history of cosmetic surgery is in extricable linked with reconstruction. The history of cosmetic surgery dates back to the initial nasal reconstruction in ancient India. Sushruta of India is credited by historians with delineating a regional pedicled flap for the nose in Samahita ca. 1000-800 BCE [1]. Today, the paramedian flap is employed for other nasal defects such as those after cancer resections, trauma and burns. The British physician Sir Harold Gilles is generally referred to as the father of plastic and facial cosmetic surgery [2]. Gilles was an otolaryngologist who served in the Royal Army Medical Corps in World War I as the medical director for the French-American dentist Auguste Charles Valadier, who had a significant influence on Gilles professional career. Valadier received his M.D. from Columbia University's College of Physicians and Surgeons in 1895, and his dental degree from the Philadelphia Dental College (now Temple University School of Dentistry) in 1901. As soon as war erupted in Europe in August 1914, Valadier offered his services to the British Red Cross Society (the British Army did not have an independent commissioned dental corps until 1921). Gilles discovered a fascination with reconstructing facial trauma with Valadier and redirected his surgical interest to facial reconstruction. He eventually wrote his classic book: Plastic Surgery of the Face [3]. Encouraged by an booming economy and general prosperity, facial cosmetic surgery became popular on the eve of the twentieth century and continued into the roaring twenties. There is little evidence for progress made in this area during the 1930s probably because of the Great Depression and the start of World War II. It is not until the mid-1950s that there is another surge of accounts of cosmetic surgery. As with any other new surgical field, coverage of the topic was opposed by the medical professionals, but as people became increasingly interested in such procedures, so did the interest among surgeons to study and find treatment plans. Cosmetic surgery research started to branch out into individual areas, i.e., the nose, face and neck, around the eyes, and other parts of the body, with researchers more specifically examining the aging process and the face subunits. In 1981, the Hungarian-born American anthropologist Leslie Farkas wrote a facial proportion report. He analysed a large group of individuals and discovered that there was a high level of variability in facial proportions between ethnic groups. His research assisted in the improvement of surgical procedures and resulted in more naturally appearing outcomes. In the early 2000s, Rohrich and Pessa explained the alterations of facial fat compartments with aging that have served an imperative role in diagnosis in facial cosmetic surgery [[4], [5], [6], [7]] Cosmetic surgery was evolving at about the same time that subspecialties of surgery were starting to take form, both in Europe and America. Cosmetic surgery thus has its origin in every branch of surgery such as plastics and reconstruction, otolaryngology-head and neck, obstetrics and gynaecology, ophthalmology, dentistry, oral and maxillofacial surgery, dermatology, and others. Evolution of the main facial cosmetic surgical procedures is listed below to serve as background to the descriptions of the subsequent case reports

Result and Discussion.

• General risks of cosmetic surgery:

In cosmetic surgery carries various risk and just like other general surgical risk and procedure risk like infection , Bacteria entering the surgical site may cause complication , excessive Bleeding or hematoma , blood pooling under the skin ,blood clots (DVT/PE), anaesthesia risk etc and other procedures specific risk like , ey Potential elide surgery ,nose

reshaping (Rhinoplasty) facelift , liposuction, Breast implants , in eyelid surgery various risk are happened like dry eyes vision changes etc
In rhinoplasty, occurs some – breathing problems, asymmetry etc and also long term risk are happened in a cosmetic surgery



• Medical ethics and the promotion of cosmetic surgery:
The promotion of plastic surgery in Australia has been a source of significant concern when it comes to medical practice. Although Australian legislation prohibits the promotion of misleading and deceptive information, it also makes a distinction between misleading information and "puffery or self-evident exaggeration.". On this point the advertising of cosmetic surgery has been condemned for capitalising on a person's insecurities regarding their appearance, and specifically insecurity about having a normal appearance for someone of their age and correlating a normal ageing look with an undesirable look. Where societies have a large number of people who complain about the way they look, such advertising is possibly immoral. But recent Australian legislation that restricts the use of before and after photos and the employment of misleading statistical data should help protect people considering plastic surgery better Advertising cosmetic surgery encourages the procedures for beauty, not to enhance health. Though these strategies are general aspects of advertising in the

beauty industry, they present specific cause for concern in the medical field, which has a duty of

care to diagnose and treat disease within the interests of protecting patients' health. Since cosmetic surgery is health-risks-involved but not health-relevant, the following issues have been pointed out regarding its advertising in the Australian context: Cosmetic surgery ,that cosmetic surgery media tends to be written by medical practitioners who stand to gain from carrying out cosmetic procedures, and copy in the media tends to be followed by adverts for the same practitioner's service; Promotion of cosmetic surgery tends to portray a typical, ageing look as unsatisfactory and employ emotive language to caption such looks;

Employing models who have not been subjected to plastic surgery in adverts suggesting that the model's appearance was attained through plastic surgery by employing deceptive before and after photographs, for instance photos that have been retouched, before and after images, since the very fast appearance changes which they experience could cause physical and psychological health dangers. available •Choosing the Right Surgeon that vary in size, resolution, colour or pose There is also been criticism of the impact of reality television shows where candidates compete to transform their image by undergoing extreme cosmetic surgical procedures. An American study found that 80% of cosmetic surgery patients surveyed had been affected to some extent by television shows. They have been criticised for minimizing the risks, misrepresenting the period over which recovery and dramatic feature enhancement take place, and overstating the chances of a successful outcome. But those who habitually watch cosmetic television shows are more inclined to think that reality shows mimic life. Cosmetic surgery 'reality' TV shows are also considered to be one of the determinants pushing up the prevalence of cosmetic surgery among Western nations. There has also been concern for the physical and ethical rights of participants

Selecting a qualified surgeon is one of the most crucial steps in the cosmetic surgery process. The following factors should be considered: Board Certification: Ensure the surgeon is certified by a recognized authority, such as the Medical Council of India (MCI) or the Indian Association of Aesthetic Plastic Surgeons (IAAPS). Certification indicates professional training and adherence to ethical and safety standards. Experience and Specialization: Review

how often the surgeon performs the specific procedure you are considering. Experience in similar cases improves outcome predictability. Accredited Facility: The surgery should be conducted in a hospital or clinic accredited for safety, hygiene, and emergency response capability. Consultation and Communication: A reputable surgeon encourages open discussion, explains risks and benefits, and never pressures you into quick decisions. Patient Reviews and Results: Request before-and-after photos and review patient testimonials. Consistent results and positive feedback are good Indicators.

•Cost and Global Comparison in India, cosmetic surgery costs vary depending on procedure type, location, and surgeon experience. For example, rhinoplasty may range from ■80,000 to ■2,50,000, while liposuction costs between ■75,000 and ■3,00,000. Compared to

Western countries, India offers high-quality procedures at 60–70% lower costs, attracting

medical tourists worldwide. However, patients must avoid low-cost clinics that compromise safety or use unqualified practitioners.

•Conclusion

My research points to three general conclusions. The first bears on the reasons Women have plastic surgery and suggests a modification of the criticisms of such Procedures. The second bears on the ways in which women create accounts of Plastic surgery, an omission from the criticisms of plastic surgery. The third returns more sympathetically to those criticisms. First, none of the women I spoke to embarked casually on plastic surgery. These women had plastic surgery only after serious consideration, often accompanied by research into the medical technology involved in the operations. Nearly all Either had to sacrifice another large purchase or to weather some sort of financial Hardship to pay for the surgery. More importantly, although physicians may serve as gatekeepers, preventing some women from receiving surgery, physicians do not, in any direct sense, recruit patients. Neither did the women I spoke to report, that they underwent surgery at the urging of a specific other—husband, parent, Lover, or friend. Rather, the decision to seek surgery seems to have been driven by the desires of women themselves, at least in the immediate circumstances, to be Sure, the women's decisions to undergo surgery were shaped by broader cultural Considerations—by notions of what constitutes beauty, by distinctively ethnic notions of beauty, and, most importantly, by the assumption that a woman's worth is measured by her appearance. Yet to portray the women I talked to as some sort of "cultural dopes," tossed and battered by cultural forces beyond their understanding, as passively submitting to the demands of beauty, is to badly misrepresent them,. A more appropriate image, I would suggest, is to present them as savvy cultural Negotiators, attempting to "make out" as best they can within a culture that limits their options. Those who undergo plastic surgery may (ultimately) be wrong, but they are not foolish. They know what they are doing. Their goals are realistic and they, in fact, achieve most of what they set out to accomplish with plastic Surgery. Although their actions surely do, in the long run, contribute to the reproduction of a beauty culture that carries heavy costs for them and for all women, in the short run they have succeeded in their own more limited purpose Second, plastic surgery requires accounts. As with the women I knew in the aerobics classes, those who pursue plastic surgery are striving to justify themselves. But the accounts of the first group are quite different in Character from those of the aerobics women. The aerobics women use hard bodily Labour as an index of character that enables them to cut their notion of their selves away from their bodies. The women who have experienced plastic surgery, on the other hand, struggle to restore the self to the body. They do so in two steps. In the first instance, they must persuade Themselves that they deserve the surgery, either through the efforts they expend at themselves that the new-looking appearances they have been assigned, however deserved, are in some way tied to the self—i.e., that they are innocent of charges of inauthenticity.2 In order to accomplish this, they appeal to essentialist conceptions of the self and related conceptions of the body as incidental, somehow unessential, or a debasement of an earlier body that more accurately represented who they really.

We will be able to do so on exactly the grounds I have just indicated. I do not find the argument persuasive to the effect that Making legs thinner is somehow less "real" than hair dyeing from grey to brow or that even eye surgery or rhinoplasty is somehow less authentic than a decision

to get a trendy, as opposed to an ethnic, hairdo. Yet, what distinguishes the actions of women in aerobics and even in beauty parlors is that they are trying, in somewhat dissimilar modes and with variable amounts of success, to neutralize. Appearance as a marker of character. Much more than the other women I research the women who have plastic surgery assist in reproducing some of the most negative elements of the culture of beauty, not necessarily through the surgery itself but through their ideological attempts to revive appearance as a marker of character. Lastly, I am returning more compassionately to the critiques of plastic surgery. but, here, also, I turn to those criticisms in light of my observations about the women I write about elsewhere. Though I have spoken of plastic surgery as a research "site "On a par with an aerobics class or a group of women in a beauty salon, the analogy is in some ways misleading.3 In an aerobics class and a beauty salon, I encountered. Women collaborating to create solutions to a common problem. But the Women who had plastic surgery were not a group in the strong sense to which that term applies to the other women

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

अहमदनगर जिल्ह्याच्या आर्थिक विकासात साखर उद्योगाचे योगदान

श्री. ज्ञानेश्वर बाळासाहेब पादर
संशोधक विद्यार्थी, संशोधन केंद्र
इतिहास विभाग
कला, वाणिज्य व विज्ञान महाविद्यालय,
सोनई, ता. नेवासा जि. अहिल्यानगर

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ता. नेवासा जि. अहिल्यानगर

प्रस्तावना:

अहमदनगर जिल्ह्यात जलसिंचनाच्या सुविधांचा विकास झाल्याने शेतकऱ्यांनी मोसमी पावसावर घेतली जाणारी पिके सोडून नगदी पिके घेण्यास सुरुवात केली. ऊस या नगदी पिकास शेतकऱ्यांनी पसंती दिली. ऊस हे नगदी पीक शेतकऱ्याची आर्थिक परिस्थिती बदलण्यास महत्त्वाचे ठरले आहे. ऊस पिकाचे क्षेत्र वाढल्याने या भागांमध्ये साखर उद्योगाचा विकास घडून आला आणि शेतकऱ्यांच्या हातामध्ये पैसा येण्यास सुरुवात झाली. साखर उद्योग प्रामुख्याने अहमदनगर जिल्ह्यात ब्रिटिश कालखंडातच सुरू झाला आहे. अहमदनगर जिल्ह्यात साखर कारखान्यांची स्थापना होण्याअगोदर ऊस पिकाचे क्षेत्र मोठ्या प्रमाणावर होते. हा ऊस गुळ तयार करण्यासाठी वापरला जात होता. मात्र काही ठराविक काळानंतर गुळाच्या किमती ढासळल्या त्यामुळे ऊस पिकाचे संपूर्ण अर्थशास्त्र बदललेले आपणास दिसून येते. हा एक गंभीर प्रश्न त्यावेळेस निर्माण झाला होता. कारण शेतकऱ्याचे संपूर्ण कुटुंब हे शेतीवर अवलंबून असते आणि शेती पिकाच्या किमती ढासळल्या तर शेतकऱ्याचे संपूर्ण अर्थशास्त्र बदललेले दिसून येते. म्हणूनच तत्कालीन शासनाने या प्रश्नावर उत्तर शोधताना त्यातून साखर उद्योगाचा विचार पुढे आलेला पहावयास मिळतो. कारण गुळ साठवणूक करण्यासाठी खर्च जास्त येतो पर्यायी त्याच्या तुलनेत उसापासून बनवलेल्या साखरेचा साठा करण्यास खर्च कमी येतो. म्हणूनच तत्कालीन मुंबई शासनातील उद्योगधंदे खात्याने साखर उद्योगाबाबत योग्य निर्णय घेण्याची भूमिका घेतली आणि साखर उद्योग निर्मितीस चालना दिली.

ब्रिटीशकालीन अहमदनगर जिल्ह्यातील साखर उद्योग :

अहमदनगर जिल्ह्यात साखर उद्योगाची सुरुवात हे स्वातंत्र्यपूर्व कालखंडापासूनच झाली आहे. शेतकऱ्यांना एक शाश्वत उत्पन्न मिळवून द्यावे हा विचार समोर ठेवून तत्कालीन सरकारने साखर उद्योगाला चालना देण्याचे ठरविले होते. अहमदनगर जिल्ह्यात साखर कारखाना निर्माण व्हावा म्हणून ब्रिटिश काळातील एक प्रसिद्ध अशी औद्योगिक कंपनी म्हणजे मार्शल ही होय. या कंपनीने सरकारकडे ऊस लागवडीसाठी काही हजार एकर जमिनीची मागणी केली. ती सरकारने मान्य करून ८००० एकर जमीन या कंपनीला ऊस लागवडीसाठी उपलब्ध करून दिली.[१] एक शाश्वत अशा कच्च्या मालाची उपलब्धता निर्माण झाल्यानंतर इ. स. १९१९ रोजी मार्शल या कंपनीने जवळ जवळ ४० लाख रुपये भांडवल जमा करून अहमदनगर जिल्ह्यातील श्रीरामपूर जवळ असणाऱ्या हरेगाव या ठिकाणी बेलापूर कंपनी या नावाने अहमदनगर जिल्ह्यातील पहिला साखर

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कारखाना सुरू केला.[२] साखर उद्योगाला तेव्हापासून आजतगायत वेगवेगळ्या समस्यांना काही कमी नाही. अशाच समस्या अडचणी तत्कालीन बेलापूर साखर कारखाना सुरू करणाऱ्या मार्शल कंपनीलाही आल्या आणि त्या कंपनीला हा कारखाना बंद करावा लागला. मात्र ब्रिटिश काळातील आणखी एक उद्योगधंदात आघाडीवर असणारी कंपनी म्हणजे ब्रॅंडी अँड कंपनी ही होय. ही कंपनी उद्योगधंद्यात जम बसवलेली कंपनी होती. मार्शल कंपनीने सुरू केलेला बेलापूर कारखाना ब्रांडी अँड कंपनी या ब्रिटिश कंपनीने चालवायला घेतला.[३] या कंपनीस आर्थिक फायदा देखील झाला नंतरच्या काळात साखर उद्योगाच्या बाबतीत सरकारने अनेक चालना देण्याच्या हेतूने निर्णय घेऊन भारतीय साखर उद्योगाला संरक्षण प्राप्त करून दिले. सरकारच्या या धोरणाचा फायदा साखर उद्योगाला झाला यातूनच अहमदनगर जिल्ह्यात नुसत्या प्रवरा आणि गोदावरी नदीच्या खोऱ्यामध्ये चार नवीन सहकारी साखर कारखाने सुरू झाले. नंतरच्या कालखंडामध्ये संपूर्ण अहमदनगर जिल्ह्यामध्ये सहकारी साखर कारखान्यांची एक चळवळ सुरू होऊन अनेक सहकारी साखर कारखाने सुरू झाले आहे.

स्वातंत्रोत्तर कालखंडातील साखर उद्योग:

अहमदनगर जिल्ह्याच्या साखर उद्योगांमध्ये स्वातंत्र्योत्तर कालखंडात घडून आलेली एक महत्त्वाची क्रांती म्हणजे सहकारी तत्त्वावर सुरू झालेले साखर कारखाने होय. आशिया खंडातील पहिला सहकारी साखर कारखाना अहमदनगर जिल्ह्यात प्रवरानगर येथे सुरू झाला.[४] इ. स. १९५० पर्यंत अहमदनगर जिल्ह्यामध्ये साखर उद्योगांमध्ये खाजगी साखर कारखान्यांचे वर्चस्व होते. नगर जिल्ह्यातच नव्हे तर संपूर्ण महाराष्ट्रामध्येच साखर उद्योगात खाजगी साखर कारखान्यांचे वर्चस्व होते. अशावेळी ही साखर कारखाने शेतकऱ्यांना त्यांच्या ऊसाला कमी भाव देत असत. तर कधी कधी जर गूळ उत्पादनासाठी ऊसाला मागणी असल्यास किंमत तिकडे चांगली मिळाल्यास शेतकरी आपला ऊस गुळ उत्पादनासाठी देत. त्याचा परिणाम म्हणजे साखर कारखान्यांना हवा असणारा कच्चामाल म्हणजे ऊस हा पुरेशा प्रमाणात उपलब्ध होत नसे. या सगळ्या वर एक उत्तम असा तोडगा म्हणजे सहकारी तत्त्वावर साखर उद्योगाची उभारणी करणे हा होता. कारण हा साखर कारखाना सर्वांच्याच मालकीचा असल्या कारणाने ऊस उत्पादक हेच कारखान्याचे सभासद देखील होते. म्हणून ते आपला ऊस याच कारखान्यात देतील या हेतूनेच इ. स. १९५० मध्ये पद्मश्री विठ्ठलराव विखे पाटील यांनी प्रवरानगर येथे सहकारी तत्त्वावरील पहिला साखर कारखाना सुरू केला.[५] यासाठी प्रवारानगरच्या आसपासच्या खेड्यातील शेतकऱ्यांनी भांडवल जमा करण्याचे काम केले. शेतकऱ्यांनी हा कारखाना सुरू करण्यासाठी जवळजवळ १२ लाख रुपयांचे भाग भांडवल जमा केले. त्याचवेळी साखर कारखान्याची निर्मिती व्हावी उद्योगधंद्यास चालना मिळावी साखर उद्योगाचा विकास घडून यावा तत्कालीन मुंबई सरकारने या साखर कारखान्याच्या उभारणीसाठी दहा लाख रुपयांची मदत केली.[६] या रकमेबरोबरच शेतकऱ्यांनी जमा केलेल्या भांडवलाच्या आधारावर इ. स. १९५० मध्ये ४५० मेट्रिक टन गाळप क्षमता असलेला कारखाना सुरू करण्यात आला. नंतर या कारखान्याची गाळक क्षमता १२०० टन अशी करण्यात आली. व पुढे जाऊन ही क्षमता वाढत वाढत गेली. आज या सहकारी साखर कारखान्याची गाळपक्षमता ही प्रतिदिन ४००० मेट्रिक टन आहे.[७]

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International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

अहमदनगर जिल्ह्यातील इ. स.१९८९-९० साखर कारखाने:

अ. क्र.	तालुका	साखर कारखान्याचे नाव	सहकारी/ खाजगी	गाळप क्षमता मे. टन प्रति दिन	प्रत्यक्ष झालेले गाळप (मे.टन)	साखरेचे उत्पादन मे.टन
१	२	३	४	५	६	७
१	राहुरी	राहुरी सहकारी साखर कारखाना लि. श्री शिवाजीनगर	सहकारी	४२५०	८,८७,३४३	९४,३३४
२	श्रीरामपूर	पद्मश्री डॉ. विठ्ठलराव विखे पाटील सहकारी साखर कारखाना लि. प्रवरानगर	_,,_	४५००	९,30,५७९	९८,००२
३	_,,_	अशोक सहकारी साखर कारखाना लि.अशोकनगर	_,,_	२६००	४,४३,५२४	४५,३६२
४	_,,_	हरेगांव शुगर मिल्स लि. हरेगांव	खाजगी	२०००	कारखाना बंद	-
५	_,,_	महाराष्ट्र शुगर मिल्स लि. टिळकनगर	_,,_	२७५०	कारखाना बंद	-
६	नेवासा	मुळा सहकारी साखर कारखाना लि.	सहकारी	२५००	५,६६,१४२	६१,५५३
७	_,,_	ज्ञानेश्वर सहकारी साखर कारखाना लि. ज्ञानेश्वरनगर	_,,_	३०००	६,००,७२५	६२,६०६
८	पाथर्डी	वृद्धेश्वर सहकारी साखर कारखाना लि. आदिनाथनगर	_,,_	८००	१,८५,१३२	१८,१६९
९	कर्जत	जगदंबा सहकारी साखर कारखाना लि. अंबिकानगर	_,,_	८००	2,५३,२०४	25,८८२
१०	श्रीगोंदा	श्रीगोंदा सहकारी साखर कारखाना लि.श्रीगोंदा फॅक्टरी	_,,_	२०००	४,४४,५७४,	४४,८८३
११	पारनेर	पारनेर सहकारी साखर कारखाना लि. देविभोयरे	_,,_	१२५०	2,२४,१९५	२३,०२२
१२	संगमनेर	संगमनेर भाग सहकारी साखर कारखाना लि. अमृतनगर	_,,_	३५००	६,८२,३४४,	७५,४६४
१३	कोपरगाव	श्री. गणेश सहकारी साखर कारखाना लि.गणेशनगर	_,,_	१७५०	३,५४,७०५	३७,४७०
१४	_,,_	कोपरगाव सहकारी साखर कारखाना लि. गौतमनगर	_,,_	२२००	६,१०,६११	६६,५७३
१५	_,,_	संजीवनी सहकारी साखर कारखाना लि. कोपरगाव	_,,_	२०००	६,०५,३६३	६६,१६५
१६	_,,_	गोदावरी शुगर मिल्स लक्ष्मीवाडी	खाजगी	१७५०	कारखाना बंद	-
१७	_,,_	गोदावरी शुगर मिल्स चांगदेवनगर	खाजगी	१२५०	कारखाना बंद	-
१८	_,,_	चांगदेव शुगर मिल्स, चांगदेवनगर	खाजगी	१०००	कारखाना बंद	-

वरील तक्त्यावरून असे दिसून येते कि यावर्षी जिल्ह्यात १८ साखर कारखाने कार्यरत होते. त्यापैकी खाजगी स्तरावर चालविले जाणारे पाच साखर कारखाने यावर्षी बंद होते. त्यांचे गाळप यावर्षी झाले नाही. तर सहकारी तत्त्वावरील १५ साखर कारखान्याचे गाळप पूर्ण झाले. या गाळप हंगामामध्ये सर्वाधिक गाळप क्षमता ही

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E-ISSN: 3049-3846
Oct, 2025

पद्मश्री डॉक्टर विठ्ठलराव विखे पाटील सहकारी साखर कारखाना लिमिटेड प्रवरानगर यांची होती. तर सर्वात कमी गाळप क्षमता ही वृद्धेश्वर सहकारी साखर कारखाना लिमिटेड आदिनाथनगर आणि जगदंबा सहकारी साखर कारखाना लिमिटेड अंबिकानगर यांची होती. ही गाळप क्षमता ८०० मेट्रिक टन प्रतिदिन एवढी असल्याचे दिसून येते. यावर्षीच्या हंगामामध्ये सर्वाधिक गाळप हे प्रवरानगर सहकारी साखर कारखान्यांनी केले आहे. जवळजवळ ९,30,५७९ मेट्रिक टन उसाचे गाळप या कारखान्यांमध्ये झाले आहे. तर सर्वात कमी गाळप हे वृद्धेश्वर सहकारी साखर कारखाना यांचे झाले आहे. १८५१३२ मेट्रिक टन गाळप या कारखान्याचे झाले आहे. साखरेचे उत्पादन सर्वात जास्त प्रवरानगर सहकारी साखर कारखान्यात झाले आहे. ९८००२ मेट्रिक टन साखरेचे उत्पादन या साखर कारखान्यांमध्ये झाले आहे. तर सर्वात कमी साखर उत्पादन वृद्धेश्वर सहकारी साखर कारखान्यामध्ये १८१६९ मेट्रिक टन झाले आहे. हरेगाव शुगर मिल्स लिमिटेड, हरेगाव, महाराष्ट्र शुगर मिल्स, टिळकनगर, गोदावरी शुगर मिल्स, लक्ष्मीवाडी, गोदावरी शुगर मिल्स, चांगदेवनगर आणि चांगदेव शुगर मिल्स, चांगदेवनगर हे खाजगी स्तरावर चालविले जाणारे साखर कारखाने बंद होते.

अहमदनगर जिल्ह्यातील इ. स. १९९८ -९९ साखर कारखाने:

अ.क्र.	कारखान्याचे नाव	ऊस गाळप क्षमता (TCD)	गाळप केलेला ऊस (M.T.)	साखर उत्पादन (क्विंटल) नेट	साखर बॅग्ड (क्विंटल)
१	अगस्ती	२५००	३९३१९२	४०८६०७	४०८५२५
२	अशोक	२६००	३६२१७३	३९९२५५	३९९२७५
३	ज्ञानेश्वर	३०००	६३१७७७	७०७४३८	७१४१७०
४	डॉ. विखे पाटील	४०००	८४९३६०	९४४०४०	९५८६७५
५	गणेश	१७५०	३१९५७२	३३७४४२	३३७४५०
६	जगदंबा	८००			
७	केदारेश्वर	२५००	२०८७५७	२१८०९१	२१८२३०
८	कोपरगाव	३०००	६३३३९०	६८५१५१	६८५१६०
९	मुळा	२५००	५१८३१६	५६२४६९	५६२६८५
१०	पारनेर	१२५०	१८५७००	२०९७५२	२०७६७५
११	राहुरी	४२५०	६८०७९६	७३६३९१	७३५४५०
१२	संगमनेर	३५००	८७१३७२	९७६३३८	९७८४६०
१३	संजीवनी	२५००	५९३६४१	६५१२१२	६५११४०
१४	श्रीगोंदा	२०००	५४१२४९	५६५७९२	५६५५५०
१५	वृध्देश्वर	२५००	२७८४६९	३०५०३९	३०९२१५
एकूण		३८६५०	७०६७७६४	७७०७०१७	७७३१६६०

स्रोत: Vasantdada Sugar Institute, Performance of sugar Factories in Maharashtra, १९९८-९९, Pune.

INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
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Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

वरील तक्त्यात असे दिसून येते की इ. स. १९९८- ९९ या कालखंडात सर्वाधिक गाळप क्षमता ही डॉक्टर बाबुराव बाबूजी तनपुरे सहकारी साखर कारखाना राहुरी यांची आहे.[८] ही गाळप क्षमता ४२५० मेट्रिक टन एवढी असून सर्वात कमी गाळपक्षमता ही जगदंबा सहकारी साखर कारखान्याची असून ८०० मेट्रिक टन एढी आहे.[९] जगदंबा साखर कारखाना सोडला तर उर्वरित सर्वच साखर कारखान्यामध्ये इ. स. १९९८- ९९ या हंगामात गाळप झाले आहे. या गाळप हंगामामध्ये सर्वाधिक गाळप संगमनेर सहकारी साखर कारखान्याने केल्याचे दिसून येते. एकूण ८७१३७२ गाळप संगमनेर कारखान्यांनी केले आहे.[१०] साखर उत्पादनात देखील संगमनेर साखर कारखानाच आघाडीवर आहे. साखर उत्पादन ९७८४६० क्विंटल झाले आहे. तर सर्वात कमी गाळप हे पारनेर सहकारी कारखान्याने १८५७०० मेट्रिक टन केले असून साखर उत्पादन देखील याच कारखान्याचे सर्वात कमी आहे. ते २७६७५ क्विंटल आहे.[११] इ. स. १९९८- ९९ च्या काळात सर्व तालुक्याची एकूण गाळपक्षमता ही ३८६५० मेट्रिक टन प्रतिदिन होती. या हंगामात एकूण उसाचे गाळप ७०६७७६४ मेट्रिक टन झाले आहे. तर एकूण साखरेचे उत्पादन ७७०७०१७ क्विंटल झाले तर निव्वळ साखर उत्पादन ७७३१६६० क्विंटल झाले आहे.

अहमदनगर जिल्ह्यातील इ. स. २००७-०८ साखर कारखाने:

अ.क्र.	कारखान्याचे नाव	ऊस गाळप क्षमता (TCD)	गाळप केलेला ऊस (M.T.)	साखर उत्पादन (क्विंटल) नेट	साखर बॅग्ड (क्विंटल)
१	अशोक	२६००	५३४९७८	६३४७१३	४८४६१०
२	ज्ञानेश्वर	५०००	९८३८३३	१११३७१९	११२५५२०
३	गणेश	१७५०	३६४६७१	४२६०४७	४२५२२५
४	जगदंबा	८००	२५३३४३	२७६०८९	२७६६७५
५	कोपरगाव	३०००	६७२२०७	७९५७३६	७९४३२५
६	मुळा	३५००	८३१६४१	१०२१०७१	१०२१७५०
७	पारनेर	१२५०	२९४५४३	३५१८९५	३५२८५०
८	डॉ. विखे पाटील	४०००	९४०४६३	११३८२००	११३५२१३
९	डॉ. बी. बी. तनपुरे	४२५०	७१०६२७	७८५९७३	७८६६१५
१०	संगमनेर	३५००	९४११४३	११४०३२९	११४००९०
११	संजीवनी	२५००	६५३२८०	८०८२९८	८०८१२५
१२	श्रीगोंदा	३५००	७८५९८८	९०२३११	९०७८५३
१३	वृध्देश्वर	२५००	४७९०४५	५५५६५३	५५६२१३
१४	अगस्ती	२५००	४२२४५५	५२२७१०	५२०५५०
१५	केदारेश्वर	२५००	३१८५३१	३५५२७५	३५६२००
१६	साईकृपा	१२५०	३२४७९४	३७२३००	३७२७५०
१७	नगर तालुका	२५००	३४६९३०	३८५८४८	२८६७५०
१८	कुकडी	२५००	६४५०६४	७७१११६	७७०४५०
एकूण	—	४९४००	१०५०४४७८	१२३७३०७३	१२०१३४३८

स्रोत: Vasantdada Sugar Institute, Performance of sugar Factories in Maharashtra, 2007- 08, Pune

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International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
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वरील तक्त्यात अहमदनगर जिल्ह्यातील इ. स. २००७ - ०८ या वर्षातील साखर कारखान्याच्या गाळप हंगामाची माहिती घेतली आहे. अहमदनगर जिल्ह्यात प्रामुख्याने १४ तालुक्यात असणाऱ्या १८ साखर कारखान्यामध्ये उसाचे गाळप झालेले पहावयास मिळते. या हंगामात ऊस गाळप क्षमता ही सर्वाधिक ज्ञानेश्वर सहकारी साखर कारखाना भेंडा यांची प्रतिदिन ५००० मेट्रिक टन एवढी असल्याची दिसून येते. तर सर्वात कमी गाळक क्षमता ही जगदंबा या साखर कारखान्याची ८०० मेट्रिक टन एवढी असल्याचे दिसून येते. सर्वाधिक उसाचे गाळप हे ज्ञानेश्वर सहकारी साखर कारखान्याने केलेले दिसून येते. ९८३८३३ मेट्रिक टन एवढे गाळप ज्ञानेश्वर सहकारी साखर कारखान्यांनी केल्याचे दिसून येते.[१२] तर सर्वात कमी काळत हे जगदंबा साखर कारखान्याने २५३३४३ मेट्रिक टन एवढे केल्याचे दिसून येते. सर्वात जास्त साखर उत्पादन हे संगमनेर सहकारी साखर कारखान्या मध्ये झाले आहे. ११४०३२९ क्विंटल एवढे साखरेचे उत्पादन संगमनेर साखर कारखान्यात झाले आहे.[१३] एकूण ऊस गाळप याचा विचार केला तर संगमनेर साखर कारखान्यामध्ये साखरेचे उत्पादन हे इतर साखर कारखान्याच्या तुलनेत अधिक झाल्याचे पहावयास मिळते. अहमदनगर जिल्ह्यात वरील तक्त्यानुसार असणाऱ्या साखर कारखान्याची गाळप क्षमता ही एकूण ४९४०० मेट्रिक टन प्रतिदिन आहे. तर इ. स. २००७ – ०८ या वर्षांमध्ये एकूण उसाचे गाळप १०५०४४७८ झाल्याचे दिसून येते. तर साखर उत्पादन एकूण १२३७३०७३ क्विंटल इतके झाले आहे.[१४] वरील तक्त्याचा सविस्तर अभ्यास केला तर असे दिसून येते की अहमदनगर जिल्ह्यात साखर उद्योग हा भरभराटीस आलेला पाहावयास मिळतो. इ. स.१८८०-८१ मध्ये २२१९ एकर ऊस पिकाखालील क्षेत्र होते.[१५] या क्षेत्रात वाढ होत जाऊन इ. स. १९७१-७२ मध्ये ४९२०४ हेक्टर झाले आहे.[१६]

निष्कर्ष:

अहमदनगर जिल्ह्यात साखर उद्योगाची सुरुवात ही ब्रिटीश कालखंडातच झालेली आहे. ब्रिटीश कंपन्यांनी साखर कारखाने अहमदनगर जिल्ह्यात सुरु करण्यास सुरुवात केली. सुरुवातीच्या काळात साखर कारखान्याची उत्पादन क्षमता कमी होती. त्यामुळे उसाचे क्षेत्र देखील कमी होते. पिकविलेला ऊस हा साखर कारखान्यास न देता गुळ उत्पादनास देत होते. सहकार चळवळीची सुरवात झाली आणि आशिया खंडातील पहिला सहकारी साखर कारखाना प्रवरानगर लोणी येथे स्थापन झाला. त्यामुळे साखर उद्योगास मोठी चालना मिळाली. आणि अहमदनगर जिल्ह्याच्या विकासात या उद्योगाने भर घातली. संपूर्ण जिल्ह्यात सहकारी तत्वावर आधारित साखर कारखान्यांची स्थापना झाली. इ. स. २००७-०८ या वर्षात अहमदनगर जिल्ह्यात साखर उत्पादन १२३७३०७३ क्विंटल झाले आहे. म्हणजेच यासाठी लागणारा कच्चा माल या जिल्ह्यातील शेतकऱ्यांनी पिकविला आहे. त्यामुळे याचा फायदा निश्चितच शेतकऱ्यांना झाला आहे. तसेच या साखर कारखान्यामध्ये अनेक लोकांना रोजगाराच्या संधी निर्माण झाल्या आहे. त्यामुळे जिल्ह्याच्या आर्थिक विकासात मोठे योगदान लाभले आहे.

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८. कित्ता

९. कित्ता

१०. कित्ता

११. कित्ता

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१३. कित्ता

१४. कित्ता

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१६. कित्ता

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Volume 1, Issue 4: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Aug, 2025

Principles of Insurance

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Abstract

Insurance plays a vital role in modern economies by providing financial protection against unforeseen risks. It operates on the principle of risk sharing, where individuals or organizations transfer potential losses to insurance companies in exchange for regular premiums. This paper explains the concept of insurance, its major types, key principles, and its importance to individuals, businesses, and society.

Keywords: Insurance, financial, Principles of Insurance, policyholder.

Introduction

Insurance is a financial arrangement that helps individuals and organizations manage risks associated with uncertain events such as accidents, illness, property damage, or death. By pooling risks, insurance reduces the financial burden on policyholders and promotes economic stability. In today's world, insurance has become an essential part of personal and professional life.

Insurance is a legal contract between the insurer (insurance company) and the insured (policyholder). Under this contract, the insured pays a fixed amount called a premium, and the insurer agrees to compensate for losses arising from specified risks. The objective of insurance is not to make a profit from loss but to provide financial security.

Objectives of the Research Study:

1. To study and understood the concept of Insurance**.**
2. To study of Principles of Insurance.

Research Methodology:

The primary source of data collection in this research paper is the secondary data. The available information on **Insurance** ship has been extensively used to complete the research paper. All the available Journals, Related books, Web, Articles, Publish and unpublished information and Papers provided necessary information to the finalize the research paper**.**

Principles of Insurance:

Before moving ahead, it's crucial to understand the meaning of insurance first. Insurance is a financial arrangement that protects policyholders against unexpected losses by sharing risk among a large group of people. In insurance, there are 7 basic principles that should be upheld, namely, Insurable interest, Utmost good faith, proximate cause, indemnity, subrogation, contribution, and loss minimization.

1. **Principle of Utmost Good Faith:**

His is a primary principle of insurance. According to this principle, you have to disclose all the information that is related to the risk to the insurance company truthfully. You must not hide any facts that can affect the policy from the insurer. If some fact is disclosed later on, then your policy can be cancelled. On the other hand, the insurer must also disclose all the features of a life insurance policy.

2. **Principle of Insurable Interest:**

According to this principle, you must have an insurable interest in the life that is insured. That is, you will suffer financially if the insured dies. You cannot buy a life insurance policy for a person in whom you have no insurable interest.

3. **Principle of Proximate Cause:**

While calculating the claim for a loss, the proximate cause, i.e., the cause that is the closest and the main reason for a loss, should be considered. Though it is a vital factor in all types of insurance, this principle is not used in Life insurance.

4. **Principle of Subrogation:**

The Subrogation principle comes into play when a loss has occurred due to some other person/party and not the insured. In such a case, the insurance company has a legal right to reach that party for recovery.

5. **Principle of Indemnity:**

The principle of indemnity states that the insurance will only cover you for the loss that has happened. It aligns with the general principles of law of insurance, which require transparency and full disclosure between both parties. The insurer will thoroughly inspect and calculate the losses. The main motive of this principle is to put you in the same financial position as you were before the loss. This principle, however, does not apply to life insurance and critical insurance policies.

6. **Principle of Contribution:**

According to the principle of contribution, if you have taken insurance from more than one insurer, both insurers will share the loss in the proportion of their respective coverage. If one insurance company has paid in full, it has the right to approach other insurance companies to receive a proportionate amount.

7. **Principle of Loss Minimization:**

You must take all the necessary steps to limit the loss when it happens. You must take all the necessary precautions to prevent the loss even after purchasing the insurance. This is the principle of loss minimization.

Conclusion:

Insurance is an essential financial tool that safeguards individuals and organizations against uncertain risks. By offering protection and promoting financial stability, insurance contributes significantly to personal security and national economic growth. A well-developed insurance sector is crucial for sustainable development.

Insurance companies mobilize savings, promote investment, and provide financial stability. They support trade, commerce, and industrial growth by reducing risks associated with business activities.

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INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5 : Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

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सारांश:-मराठी साहित्यातील अतिशय ज्येष्ठ ग्रामीण कथाकार व कादंबरीकार व्यंकटेश माडगूळकर यांची सत्तांतर ही कादंबरी असून ती एका वेगळ्या धर्तीवरील कादंबरी आहे. या कादंबरीमध्ये वानर हा 'हनुमान लंगूर'आहे. वानराच्या एकूण १६ उपजातींची नोंद प्राणी शास्त्रज्ञाने केलेली आहे. ललित लेखकाच्या भूमिकेतून मी एक सर्व नर-टोळी, मिश्र टोळीवर पद्धतशीर हल्ला करते,मिश्र टोळी- नायकाचा पराभव होतो आणि सत्तांतर घडून येते, एवढी वानराच्या जीवनातील नाट्यपूर्ण आणि अर्थपूर्ण घटिते निवडली.सत्तांतर हे वानरांच्या वर्तनाचा अभ्यास म्हणून लिहिलेले शास्त्रीय पुस्तक नव्हे, पानगळी जंगलात प्रत्यक्ष घडणाऱ्या घटितांवर आधारलेली ती एक कल्पित कथा आहे.

बीज शब्द:-(सत्ता संघर्ष, हनुमान लंगूर,कथानक, प्रमुख पात्रे,भाषाशैली, निवेदन, ऋतू चक्र)

प्रस्तावना:-मराठी साहित्यातील सत्तांतरही एक कादंबरी असून ती व्यंकटेश माडगूळकर लिखित आहे. या कादंबरीमध्ये मुख्यतः वानरांच्या विविध उपजातींचा समावेश हा करण्यात आलेला आहे. त्यातील काही महत्त्वाची पात्र रचना पाहिली तर त्यामध्ये मुख्य पात्र, व गौण पात्र ही रंगवण्यात आली आहे. मुख्य पात्रांमध्ये 'हनुमान लंगूर' या जातीच्या वानराच्या टोळ्या त्यांची दैनंदिन जीवन व्यवहार तसेच सत्ता मिळवण्यासाठी सातत्यपूर्ण प्रयत्न इत्यादींचे दर्शन या कादंबरीमध्ये घडते.

व्यंकटेश माडगूळकर यांनी भंडारा जिल्ह्यात असणाऱ्या 'नागझिरा' या अभयारण्यात साधारणतः एक महिना वास्तव्य हे खऱ्या अर्थाने केले आहे. त्यावेळी त्यांनी वन्यप्राणी जीवनाची केलेले सूक्ष्म निरीक्षण, वानरांचे खाणे पिणे, पाणी पिताना घेतली जाणारी खबरदारी, विश्रांती घेणे, खार माती चाटणे, दोन गटातील हाणामाऱ्या,सर्व नर- टोळी तिचा धीटपणा, वानरांची वेगवेगळे आवाज, त्यांच्या अंगावरचे व्रण, आपल्या हद्दीत येणाऱ्या माझ्यासारख्यांना घाबरवण्यासाठी केलेले हावभाव वानरांची पोरे त्यांची क्रीडा या विषयाची निरीक्षण ही लेखकांनी केली होती. त्यामुळे त्यांनी वानरांच्या स्वभाव व शरीर वैशिष्ट्यानुसारच त्यांना काही नावे दिले आहेत. उदा. टोळीचा नेता 'हुप्पा'या उपायाच्या डाव्या कानाचा वरच्या बाजूचा मोठा तुकडा हाणामारीत गमावला होता आणि तो मुड्या कानाचा झाला होता. याशिवाय या कादंबरीत इतरही गौण पात्र रचना ही आलेली दिसते.

कादंबरीच्या व्याख्या:-

कॅथरीन लिव्हर:-"कादंबरी म्हणजे कथनात्मक लिखित गद्याचा बऱ्यापैकी दीर्घ म्हणता येईल असा लेखकाने निर्मिलेल्या नव्या आणि कल्पित वास्तवात वाचकाला गुंगवून टाकणारा रचनाबंध होय."

जोसेफ शिप्ले:-वाङ्मयीन परिभाषा कोश "कादंबरी हे गद्य स्वरूपातील एक दीर्घ काल्पनिक कथानक आहे."

हॅरी शॉ:-"कादंबरी म्हणजे काल्पनिक व्यक्तिरेखांची चित्रणे व विविध प्रसंगाच्या मालिकांची व पार्श्वभूमीची सुसंगत अशी मांडणी होय. सुमारे ३० ते ४० हजार शब्दांपेक्षा कमी असलेली कथानक लघुकथा समजले जाते; परंतु कादंबरीला खरे तर शब्द मर्यादा नाही. प्रत्येक कादंबरी जीवनाचा हिशोब सादर करत असते त्यामध्ये संघर्ष,पात्रे, कृती,पार्श्वभूमी, कथानक व आशय सूत्र येतात."

INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
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Volume 1, Issue 5 : Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

रा.ग.जाधव:-"कथानक, व्यक्तीचित्रण ,लेखकाचा दृष्टिकोन व यांना अनुरूप अशी निवेदन तंत्रे, वर्णने ,वातावरणनिर्मिती, शैली इत्यादी घटकांनी गद्यात विस्तृतपणे संघटित केलेले वास्तव जीवनाचे चित्रण म्हणजे कादंबरी होय."

रा.ग.जाधव यांनी कथानक, व्यक्तिचित्रण, लेखकाचा दृष्टिकोन, वातावरण निर्मिती अशा घटकांना कादंबरीकरिता विशेष महत्त्व दिल्याचे लक्षात येते.

कथानक:-कादंबरी मधील कृती कोणत्या स्थळ, कालाच्या अवकाशात घडत आहेत. कादंबरीतील पात्र काय करीत आहेत. त्यांचे विचार काय आहे हे कादंबरीकार सांगत असतो. या साऱ्याची योग्य जुळणी करणाऱ्या एकात्म विणीलाच 'कथानक' असे म्हटले जाते. कथानकाच्या संदर्भात **इ.एम.फॉस्टर** यांनी आपले विचार व्यक्त केले आहेत ते म्हणतात की, गोष्ट (Story) व कथानक(Plot) यातला नेमका फरक केला आहे. उदा. राजा वारला त्यानंतर राणी मृत्यू पावली ही गोष्ट आहे. परंतु राजा वारला पण नंतर त्या दु:खाने राणी मृत्यू पावली हे कथानक आहे. गोष्टीमध्ये पुढे काय झाले हा प्रश्न असतो तर कथानकात असे का झाले हा!या 'का?'मध्ये बुद्धिजन्य, वस्तुनिष्ठ कारण अभिप्रेत नसते, तर सौंदर्य निष्पत्ती होईल असा अन्वय अपेक्षित असतो. स्थानक ही एक संरचना असते ती घटना, प्रसंग, वातावरण यातून निर्माण होते.

'सत्तांतर'या कादंबरीतील कथानक हे मध्य भारतातील एका मोठ्या पानगळी वृक्षाच्या जंगलात घडते. या ठिकाणी नानाविध प्रकारची वृक्ष होती वेली होत्या झुडपं होती.साग,बिजा,ऐन,करु,असे दहा - दहा,बारा- बारा, पुरुष उंचीचे भव्य वृक्ष होते. मोठ्या तळ्याच्या काठांनी आणि या जंगलातून वाहणारी अनेक नाले ओढे यांच्या काठांनी आंबा, चिंच,उंबर जांभूळ, वड,पिंपळ असले फळांनी लहडणारे वृक्ष होते. उन्हाळ्यात झगझगीत रंगाचा फुलोरा येऊन वनप्रदेश सुगंधित करणारे सावरी,पळस, पांगारा, यासारखी काही फुलणारे वृक्ष देखील होती. तसेच बाबूंची घनदाट बेटं होती. इथे अनेक प्राणी, पाखरं राहत होती. काही तर हंगामापुरती येत होती. अशा याच जंगलातील वानर नराचं राज्य होतं. त्यांना ते स्वतः सामर्थ्याने प्राप्त केलेले होते. या प्रदेशात झाड त्यांची होती. इथल्या झाडांनी लुसलुशीत कोवळी पालवी,कळ्या, फुलं, फळ, भेंड, रस, डिंक, सगळं त्यांचं होतं. या ठिकाणी असलेली हिरवळ त्यांच्या पोरांना लोळण्यासाठी होती. इथलं पाणी त्यांचं होतं. इथली खार माती त्याला चाटण्यासाठी होती. हा एवढा प्रदेश तो आपल्या भूपकारान दणाणून सोडत होता. टोळीतल्या सगळ्या वानरी त्याच्या होत्या सारी लहान-मोठी पोरं, बाळ त्यांची होती.गेली चार पावसाळे तो या लहान संस्थानचा अधिपती होता. हे राज्य त्याला वडिलोपार्जित असं, वारस म्हणून मिळालेले नव्हते.ते त्याला स्वसामर्थ्याने मिळवावं लागलेलं होतं. एकवार मिळालं म्हणून आता आपलाच राहील म्हणून त्याला स्वस्त राहता येत नव्हतं सतत युद्ध मग्न राहून त्याला ते सांभाळावं लागतं होतं अनेकांनी त्याच्या अधिकाराला आजवर आव्हान दिलं होतं.

कारण त्याची टोळी ही काही एकमेव वानर टोळी या जंगलात नव्हती. लहान मोठ्या अशा आणखी सात इतर टोळ्या या जंगलात राहत होत्या. त्या प्रत्येकाचं, स्वतःचं म्हणून बळकवलेलं क्षेत्र होतं. वर्षानुवर्ष त्यात नवी पोरं जन्माला येत होती, वाढत होती. बलदंड ही होत होती. टोळीतून हाकलून दिली जात होती. एकत्र येऊन ही पोर एकोप्यानं दुसऱ्या टोळीच्या हद्दीत खुसखोरपणा करत होती. हाणामाऱ्या होत होत्या. पराभूत पळून जात होते. ठार मारले जात होते, सतत हा संघर्ष चालू होता.

पाणी हेच जीवन:-ते उन्हाळ्याचे दिवस असतात. जंगलातील सर्व ठिकाणी असणारे पाणी हे आटलेले होते; परंतु तळ्याकाठी जात पाणी पिण्या वाचून इतर पर्याय आता शिल्लक नव्हता.सगळी टोळी तळ्याकाठी एका उंच असणाऱ्या सागावर जमा झाली. त्या ठिकाणी असणारे झाड हे पाण्याच्या काठावर होते. सुमारे साठ पावलाचं अंतर होतं. आणि ते अंतर पार करून पाणी पिऊन,परत झाडावर येणे हीच गोष्ट फार जोखमीची होती. साग झाडीच्या कडेवर होता मागे टेकडी होती आणि गर्द झाडे झुडपं होती. या जाळकटात दाबा धरून कोणीही हिंस्रप्रशू बसला असण्याची शक्यता होती.

मुडा आपल्या टोळीसह या झाडावर काही वेळ बसला. सर्वांनी आपल्या तीक्ष्ण नजरेतून आजूबाजूचं रान बारकाईने पाहिलं. काही गडबड न करता सगळी टोळी अतिशय शांततेत सागाच्या झाडावर बसून होती. या ठिकाणी धारिष्ट्य व आणीबाणीची स्थिती यांचे काही क्षण हे येत असतात. यासाठी जोखीम घेण्याची जबाबदारी संपूर्ण टोळीतून फक्त दोन जणांवर होती,ती म्हणजे

'तरणी'व 'मुडा' यांच्यावर या दोघांशिवाय कोणीतरी पुढे झाल्याशिवाय इतरांना पाण्यासाठी व्याकूळ झालेल्या वानरांना पुढे जाता येणार नव्हतं आणि या सर्व परिस्थितीची नेमकी जाण ही तरणी, मुडा यांना आली होती.आणि अखेर मुडाने आपल्यातलं धारिष्ट दाखवलं.आपलं पहिलं असणार झाड उतरू न आता मुडा सावधगिरी बाळगत पाण्यापासून पंधरा ते वीस पावलावर गवतात बसून राहिला.

सगळी वानर स्तब्ध राहून बघत होती. बाजूच्या झाडीतून झेपावत काळ आला तर जीवाच्या कराराने सगळं बळ एकवटून वाऱ्याच्या वेगाने सुसाट पाठीमाग पळणं आपल्या जीवाच्या सुरक्षिततेसाठी एकमेव असा पर्याय होता. आता मुळा पाण्याच्या अगदी काठाशी गेला.ओल्या काठाशी जाऊन बसला सगळीकडे सुक्ष्म नजरेने पाहिले.आता येथे धोकादायक असं काही दिसलं नाही;परंतु आणीबाणीचे खरे क्षण पुढे येणारे होतं. पाणी पिण्यासाठी दोन्ही हात जमिनीला टेकून मुडाला वाकावं लागणार होतं. तोंड लावून पाणी प्यावं लागणार होतं.इतर बाबींचा अर्थ हा पाण्यातल्या प्रतिबिंबाकडे बघत लावावा लागणारे.यानंतर तरणीनं आपलं धारिष्ट्य दाखवलं सागावरून खाली येत ती पाण्याकाठी आली व चौफेर नजर टाकली. इतर कोणतीच भीती नाही असे कळतात तिने इतर उर्वरित टोळीला सावध केलं.मागे तरणी आहे. हे बघतात दोन्ही हात गवतात ठेवून मुडाखाली वाकला आणि त्यात पाण्याला तोंड लावलं. व त्यानंतर इतर वानरं क्रमाक्रमाने मुडाच्या ओळीत पाणी पिण्यासाठी पंगतीला बसावी तशी बसली आकंठ पाणी पिऊन होताच तत्काळ मुडा उडाला आणि धोकेबाज पाण्याकाठी क्षणभर न रेंगाळता धावला. इतरही वानरांनी तरणी,मुडाने ज्या जागी पाण्याला तोंड लावलं होतं, त्या जागी तोंड घातलं आणि तिचं पाणी पिऊन अजून संपलं नाही तोवर एक पोर पुढे होऊन व ओणवं झालं. त्याने पाण्याला तोंड लावलं दोघं पोरं राखणदारासारखी मागं बसूनच होती. अशा पद्धतीने पाणी पिण्याचा हा विधी अर्धा तास चालला.निर्वेधपणानं पाणी पिऊन सगळी टोळी पुन्हा उड्या ठोकीत पांगली.

सत्तांतरमधील प्रमुख पात्रे:-

मुडा-'मुडा' हा जंगलातील एक वानर टोळीचा प्रमुख होता. या हुप्याच्या डाव्या कानाचा वरच्या बाजूचा मोठा तुकडा हाणामारीत गमावला होता. आणि तो मुड्या कानाचा झाला होता. हा वजनाने भारी होता आणि फार संतापी होता. याचे स्नायू पिळदार होते. एकूणच हा खैराच्या गाठी सारखा टणक होता मारामारीच्या बऱ्याच खुणा त्याच्या अंगावर होत्या शेपटावर सुद्धा चांगला दोन विती लांब असा उभा व्रण होता.

लालबुड्या:-'लालबुड्या'च असे हा मुडाचा शेजारीच होता. या दुसऱ्या १३ जणांच्या टोळीचा प्रमुख 'लालबुड्या' हा होता. हा चांगला ताकदवान, वजनदार वयाने मुड्याच्याच बरोबरीचा नर होता. लालबुड्या हा थोडा साहसी होता. स्वतःची टोळी व हद्द सोडून तो फार लांब कुठे जात नसे;पण थोडे दूर पर्यंत झाडांच्या शेंड्यावरून उड्या घ्यायची त्याला सवय होती.

मोगा:-'मोगा' हा एका टोळीतून हाकलून लावलेला एक वानर असतो. मोगा आणि त्याचे पाच पेंढारी यांनीही लालबुड्या नाहीसा झाला आहे.याचा सुगावा लागला होता. दबकत-दबकत एकवार बुटका, भक्कम शरीराचा, तीक्ष्ण दृष्टी असलेला आणि दहा जणांत उठून दिसावा असा 'मोगा' या कळपात शिरला. शहाण्या झालेल्या आणि मुडाला तत्काळ वश झालेल्या त्या वानरीनं लगोलग त्यांच्याशी जवळीक केली.

थोटी:-'थोटी' ही मुडाच्या टोळीतली एक लेकुरवाळी वानरी होती.लहान असतानाच एका घुसखोर वानरानं तिच्यावर हल्ला केला होता. तिच्या आईकडून तिला पळून तिच्या डाव्या हाताचा चावा घेतला होता; पण नंतर टाकून दिले होते. त्यामुळे तिचा डावा हात दंडापर्यंतचा होता तशा एका हाताने ती आपल्या पिलाला सांभाळायची,त्याला घेऊन फिरायची थोट्या हाताची पर्वा न करता भांडणात पुढे व्हायची. याशिवाय या कादंबरीत काही गौण पात्रे देखील आलेली आहेत.

वातावरण:-कादंबरीचे कथानक हे विशिष्ट स्थळ, काळात घडते. कथानकाला व्यक्तिरेखांना विशिष्ट जीवन प्रसंगाची पार्श्वभूमी असते.स्थल, काल निरपेक्ष वातावरण देखील लक्षनीय ठरते.

प्रा. जान्हवी संत- "स्थल, काळ वैशिष्ट्यांचे कादंबरीत पडलेले प्रतिबिंब म्हणजे वातावरण होय. कादंबरीतील घटना कोणत्या तरी स्थळी व कोणत्या तरी काळी घडलेल्या असतात. म्हणजेच स्थळ व काळाचे दर्शन कादंबरीतून दर्शवणे यास पार्श्वभूमी वा वातावरण असेही म्हटले जाते."

INTERNATIONAL JOURNAL OF INNOVATIVE TRENDS IN MULTIDISCIPLINARY RESEARCH
International E-Research Journal
Volume 1, Issue 5: Multidisciplinary Issue
Peer-Reviewed Journal
E-ISSN: 3049-3846
Oct, 2025

व्यंकटेश माडगूळकर यांच्या 'सत्तांतर' या कादंबरीचे कथानक हे जंगलात घडते. कादंबरीतील पात्रे जंगलात वावरतात. साहजिकपणे कादंबरीतील वातावरण नैसर्गिक अशा प्रकारचे आहे. जंगलातील साग, बिजा,ऐन यासारखी उंचीच्या झाडाची वर्णने कादंबरीतून पदोपदी येताना दिसून येतील. या कादंबरीची सुरुवात ही उन्हाळा या ऋतूने झाली, शेवट पावसाळा या ऋतूने होतो.उन्हाळ्यात इतर झाडे ही निष्पर्ण होत असली तरी सागाचे वृक्ष मात्र हिरवेगार असल्याचे लेखक नोंदवतात.

वानरांमधील सत्तासंघर्षाबरोबर त्यांच्या जीवनातील वेगवेगळ्या घटना,टोळी प्रमुखांशी वागणे, राग-लोभ, वात्सल्य शेजारच्या टोळीप्रमुखाशी होणारी लूटपुटूची हाणामारी,भांडणे, वानरांच्या पिल्लांचे बागडणे या सर्वांची सूक्ष्म वर्णन यात येते.

नर म्हणून जन्माला आलेलं वानराचं पोर टोळीत सहसा टिकत नसे.अनेक वेगवेगळ्या अवस्थांमधून त्याला जावे लागे. माद्या मात्र जगल्या,वाचल्या तर कळपातच वीस-वीस वर्ष राहत.पावसाळा सुरू झाला सारं जंगल ओल कच्च राहू लागलं. झाडांची पान अधिक गहिरी हिरवी झाली. जागोजागी गवत उफाळून वर येऊ लागलं.सगळीकडे हिरवंगार झालं. सतत ओलसर राहून-राहून झाडांच्या खोडांना शेवाळ लोंबू लागली. वानर आता जमिनीवर उतरेनासी झाली. एकमेकांच्या अंगाची ऊब घेत राहावं. जाडजाड पानांच्या गर्द उन्हाळ्यातून हिडावं.अशा प्रकारचे वातावरण कादंबरीला प्राप्त झाले आहे.

निवेदन शैली:-निवेदन हे भाषेच्या माध्यमातून आकाराला येत असते. यासंदर्भात प्रा.जान्हवी संत लिहितात की, "कादंबरीत गोष्ट असते व ही गोष्ट जितक्या चटकदार पद्धतीने व आकर्षक रीतीने सहजपणे सांगता येईल इतकी सांगावी.जीवनाचे व्यापक दर्शन घडवणाऱ्या कादंबरीची निवेदन शैली सहज, अकृत्रिम व स्वाभाविक असली म्हणजे तिचा परिणाम उत्कट होतो."

निवेदनाच्या वेगवेगळ्या पद्धती असल्या तरी 'सत्तांतर' या कादंबरीकरिता तृतीय पुरुषी निवेदन पद्धतीचा अवलंब आहे. घटना ज्याप्रमाणे घडल्या त्याच क्रमाने अनुलोम पद्धतीने सांगितल्या गेल्या आहेत. फक्त लालबुड्या या वानराची कथा विलोम पद्धतीने सांगितली आहे.आधी त्यांचं होण्याची हकीगत येते. नंतर त्यांच्या जन्माची, त्यांच्या वाढण्याची, टोळी प्रमुख बनण्याची हकीगत येऊन पुन्हा हा धागा त्यांच्या नाहीसं होण्याशी जोडला जातो. यातील काही निवेदन प्रवाही असल्याने कादंबरीला एक गती प्राप्त झाली आहे निवेदनाबरोबरच लेखकांचे भाष्य या कादंबरीत आलेली आहेत.

उदा.१)कोणत्याही धारिष्ट्याची गोष्ट करताना आणीबाणीचे क्षण अगदी थोडे असतात.

२) सत्ता काबीज करणे ही एकट्या दुकट्याची कामगिरी नसते. दोन हात झोडपी उभारु शकतात. प्रासाद उभा करायचा,तर हजारो हात लागतात.

३) एकटी थोटी मात्र आपलं पोर घेऊन,टोळी सोडून एकटी दूर रानात पळाली पळून गेलं की, सगळ्या धोक्यातून सुटका होते,असं थोडंच आहे?धोक्यामुळे तर दहा जण एकत्र येतात आणि एकत्र राहू लागतात. एकत्र राहण्यासाठी धाक लागतोच.बाहेरचा नसला, तरी घरातला ! घरातला नसला,तर मनातला! मनं धाक वितात आणि झोटिंग, हडळी जन्माला येतात.

४) काळाबरोबर संघर्ष ही सतत वाहतच असतो. त्याला खंड असा नसतोच. असलीस तर भरती असते. पूर असतो संघर्ष सर्वत्र भरून राहिलेला असतो. इत्यादी यातून लेखकाची चिंतनशीलता प्रकटते.

भाषाशैली:-शब्द हे भाषेचे शरीर आहे मानवी भावभावनांचे प्रकटीकरण हे भाषेतून होते. व्यक्तीनुरुप भाषा ही बदलत असते. मानवी स्वभावातील आनंद दु:ख राग इत्यादी भावनांना भाषेतील शब्दातूनच व्यक्त केले जाते. शैली म्हणजे लिहिण्याची पद्धती Style is the man व्यक्तीनुरूप शैली बदलते.

प्रा.जान्हवी संत लिहितात की, "कादंबरी ही ललित साहित्यांतर्गत येत असल्यामुळे सामान्य होऊन सामान्य वाचक हा तिचा ग्राहक असल्यामुळे तिची भाषा जितकी साधी, सोपी, घरगुती व प्रासादिक असेल तितके तिचे स्वरूप रमणीय व आकर्षक होईल. ही अलंकृत असावी पण क्लिष्ट व बोजड नसावी."

'सत्तांतर' या कादंबरीची भाषा प्रवाही आहे शैली साधी सुटसुटीत अशा प्रकारचे आहे.कादंबरीच्या माध्यमातून आपल्यासमोर

येणारी काही वाक्यरचना अतिशय लहान स्वरूपातील असल्याचे लक्षात घेता येते.

उदा.१) टळटळीत दुपार होती. २) सगळीकडंच चुपचाप झालं. कादंबरीची शैली चित्रदर्शी देखील आहे.

उदा. १)ते जाणतं पोर टवकारून बसलं होतं.

२) पावसाच्या धारांनी तुषार आणि वातावरण धुरटून गेलं. कादंबरीतून काही अलंकारिक वाक्यरचना देखील आलेले पाहावयास मिळते ती अशी १) हे जांभळीच झाड फळांनी फणसांनी लढावं तसं आता वानरांनी लहडलं होते.

२) सोनेरी पाठीवर पांढऱ्या चांदण्या असलेला मृग मोठ मोठी उड्डाण घेत सैरावैरा धावत होता आणि त्याच्या माग आगीचा लोड झोपा आता वाघ झेपावला होता.३) सृष्टी अन्नब्रह्माच्या पूजेला बसणार होती.

'सत्तांतर' या कादंबरीमध्ये अगदी वेगळी शब्द देखील आलेली आहे. त्यामध्ये उष्णकाळ, भीजपाऊस, पातेरा, धगाटा अशी शब्दरचना बोली भाषेतून आलेली आहे.याशिवाय पक्ष्यांचे वर्णन व्यंकटेश माडगूळकर यांनी अतिशय समर्पक विशेषणाचा अर्थ जपत केल्याचे लक्षात घ्यावे लागते. त्यामध्ये हिरवे रावे, लाजरे हरेल,निळेगर्द निलकंठ,पिवळ्यारंजन रंगाच्या धोबिणी, कुलूकुलू बोलणाऱ्या साळुंख्या इत्यादी अशी एक समर्पक अर्थाची मांडणी कादंबरीतून केली आहे.

निष्कर्ष:-व्यंकटेश माडगूळकर यांच्या 'सत्तांतर' या मराठी कादंबरीतील काही महत्त्वपूर्ण निष्कर्ष येथे घेतले आहेत.

१) कादंबरीकार व्यंकटेश माडगूळकर हे या जंगलाशी, जीवनाशी तसेच वातावरणाशी अत्यंत समरस झाल्याचे कादंबरीच्या माध्यमातून दिसून येते.

२) स्वत:चे अस्तित्व टिकवण्यासाठी संघर्ष अटळ असतो.

३) 'सत्तांतर'कादंबरीतून संघर्षाची विविध रूपे ही वेगवेगळ्या प्रसंगामधून प्रत्येककारित्वाने प्रकटली आहेत.

४)'सत्तांतर' कादंबरीतून आपल्याला बदलणारे ऋतू,वानरांचा दिनक्रम, या सर्वांची व्यंकटेश माडगूळकर यांनी चित्रमय शैलीत वर्णन केली आहेत.

५) कादंबरीत माडगूळकरांनी घटनांच्या निवेदनाबरोबर जंगलातील प्राण्यांच्या वागण्यातील सूक्ष्मपणाचे तपशील रंगवले आहेत.

६) जंगलामध्ये सत्ता मिळवण्यासाठी चाललेला संघर्ष व तो देखील एकाच जातीच्या प्राण्यांमध्ये, सुरुवातीपासूनच दिसतो.

समारोप:- 'सत्तांतर'या व्यंकटेश माडगूळकर यांच्या कादंबरीतून नागझिरा जंगलातील मुक्काम ठोकून लेखकांनी वानरांचा अतिशय सूक्ष्मपणे अभ्यास केल्याचे आपल्याला लक्षात येते.कादंबरीत वानरांचा दिनक्रम त्यांच्या टोळ्या, त्यांचे वात्सल्य त्यांच्यातील सत्तासंघर्ष या सर्वांच्या अतिशय वेधक चित्रण केले आहे.

'सत्तांतर' या अगदी वेगळ्या प्रकारच्या कादंबरीमधून लेखकाने सत्तासंघर्षाचे जे चक्र निसर्गात अव्याहत चालू आहे.त्याचे परिणाम दर्शन घडवलेले आहे.कादंबरीत सुरुवातीला उन्हाळा आणि उन्हाळ्यातील जंगलातील वर्णन येते.आणि सर्वात शेवटी पावसाळा या ऋतूचे चित्रण आलेले दिसून येते.कादंबरीकार व्यंकटेश माडगुळकर यांनी वर्षभरात जंगलात घडणाऱ्या अनेक घडामोडींचा आणि प्राणी- पक्षी जीवनाचा अतिशय नाट्यपूर्ण आणि रसपूर्ण वेध हा 'सत्तांतर' या कादंबरीत घेतला आहे.

संदर्भ ग्रंथ:-

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२) डॉ. द.के.गंधारे,-'मराठी वाङ्मय प्रकार: संकल्पना व वाटचाल' शब्दालय प्रकाशन श्रीरामपूर ,जानेवारी २०१७.

३) व्यंकटेश माडगूळकर,-'विशेष ग्रंथकार अभ्यास'टिळक महाराष्ट्र विद्यापीठ,पुणे.

४)विलास शिरसाट -'मराठी साहित्याचा परिचय'कोमल प्रकाशन ठाणे, नोव्हेंबर २०१३.