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EFFECT OF SEAWEED EXTRACT ON ONION UNDER DROUGHT CONDITIONS

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ABSTRACT

Drought stress is a significant constraint on crop productivity, especially in arid and semi-arid regions. Onion (Allium cepa L.) is highly susceptible to water deficits, which impact bulb yield, size, and quality. Seaweed extracts (SWE) have emerged as effective biostimulants, enhancing plant resilience to abiotic stresses, including drought. This study evaluates the role of SWE in improving onion growth under drought stress by analyzing its effects on root development, water retention, photosynthetic efficiency, and nutrient uptake. The results indicate that SWE-treated onions exhibit increased drought tolerance, improved water use efficiency (WUE), and enhanced yield compared to untreated controls.

KEYWORDS

Seaweed extract, onion, drought stress, biostimulants, water use efficiency, plant physiology

INTRODUCTION

❖ Background on Drought and Onion Cultivation

Onion (Allium cepa L.) is an economically valuable vegetable crop with high water sensitivity due to its shallow root system. Drought stress adversely affects growth, leading to reduced leaf area, poor bulb development, and decreased marketable yield. Physiological responses to drought include:

- Decreased chlorophyll content, impairing photosynthesis.
- Leaf wilting due to osmotic imbalance.
- Reduced root function, affecting water and nutrient uptake.

❖ Role of Seaweed Extracts in Agriculture

Seaweed extracts (SWE), derived from marine macroalgae, contain bioactive compounds such as:

- Polysaccharides (alginates, fucoidan, laminarin) – Enhance drought tolerance.
- Phytohormones (auxins, cytokinins, gibberellins) – Improve root growth and stress resistance.
- Antioxidants and betaines – Reduce oxidative stress under drought conditions.

Studies suggest that SWE application enhances plant resilience, nutrient uptake, and drought tolerance, making them valuable biostimulants in sustainable agriculture.

MATERIALS AND METHODS

❖ Experimental Design

A randomized complete block design (RCBD) was employed to assess the effect of SWE on onion growth under drought conditions.

❖ **Treatments**

1. Control (T0) – No SWE application.
2. Foliar application (T1) – 3% SWE solution sprayed biweekly.
3. Soil drench (T2) – 2% SWE solution applied to the soil every two weeks.
4. Combined application (T3) – 3% foliar spray + 2% soil drench.

❖ **Parameters Measured**

- Physiological traits: Relative water content (RWC), chlorophyll index, stomatal conductance.
- Growth attributes: Root length, leaf area, bulb weight.
- Yield parameters: Bulb diameter, fresh and dry weight.
- Biochemical assays: Antioxidant enzyme activity (SOD, CAT, APX)

RESULTS AND DISCUSSION

❖ **Water Retention and Root Development**

SWE application improved RWC and root length significantly. T3 treatment (combined foliar + soil) recorded the highest RWC (82%) and longest root length (22 cm), indicating enhanced drought adaptation.

❖ **Photosynthetic Efficiency and Chlorophyll Content**

SWE-treated onions maintained higher chlorophyll levels compared to controls, preventing early senescence. Chlorophyll content increased by 23% in T1 and 31% in T3, improving photosynthetic efficiency.

❖ **Antioxidant Enzyme Activity and Stress Tolerance**

Drought stress increased oxidative damage, but SWE treatments enhanced antioxidant enzyme activities, reducing reactive oxygen species (ROS).

Treatment	SOD (U/mg protein)	CAT (U/mg protein)	APX (U/mg protein)
T0 (Control)	8.3	G.5	5.1
T1 (Foliar)	10.1	8.7	G.U
T2 (Soil)	11.3	U.1	7.4
T3 (Combined)	12.8	10.5	8.3

❖ **Yield and Bulb Quality**

SWE-treated onions exhibited a 17% increase in bulb diameter and 21% higher total yield compared to control. The presence of higher sugar content suggested improved metabolic activity under drought stress.

CONCLUSION

This study demonstrates that seaweed extracts significantly enhance onion resilience to drought stress. The combined foliar + soil application (T3) was the most effective in:

- Improving water retention and root growth.
- Enhancing chlorophyll content and photosynthesis efficiency.
- Increasing antioxidant activity, mitigating oxidative stress.
- Boosting bulb yield and quality.

Future research should focus on long-term field trials, economic feasibility, and integration with other biostimulants to maximize sustainable agriculture practices.

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UTILIZATION OF GRAPE SEED OIL, LINALOOL AND DRAKSHSAVA FOR QUALITATIVE SILK COCOONS FROM SILKWORM, BOMBYX MORI (L).

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ABSTRACT

The nutrition quality and health of larval instars exert influence on quality of the silk yield in sericulture. The acetone solutions of Grape-Seed-Oil (10 ml Grape-Seed-Oil dissolved in 90 ml acetone) and ten microliters of acetone solutions of Linalool (100 ppm) were used in present attempt for the topical application to the fifth instar larval stages of silkworm, Bombyx mori (L) (Double Hybrid Race). Group of larvae fed Mulberry leaves treated with aqueous solution Drakshasav; group of larvae topically applied with acetone solutions of Grape-Seed-Oil (10 ml Grape-Seed-Oil dissolved in 90 ml acetone) followed by feeding Mulberry leaves treated with aqueous solution Drakshasav were also maintained. Fifth Instar Larval Life Duration (Hours) and Tissue Somatic Index (TSI) of silk glands of fifth instar silkworms of control group, Grape-Seed-Oil treated group; Linalool treated group; group fed with mulberry leaves treated with aqueous solution of Drakshasav and group treated with Grape-Seed-Oil treated acetone (topical) followed feeding by mulberry leaves treated with aqueous solution of Drakshasav were recorded 145.33 (± 13.786), 31.426; 168.73(± 13.221), 52.625; 177.46 (± 13.786), 52.728; 162.87(±14.572), 52.759 and 168.58(±18.789), 53.854 units respectively. Shell Ratio of cocoon spun by fifth instar silkworms of control group, Grape-Seed-Oil treated group; Linalool treated group; group fed with mulberry leaves treated with aqueous solution of Drakshasav and group treated with Grape-Seed-Oil treated acetone (topical) followed feeding by mulberry leaves treated with aqueous solution of Drakshasav were recorded 19.422; 23.970; 27.989; 28.048 and 28.378 units respectively. Denier scale of silk filament spun by fifth instar silkworms of control group, Grape-Seed-Oil treated group; Linalool treated group; group fed with mulberry leaves treated with aqueous solution of Drakshasav and group treated with Grape-Seed-Oil treated acetone (topical) followed feeding by mulberry leaves treated with aqueous solution of Drakshasav were recorded 3.243; 4.706; 4.793; 4.882 and 4.948 units respectively. The range of improvements of tissue somatic index of silk glands (TSI); Shell Ratio of cocoon and Denier scale of silk filament through treatment was 52.625 to 53.854; 23.970 to 28.378 and 4.706 to 4.948. Efficient use of source of juvenoids like linalool, grape seed oil and drakshasav in desired solvent for treating the silkworm larvae serve to orchestrate the fortification of

health through the preventing the infection of microbial pathogens; extension of larval age, consumption and utilization of nutrition for significant yield of silk product.

KEYWORDS

Grape-Seed-Oil, Linalool, Drakshasav, Tissue Somatic Index (TSI), Shell Ratio, Denier Scale of Silk.

INTRODUCTION

The significant feature of autotrophic and heterotrophic lives on earth is orchestrate progression. Autotrophic plants are serving as innovative and the richest sources of nutrients for the animal lives. The heterotrophic lives (like animals) utilize the nutrients (in the form of functional food material and biochemical nutrient-compounds) and derive energy to lead successful life. In a virtual sense, synthesis of energy rich food-material (in the form of biochemical compounds) by autotrophs through the use of chlorophyl is for the purpose of their own-life [1].

The common grape vine Vitis vinifera (L.), the common grape vine, is a species of the plants with flowers. The variety of grapes, process of vinification, grape-maturation, and grape-aging are the factors associated with qualities of aroma of grape-wine. Monoterpenols, particularly linalool, geraniol and nerol, are responsible for the characteristic floral aroma in grapes [2-5]. In grapes, terpenoids exist both free and as glycosides, being some of the bound terpenoids released either chemically or by natural β-glycosidase activity of either the grape or of yeasts and bacteria during the vinification phases [6 – 13]. Linalool is a colorless oil, belongs to “Acyclic Monoterpenoid”. In plants, linalool is a volatile-metabolite with antimicrobial property [3,4].

Grape seed oil is a derived from the grape-seeds. Grape-seed is by-product of winemaking industry. Grape seed oil is commonly used as an edible oil. It has a light taste and a content of polyunsaturated fat, making it suitable for use in salad dressing, mayonnaise and as a base for oil infusions of garlic, rosemary, or other herbs or spices. It is widely used in baked goods, pancakes, and waffles. It is used for spraying on raisins to help them retain their flavor [14]. The “Drakshasava”, ayurvedik tonic is derived from grapes. It is in the form of partial fermentation. Utilization of raisin concentrate is also followed for the preparation of “Drakshasava”, ayurvedik tonic. The “Drakshasava” is claimed to be beneficial for ailments (such as conditions of lethargy, weakness-conditions and heat- burnout (or heart-exhaustion). The most significant categories of metabolites and herbal formulations derived from Vitis vinifera (L) linalool, grape seed oil and “Drakshasava”, ayurvedik tonic [15].

Many more compounds of herbal origin; compounds of synthetic categories and animal derived biochemicals appearing in the classified list of compounds with features analogous with Insect Juvenile Hormone / J.H. The compounds of herbal origin; compounds of synthetic categories and animal derived biochemicals with the analogous features and mechanism of working of natural “Insect-

Juvenile-Hormone" (JH) are designated as a special category as "Juvenoids" by Williams in the year: 1956 [16,17]. The topical applications of exogenous insect juvenoid compounds through appropriate solvent (like acetone) to the larval stages of silkworms of specific age (in hours) are reported to exert inhibition of deposition of chitin in the body wall and extension of the larval age [18,19]. That is to say, the compounds of "Insect-Juvenoid" class belong to herbal category through suitable solvents are reported for the potent natural "Insect-Juvenile-Hormone" (JH) activities through impressive sum of all the metabolic reactions (turnover), alterations of constituencies of metabolites like proteinaceous compounds, lipid compounds, carbohydrate compounds, pool of amino-acids, pool of fatty-acids & chitin (long chain of polymer compound of N-acetyl-glucose-amine) [20,21]. There are several citations and reports on improvements in the physiological conditions of bodies of larval stages of insect lives through the recipiency of exogenous JH and analogues (or Juvenoids). The exogenous compounds of herbal origin; compounds of synthetic categories and animal derived biochemicals with the analogous features and mechanism of working of natural "Insect-Juvenile-Hormone" (JH) are reported for the topical spray (or application) to the individuals of fifth instar silkworms for the qualitative improvements in the silk yield [22,23,24]. The "Terpene" and "Terpenoids" are the largest and varied group of chemical compounds of organic nature. The terpene compounds are with strong odor. They are concerned with protection of the plants through deterring herbivorous animals and through attracting predators and parasites of herbivorous animals [25,26,27,28].

The insect "Juvenile-Hormone" (J.H.) exert the influence concerned with maintenance of juvenile stage (younger and younger stage) of insect life. Inhibition of deposition of chitin in the body wall and extension of the larval age are the most significant effects exerted by natural JH (and exogenous juvenoids) in the larval stage of silkworm. The concentrations or titers of the natural insect moulting hormone (M.H.) serves to proceed to the next phase of life. That is to say, the concentration or titer of the insect "Moulting-Hormone" (M.H.) serve to proceed further metamorphosis through many events of physiological actions (including enhancement of deposition of chitin in specific parts of the larval body-frame). In presence of particular / specific concentrations or titers of the hormone of Moulting (M.H.) in the haemolymph (blood) of insect life stage, the mechanism of deposition of chitin in the parts of body-frame appears to be at higher rate. The distinct feature of JH and analogues is inhibition of morphogenetic program at determined in advance by the embryonic constitution (predetermined) and group specific ontogenetic or embryonic developmental positions. It appears that, insect metamorphosis is the outcome of the integrations of fruitful-interplays of specific titers of the JH and MH [16]. The JH and MH, with their specific concentrations are working for the smooth progression of metamorphosis from larval stage to the pupa; from the stage of pupa to the adult stage. In the earlier

attempts of authors, topical application (in the form of spray) of acetone extractives of stem pieces of grape, Vitis vinifera (L.) was found effecting significant increase in both soluble and total protein contents of silk glands [20]. Therefore, further to analyze the influence of acetone solution of grapeseed oil (topical application); acetone solution of linalool (topical application) and aqueous solution of Drakshasav (Through Mulberry Leaves) on economic parameters in silkworm, Bombyx mori (L.) (fifth instar larval life duration; weight of cocoon; weight of shell of cocoon; silk shell ratio and denier scale of silk), present attempt has been sketched out.

MATERIAL AND METHOD

The attempt has been completed through the four major steps which include: Rearing of larval instars of Silkworm; Preparation of acetone solution of grape seed oil; Preparation of acetone solution of linalool; Preparation of aqueous solution of drakshasav; Feeding the larvae with mulberry leaves; Provision of Mountage for Spinning; Cocoon Harvesting; Reeling; collection of data on economic parameters and Analysis through the statistical methods. The standard sericultural method of silkworm-rearing as prescribed by Krishnaswami, et al. was followed [20, 29]. The race of silkworm, Bombyx mori (L.) utilized in the present attempt was double hybrid [(CSR6 x CSR26) (hybrid bivoltine) x CSR2 x CSR27) (hybrid bivoltine)]. The grape seed oil; linalool and drakshasav were procured from Ases Chemical Works (Brahm Bagh, Jalori Gate, Jodhpur- 342001 India) through local supplier.

Acetone solution of grape seed oil was prepared by dissolving 10 mg grape seed oil in 90 ml acetone solvent. The acetone solution of linalool of 100 ppm (mg/litre) strength was prepared by dissolving 10 mg linalool in 100 ml acetone solvent. Aqueous solution of drakshasav was prepared by dissolving 10 ml drakshasav in 90 ml distilled water (as a solvent). All the three solutions were prepared just few minutes before their utilization. The fifth stage silkworm larvae were utilized for the attempt on treatment. Shortly after lasting moult of fourth number, the larval stages of fifth number were used to transfer in a separate tray (disinfected). The larval stages of fifth number were divided into seven groups (1. Untreated Control Group; 2. Acetone / solvent Treated Control Group; 3. Water / solvent Treated Control Group; 4. Topical application of Acetone Solution of Grapeseed Oil; 5. Topical application of Acetone Solution of Linalool; 6. Treating the mulberry leaves with Aqueous Solution of Drakshasav for feeding and 7. Topical application of Acetone Solution of Grapeseed Oil followed by feeding mulberry leaves treated with Aqueous Solution of Drakshasav).

Each and every group of the larval stages of fifth instars of silkworm was containing hundred individuals. Each and every group of the larval stages of fifth instars of silkworms was in the set of triplicates. First group of the fifth instar silkworm larvae in the attempt was considered as: Untreated Control Group. The second group of the fifth instar silkworm larvae in the attempt was considered as:

Solvent (Acetone) Treated Control Group. The third group of the fifth instar silkworm larvae in the attempt was considered as: Water / solvent Treated Control group. The fourth group of the fifth instar silkworm larvae in the attempt was considered as: Topical application of Acetone Solution of Grapeseed Oil Treated Group. The fifth group of the fifth instar silkworm larvae in the attempt was considered as: Topical application of Acetone solution of linalool Group. The sixth group of the fifth instar silkworm larvae in the attempt was considered for Treating the mulberry leaves with Aqueous Solution of Drakshasav and feeding fifth instar larvae of silkworm. The seventh group of the fifth instar silkworm larvae in the attempt was considered for Topical application of Acetone Solution of Grapeseed Oil followed by feeding mulberry leaves treated with Aqueous Solution of Drakshasav.

There was no any topical application to the “Untreated control group” of larval stages of fifth numbered silkworms. The solvent treated group of larval stages (hundred) of fifth numbered silkworm received the spray ten milliliters of plain solvent (acetone) at forty-eight hours following the fourth moult.

The grape seed oil (through acetone) treatment to the fifth stage silkworm larvae (hundred) was in the form of uniform spray of ten milliliter solution of acetone solution of grape seed oil and was executed at forty-eight hours following the process of fourth numbered moulting (on second day of fifth stage silkworm larvae). Hand-sprayer (household category) was used for spraying the solution of grape seed oil in acetone to the fifth stage silkworm larvae.

The linalool (through acetone) treatment to the fifth stage silkworm larvae (hundred) was in the form of uniform spray of ten milliliter solution of acetone solution of linalool and was executed at forty-eight hours following the process of fourth numbered moulting (on second day of fifth stage silkworm larvae). Hand-sprayer (household category) was used for spraying the solution of grape seed oil in acetone to the fifth stage silkworm larvae.

The Drakshasav (through distilled water) treatment to the fifth stage silkworm larvae (hundred) was in the form of feeding mulberry leaves treated with aqueous solution of Drakshasav. 100 mg of fresh mulberry leaves were used to keep immersed in 100 ml of aqueous solution of drakshasav for about an hour. The treated mulberry leaves were decanted and used for feeding to the fifth instar larvae of silkworm at forty-eight hours after fourth moult. The solvent treated group was fed with water treated mulberry leaves.

The seventh group of the fifth instar silkworm larvae in the attempt was considered for Topical application of Acetone Solution of Grapeseed Oil followed by feeding mulberry leaves treated with Aqueous Solution of Drakshasav.

Uniform spray of ten milliliter solution of acetone solution of linalool and was executed at forty-eight hours following the process of fourth numbered moulting (on second day of fifth stage silkworm larvae). Hand-sprayer (household category) was used for spraying the solution of grape seed oil in acetone to the fifth stage silkworm larvae.

The parameters considered for the present attempt include the age of larval stage of fifth instar; weight of entire cocoon; weight of silk-shell; pupal weight (weight of pupa); length and weight of silk fibers (filament) belong to individual cocoon. The age of the fifth stage silkworm larvae was counted from the initial time of release of fourth moult to the fifty percentage of completion of spinning the silk cocoon. Explanation of features of the data (fact of information in digital form) used to analyze; for explorations of the relations of the data belongs to underlying groups; summarizations of association of the data to elemental groups; validity setting up for the proof of the replica (model) and to heed the analytics of prediction are the consequences of any analysis through the methods of statistics. Identification of the trends parameters in the attempt appears to be the sole aim of data analysis32. Each and every event of attempt of the present experimentations were repeated for thrice. The aim of repetitions of the attempt in present experimentation is to obtain the result of category of consistent qualities. Parameters expected in statistics include: mean, standard deviation and percent change. All these parameters were calculated through the use primary data collected in all the attempts. Finally, the data subjected for the statistical analysis. The percent variations and student “t” – tests were considered for knowing the levels of significance [30,31,32].

RESULTS AND DISCUSSION

The results dealing with utilization of Grape Seed Oil (GSO) through acetone; Linalool through acetone and Drakshasav through water for qualitative and quantitative silk yield from silkworm larvae [Race: Bivoltine Double Hybrid] are presented through tabular form (table No.1,2 and 3) and presented through plotting the graphs (figures: 1,2 and 3). The age (hours) of larval stages of fifth numbered silkworm, Bombyx mori (L) [Race: (CSR6 x CSR26) (hybrid bivoltine) x CSR2 x CSR27) (hybrid bivoltine)] of the untreated control group; acetone treated control group and water treated control group was found recorded 145.33 (±13.786); 145.33 (±13.786) and 146.59 (±13.003) hours respectively (table- 1 and Fig.1.A). The age (hours) of fifth stage silkworm larvae belong to the group treated with topical application of Grape seed oil (GSO) (through acetone) and the group treated with topical application of linalool (through acetone) was found recorded 168.73 (± 13.221) and 177.46 (± 13.786) hours respectively (table- 1 and Fig.1.A). The age (hours) of fifth stage silkworm larvae belongs to the group received the leaves of mulberry treated with aqueous solution of Drakshasav and the group received the topical application of acetone solution of Grape Seed Oil (GSO) followed by feeding with leaves of

mulberry treated with aqueous solution of Drakshasav was found recorded 162.87 (± 14.572) and 168.58 (± 18.789) hours respectively (table- 1 and Fig.1.A).

Tissue-Somatic-Index (TSI) signifies the percentage of tissue in entire body. Tissue-Somatic-Index (TSI) of the silk glands of silk larvae in the untreated control group; acetone treated control group and water treated control group was found recorded as 31.426 units (table- 1 and Fig.1.B). Tissue-Somatic-Index (TSI) of the silk glands of silkworm larvae in the group treated with topical application of acetone solution of Grape Seed Oil (GSO) and topical application of acetone solution of Linalool was found recorded 52.625 and 52.728 units respectively (table- 1 and Fig.1.B). Tissue-Somatic-Index (TSI) of the silk glands of silkworm larvae belongs to the group received the leaves of mulberry treated with aqueous solution of Drakshasav and the group received the topical application of acetone solution of Grape Seed Oil (GSO) followed by feeding with leaves of mulberry treated with aqueous solution of Drakshasav was found recorded 52.759 and 53.854 units respectively (table- 1 and Fig.1.B).

The weight (unit: gm) of entire cocoon (with floss); weight (unit: gm) of whole cocoon (deflossed) of the group of untreated control group was found recoded 2.962 (±0.487) and 2.873 (±0.441) respectively (table-2. And Fig.2.A). The weight (unit: gm) of entire cocoon (with floss); weight (unit: gm) of whole cocoon (deflossed) of the group of Acetone treated control group was found recorded 2.962 (±0.439) and 2.873 (±0.493) respectively (table-2. And Fig.2.A). The weight (unit: gm) of entire cocoon (with floss); weight (unit: gm) of whole cocoon (deflossed) of the group of water treated control group was found recorded 3.146 (±0.831) and 3.051 (±0.557) respectively. The weight (unit: gm) of entire cocoon (with floss); weight (unit: gm) of whole cocoon (deflossed) of the group of topical application of acetone solution of Grape Seed Oil (GSO) was found recorded 5.381 (±1.078) and 5.219 (±1.081) respectively. The weight (unit: gm) of entire cocoon (with floss); weight (unit: gm) of whole cocoon (deflossed) of the group of topical application of acetone solution of Linalool was found recorded 5.596 (±1.788) and 5.427 (±1.149) respectively. The weight (unit: gm) of entire cocoon (with floss); weight (unit: gm) of whole cocoon (deflossed) of the group of larvae received mulberry leaves treated with Drakshasav was found recorded 5.691 (±1.739) and 5.519 (±1.557) respectively. The weight (unit: gm) of entire cocoon (with floss); weight (unit: gm) of whole cocoon (deflossed) of the group of topical application of acetone solution of Grape Seed Oil (GSO) followed by feeding the larvae with mulberry leaves treated with Drakshasav was found recorded 5.738 (±2.013) and 5.564 (±1.786) respectively.

Silk shell ratio (percentage) of the cocoons harvested from the group of untreated control group was found recoded 19.422. Silk shell ratio (percentage) of the cocoons harvested from the group of Acetone treated control group was found recoded 19.422. Silk shell ratio (percentage) of the cocoons

harvested from the group of water treated control group was found recoded 19.436. Silk shell ratio (percentage) of the cocoons harvested from the group of topical application of acetone solution of Grape Seed Oil (GSO) was found recorded 23.970. Silk shell ratio (percentage) of the cocoons harvested from the group of topical application of acetone solution of Linalool was found recoded 27.989. Silk shell ratio (percentage) of the cocoons harvested from the group of larvae received mulberry leaves treated with Drakshasav was found recorded 28.989.

Denier scale of silk obtained from the cocoons harvested from the group of the Untreated Control Group; Acetone Treated Control and Water Treated Control Group was found recorded 3.243; 3.243 and 3.241 respectively.

Table-1: Characters of the fifth instar larvae of silkworm treated with Vitis derived herbal juvenoid formulations.

Parameter Group	Fifth Instar Larval Life Duration (Hours)	Fifth Instar Larval Weight (Gram)	Fifth Instar Silk Gland Weight (Gram)	Tissue Somatic Index of Silk Glands
Untreated Control	145.33 (± 13.786) 00.000	03.478 (±00.332)	01.093 (±00.107)	31.426
Acetone Treated (Topical) Control	145.33 (± 13.786) 00.000	03.478 (±00.337)	01.093 (±00.111)	31.426
Water Treated (Through Mulberry Leaves) Control	146.59 (± 13.003) 00.867	03.478 (±00.339)	01.093 (±00.119)	31.426
Acetone Solution of Grapeseed Oil Treated (Topical)	168.73* (± 13.221) 16.101	05.294* (±00.569) 52.213	02.786* (±00.213) 154.89	52.625*

Acetone Solution of Linalool Treated (Topical)	177.46** (± 13.786) 22.108	05.479** (±00.623) 65.353	02.889* (±00.339) 186.00	52.728*
Aqueous Solution of Drakshasav (Through Mulberry Leaves)	162.87** (± 14.572) 12.069	05.563** (±00.786) 59.948	02.935** (±00.362) 168.52	52.759**
Acetone Solution of Grapeseed Oil Treated (Topical) followed by Aqueous Solution of Drakshasav (Through Mulberry Leaves)	168.58*** (± 18.789) 15.998	05.786*** (±00.674) 66.359	03.116*** (±00.519) 173.01	53.854***

-Each figure is the mean of the three replications; -Figure with ± sign in the bracket is standard deviation.;

-Figure below the standard deviation is the increase for calculated parameter and percent increase for the others over the control. *: P < 0.05; **: P < 0.005; ***: P < 0.01

Table-2: Characters of cocoon spun by the fifth instar larvae of silkworm treated with Vitis derived herbal juvenoid formulations.

Parameter Group	**Weight of Whole (with floss) Cocoon (Gram)**	**Weight of Whole (without floss) Cocoon (Gram) (A)**	**Weight of Silk Shell of Cocoon (without floss) (Gram) (B)**	**Silk Shell Ratio [(B÷A) x 100]**

Untreated Control	2.962 (±0.439) 00.000	2.873 (±0.441) 00.000	0.558 (±0.017) 00.000	19.422
Acetone Treated (Topical) Control	2.962 (±0.487) 00.000	2.873 (±0.493) 00.000	0.592 (±0.033) 00.000	19.422
Water Treated (Through Mulberry Leaves) Control	3.146 (±0.831) 00.000	3.051 (±0.557) 00.000	0.593 (±0.041) 00.000	19.436
Acetone Solution of Grapeseed Oil Treated (Topical)	5.381* (±1.078) 81.667	5.219* (±1.081) 81.667	1.251* (±0.069) 124.19	23.970*
Acetone Solution of Linalool Treated (Topical)	5.596** (±1.788) 88.667	5.427** (±1.149) 88.896	1.519** (±0.347) 172.22	27.989**
Aqueous Solution of Drakshasav (Through Mulberry Leaves)	5.691*** (±1.739) 92.133	5.519*** (±1.557) 92.098	1.548*** (±0.786) 176.88	28.048***
Acetone Solution of Grapeseed Oil Treated (Topical) followed by Aqueous Solution of	5.738*** (±2.013) 93.720	5.564*** (±1.786) 93.665	1.579*** (±0.998) 182.79	28.378***

Drakshasav (Through Mulberry Leaves)				

- Each figure is the mean of the three replications; -Figure with ± sign in the bracket is standard deviation.;

-Figure below the standard deviation is the increase for calculated parameter and percent increase for the others over the control. *: P < 0.05; **: P < 0.005; ***: P < 0.01

Table-3: Characters of silk reeled from the cocoon spun by the fifth instar larvae of silkworm treated with Vitis derived herbal juvenoid formulations.

Parameter Group	Silk Filament Length (meter) (C)	Silk Filament Weight (gm) (D)	Denier Scale of Silk Filament [(D ÷ C) x 9000]
Untreated Control	1173.88 (±119.53) 00.000	0.423 (±0.087) 00.000	3.243 00.000
Acetone Treated (Topical) Control	1173.88 (±119.53) 00.000	0.423 (±0.087) 00.000	3.243 00.000
Water Treated (Through Mulberry Leaves) Control	1171.84 (±113.52) 00.000	0.422 (±0.089) 00.000	3.241 00.000
Acetone Solution of Grapeseed Oil Treated (Topical)	1497.21* (±216.64) 27.543	0.783** (±0.123) 85.106	4.706*** 01.463
Acetone Solution of Linalool Treated (Topical)	1494.61* (±169.55) 27.322	0.796** (±0.118) 88.179	4.793*** 01.550

Aqueous Solution of Drakshasav (Through Mulberry Leaves)	1509.55* (±173.55) 28.594	0.819** (±0.129) 93.617	4.882*** 01.639
Acetone Solution of Grapeseed Oil Treated (Topical) followed by Aqueous Solution of Drakshasav (Through Mulberry Leaves)	1533.28* (±352.78) 30.616	0.843** (±0.387) 99.290	4.948*** 01.705

- Each figure is the mean of the three replications; -Figure with ± sign in the bracket is standard deviation.;

Figure below the standard deviation is the increase for calculated parameter and percent increase for the others over the control. *: P < 0.05; **: P < 0.005; ***: P < 0.01

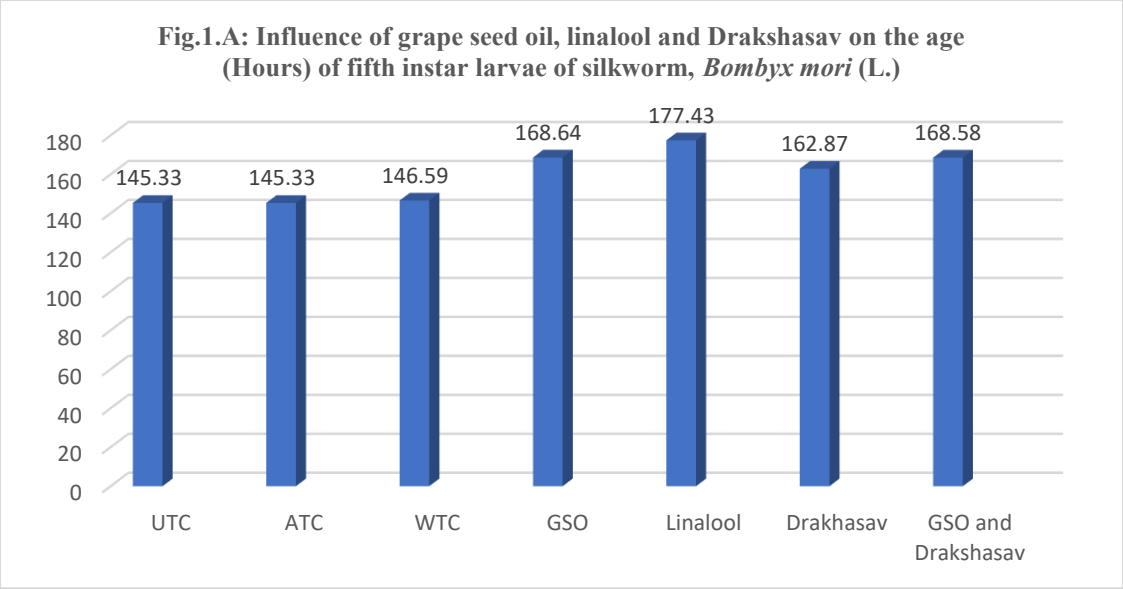


Fig.1.B: Influence og grape seed oil (GSO); Linalool and Drakshasav on Tissue Somatic Index (TSI) in the fifth instar larvae of silkworm.

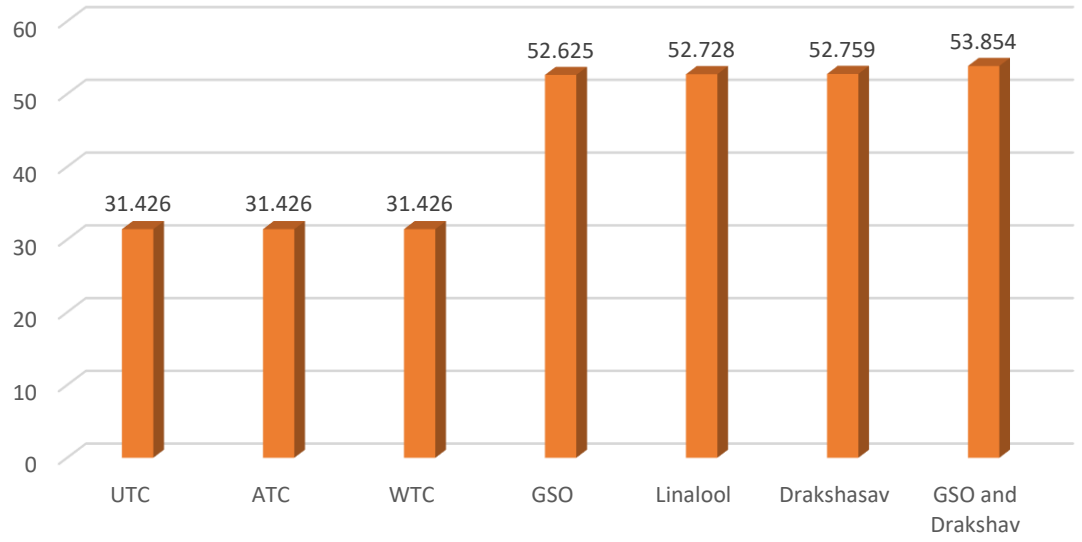


Fig.2.A: Influence of Grape Seed Oil (GSO); Linalool and Drakshasav on the parameters of cocoon (cocoon weight and shell weight) spun by silkworm, *Bombyx mori* (L.).

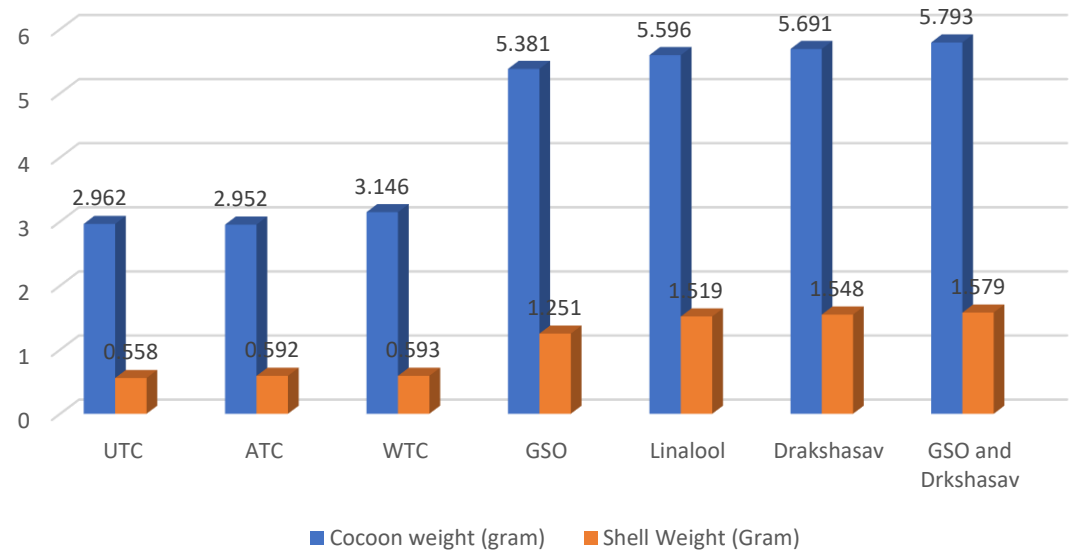


Fig.2.B: Influence of Grape Seed Oil (GSO); Linalool and Drakshasav on Shell Ratio of silk-cocoons in silkworm, *Bombyx mori* (L.).

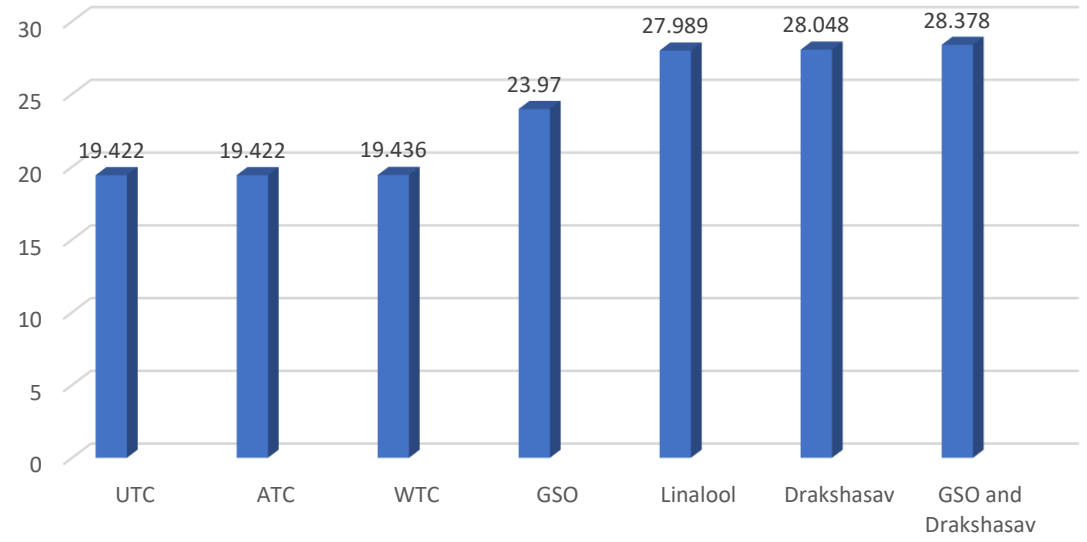
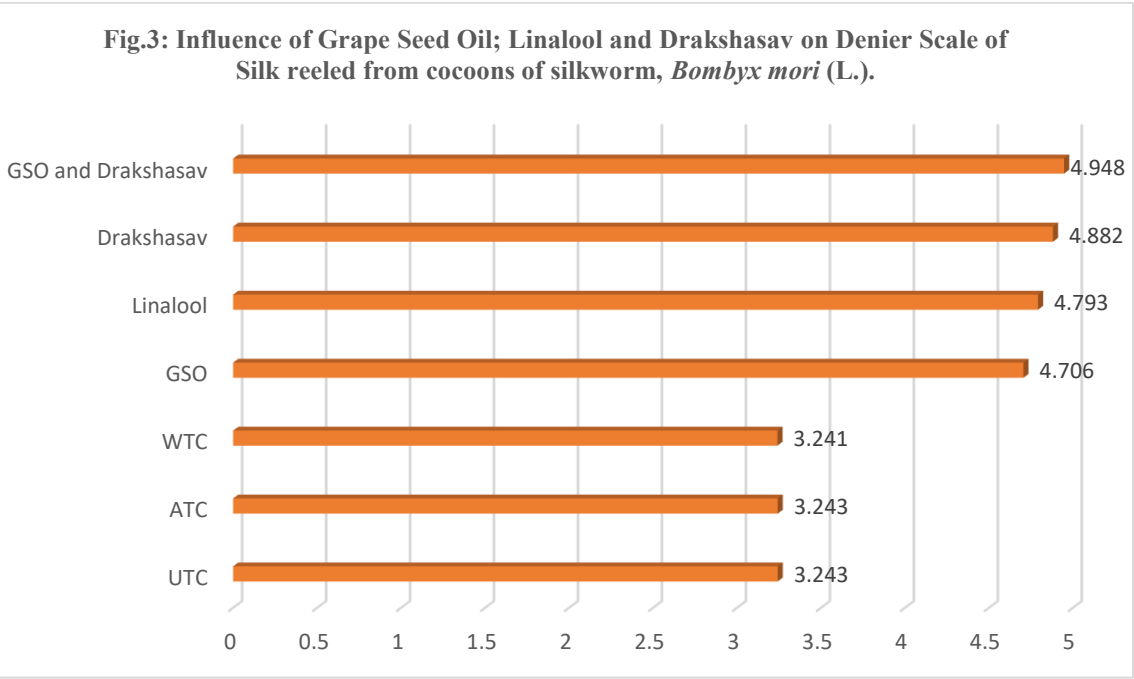


Fig.3: Influence of Grape Seed Oil; Linalool and Drakshasav on Denier Scale of Silk reeled from cocoons of silkworm, *Bombyx mori* (L.).



The Denier scale of silk obtained from the cocoons harvested from the group of Grape Seed Oil Treated (GSO) Group was found recorded 4.706 units. The Denier scale of silk obtained from the cocoons harvested from the group of the group of Linalool Treated group was found recorded 4.793 units. The Denier scale of silk obtained from the cocoons harvested from the group of larvae received the mulberry leaves treated with aqueous solution of Drakshasav was found recorded 4.882 units. The Denier scale of silk obtained from the group of larvae treated with acetone solution of Grape Seed Oil

(GSO) followed by feeding the mulberry leaves treated with aqueous solution of Drakshasav was found recorded 4.948 units.

The foremost and significant feature in sericulture lies in the silk yield in the form of silk-cocoon prepared (spun) by mature fifth stage silkworm larvae. The silk cocoon is the sole source for commercial silk-filament (silk fiber). Extension of the life of is the significant feature of insect larvae recipient of exogenous chemical compounds with juvenoid activity. Most of the compounds of "terpene" category utilized for treatment (for spray /topical application) to the silkworm larvae are mimicking the working mechanism of natural insect Juvenile Hormone Analogue (JHA) [20,21,22,23,24,25]. The significant increase (12.069 to 22.108 percentage) in the age of fifth instar larval stage in present attempt is sufficient to label the Grape Seed Oil (GSO); Drakshasav and Linalool as "Herbal source Insect Juvenoid Formulation" and "Insect Juvenoid compound" respectively. Most possible working mechanism of "Herbal source Insect Juvenoid Formulation" and "Insect Juvenoid compound" is to extend the larval duration / age. The larval instars of silkworm may have been utilized the system of extension of larval life for more consumption of food material, more secretion of silk, spinning the larger and fortified silk shell. For the fortification of the concept, further studies (on effect of Grape Seed Oil (GSO); Drakshasav and Linalool on chitin deposition in insect larval stages) are essential.

Use of "Herbal source Insect Juvenoid Formulation" and "Insect Juvenoid compound" for rearing the larval stages of silkworm appears to be much more easy method. Utilization of "Herbal source Insect Juvenoid Formulation" and "Insect Juvenoid compound" is going to open a new boulevard (avenue) in sericultural practices for the quantitative and nuanced research findings (qualitative) of yield of silk.

CONCLUSION

The present attempt reports significant influence on the yield of silk through the utilization of acetone solution of Grape Seed Oil (GSO); Linalool for topical applications and feeding the larvae with mulberry leaves treated with aqueous solution of "Drakshasav" at forty-eight hours after the fourth moult to the fifth instared larval stages of silkworm, Bombyx mori (L) [Race: Double Hybrid - (CSR6 x CSR26) (hybrid bivoltine) x CSR2 x CSR27(hybrid bivoltine)]. The result on the "increase in the age of larval stage of silkworm, Bombyx mori (L) [Race: Double Hybrid - (CSR6 x CSR26) x CSR2 x CSR27] in the treated groups is sufficient to label Grape Seed Oil (GSO); "Drakshasav" and Linalool as "Herbal source Insect Juvenoid Formulation" and "Insect Juvenoid compound" respectively.

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REDEFINING INDIAN EDUCATION: INTELLECTUAL PROPERTY RIGHTS AND THE NATIONAL EDUCATION POLICY-2020

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ABSTRACT

The world is witnessing advancement in science and technology at an incredible pace. Additionally, the advent of AI technology is leading towards repatterning of employment scenario worldwide. In the coming era, a knowledgeable person with multidisciplinary skills will be valued higher. This necessitates the channelization of current education system towards innovation and improvisation to meet the universal changes in career platforms. Under the premise of India contributing as a "global knowledge superpower", the Ministry of Education, Government of India, has launched the National Education Policy-2020 (NEP-2020) to tap the maximum potential of an individual. It aims towards holistic development of an individual as well as discovering the scientific temperament and enhancing creative imagination right from the early stages of education. Besides, this policy also sets awareness of intellectual property rights as one of the major objectives to be imparted by educational organizations. All this will definitely delimit the research and development sector from only a few higher educational institutes to a normally practiced approach at all Indian avenues.

KEYWORDS

Education system, National Education Policy- 2020 (NEP-2020), Intellectual Property Rights (IPR), Research and Development

INTRODUCTION

For any nation, education is key asset playing extremely crucial role in laying foundations of a stable economy and indirectly uplifting the society at large. At an individual level also, it plays an imperative role in the holistic growth and development of any person be it academics or the other vital spheres of one's life. The first education system was promulgated in 1968 and then amended in 1986. Thereafter it monotonously followed the same norms for 34 years and had a lot of challenges due to which education per say was unable to truly fulfill its role. Hence, there arose a need to improvise our education system right from beginning and positively impact the development of our country. Thus, with the same of strengthening our education and making it more flexible, the Union Cabinet for the

third time restructured and broadcasted a historical decision by releasing the National Education Policy (NEP) on July 29th, 2020 (Kumar, 2020).

The National Education Policy (NEP) of 2020 marks an infinite development in the education system of India. It provides a unique opportunity to Indian students from "sorting and selection" to "human development"; enabling every student to recognize their unique capabilities and best realize their potential. The old policy laid more emphasis on improving the academic purview of the children in comparison to holistic development. It did not provide enough space to the students to think out-of-the-box. In Higher Education in India, once a student selected any stream, the education acquired became very narrow or limited to the subject. They did not get the opportunity to get exposure of other areas from different streams. Comparatively, less attention was given to the understanding of concepts rather than just cramming up the formulas and theories with the sole motive of achieving good marks. It was less skill-oriented, did not focus on creativity, interdisciplinary approach, logical and analytical thinking. Research and development were limited to few institutes of higher learning.

Theoretical understanding of any subject is definitely important, but it may not always suffice for a successful practical implementation in the real world. At the same time students should be made well aware of their rights. Also, blending of different fields and flexibility is the need of the hour as many students are not able to complete their studies owing to any financial or family constraints. Therefore, an urgent need to restructure this education system was realized that emphasized on protecting India's rich heritage and culture and at the same time it should provide an atmosphere for inter-disciplinary, concept-based learning, and practical implementation of acquired knowledge by exposing students to various skill enhancement and value-added courses to improve employment aspect. Over the last 8 years, India has climbed up 41 places in the Global Innovation Index released every year by World Intellectual Property Organization. Similar to the year 2022, in the year 2023 too, it retained its 40th rank out of 132 in the chart and this changing trend of education should surely help the nation to rise up higher (Global Innovation Index, 2023).

Objectives of NEP

NEP was launched in 2020, by Ministry of Education (MHRD), Government of India in consultation with expert academicians and policy builders to meet one of the prime goals of the United Nations Sustainable Development goals. Under the NEP, the present schooling will be divided into 5 + 3 + 3 + 4 stages as foundation, preparatory, middle and secondary schooling respectively; replacing the earlier 10+2 system (Aithal and Aithal, 2020a). National Education Policy emphasizes to encourage students' distinctive capabilities to full potential by promoting their creativity, critical thinking and digital literacy.

The attention is on the skill improvement and competency development among the students so that they are better prepared to compete with the changing global employment scenario.

NEP seeks to ensure a comprehensive, impartial and good quality education for all, offering a holistic avenue for mental, cultural and ethical growth that helps in bridging the gaps in the current education scenario as well as reforming the existing structure. The new education policy brings some significant changes to the current education system, and the key highlights are multidisciplinary approach, universities and colleges in every district, refurbish student curricula, use of modern pedagogy, evaluation and support for enhanced student experience and also establishing a National Research Foundation to support excellent peer-reviewed work even at university and college level (Aithal and Aithal, 2020a). The inflexibility of the conventional system is going to be replaced with high-quality liberal education that furnishes the best possible learning environment and multidisciplinary approach in future. It will also provide many opportunities for students to break the prevalent rigid boundaries and have ample possibilities of lifelong learning. By the end of the year 2030, Indian government is targeting 100% Gross Enrollment Ratio from pre-school to secondary school with help of imparting education through help of various online teaching platforms such as SWAYAM, SWAYAMPRABHA and DIKSHA and thus expanding the distance learning program (Panditrao and Panditrao, 2020). These e-learning portals will provide similar experience in the virtual labs as the actual hands-on experiment-based learning, giving students access to quality practical in the digital medium. Thus, harnessing the maximum and best potential of the students.

NEP 2020 will unlock new learning opportunities for the students and at the same time also expose them to new manner of learning. It will make the students more competent and abled i.e., future-ready by building 21st-century skills and focusing on both academic and non-academic pursuits. It will also expedite the widespread use of pedagogical tools in teaching and learning process, focusing on educational planning management and eliminating all the language barriers. So, in a nut-shell we can conclude that the objective of NEP is to build up novel and excellent quality of educational institutes which will be at par with global standards (Sattiraju et al, 2023; Smitha et al, 2020). Innovation, research and novelty will surely demand an exposure of Intellectual Property Rights so that one is better equipped to protect their own creations.

Intellectual Property Rights

As India celebrated its 75th Anniversary of Independence or as popularly called 'Azadi Ka Amrit Mahotsav', the Office of the Controller General of Patents, Design and Trademarks, Ministry of Commerce and Industry, Government of India has been involved in propagating a pan-India ambition of creating IP awareness among the one million student community in the country under its National

Intellectual Property Awareness Mission (NIPAM) launched in December, 2021. The main goal has been to ensure that proper recognition and protection is rendered to whatever intellectual capital that gets generated. For their first phase, main targets were Level A - Schools (Class 9th to 12th) and Level B - Universities / Colleges as they are the future of our nation (Annual Report Intellectual Property India, 2023).

The eminence of a country relies on its innovation and research and the onus is credited to the various research institutes and universities. India is bestowed with a rich culture and heritage; and the National Educational Policy stresses majorly on innovation and creative thinking. Thus, knowledge about Intellectual Property Rights is inevitable and highly valuable even for educational sector.

The National IPR Policy was approved by the Union Cabinet in May 2016 (Das, 2016; National Intellectual IPR Policy, 2016). The main objective of the policy was to promote novelty and ingenuity amongst the students. Consequentially, it resulted into inclusion of IPR in CBCS (Choice Based Credit System) syllabi by the University Grant Commission (UGC). Yet, majority of the population remain clueless about their rights based upon their intellect, thereby, making it essential to be engrained in the National Education Policy (NEP), at the grass root level itself.

A feature of intellectual property is that it is not a materialistic object yet the valuable information can be easily emulated and stolen. Intellectual Property rights refers to “Intellectual Property” such as music, literature, film, a new device used in industries and laboratories; trademarks and other marks that are used to indicate goods or services in business activities; trade secrets and other technical or business information useful for business activities and all created through innovative ideas Dratler and McJohn, 2023). It can be used by people without giving proper acknowledgment to the creator or inventor (Maurya, 2016). The IPR system restricts and protects the rights of the creator during the tenure of the IPR. In order to maintain this system design, the creators of intellectual property as well as its beneficiaries should have a proper understanding of their rights which helps innovators to protect their creation and invention, and also provides better collaboration and funding opportunities. It teaches us to respect the rights of a creator and to give due credit while using someone else’s creation (Maurya, 2016).

For the last few years, COVID-19 has had a strong control over our lives, putting our health at risk, and also it greatly impacted our economy. While insecurity persisted during the entire period of pandemic, intellectual property (IP) played an essential role in the creation and development of solutions to combat COVID-19. IP drove the development of innovative vaccines, therapeutics and technologies that kept us safe, secure, connected and productive throughout the pandemic. IP-driven innovation and creativity allowed not only to stay alive but also to flourish and bloom. The vaccines, therapeutics

and technologies that have led the global community overcome the pandemic are the result of the pre-existing innovation ecosystem that relies on IP rights to enable allocation of resources, formation of partnerships, and transfer of technology on commercial terms. Effective IP facilitated hundreds of voluntary licensing agreements that allowed the rapid scale-up of global manufacturing. An efficient and successful IP system will continue to deliver the innovative, creative and productive goods and services to the next generation to compete for a better tomorrow.

According to the US Chamber of Commerce, out of the 55 leading global economies, India ranked 42nd in International Intellectual Property (IP) Index in 2024 (not changed since 2022). Improvements were witnessed in different sectors, an increase in trend can be observed in the number of IP applications filed in India (Fig 1), within the last 5 years (Annual Report Intellectual Property India, 2023). In fact, there has been an increase of 5.94% of filling from last year. Among the creative economies of the world, India's jump up in the ladder is attributed to the most regarded sectors like advanced manufacturing, bio-pharmaceuticals and creative content. Thus, with continued efforts, new policies and patent regulations, the performance of IP can be further enhanced (International IP Index 2023). The social and economic reform, IPR can bring in the India, makes it an utmost necessity to deal with IPR in NEP. India, has been very late in popularizing these rights amongst people, thereby not allowing the country to reap multifaceted benefits. In economic terms too, registrations of different IP can help in generating substantial revenue which can prove extremely beneficial for a developing nation like India as can be seen from Fig 2. The amount of revenues increased total was calculated to be Rs. 1185.04 Crore in the year 2022-23 (Annual Report Intellectual Property India, 2023).

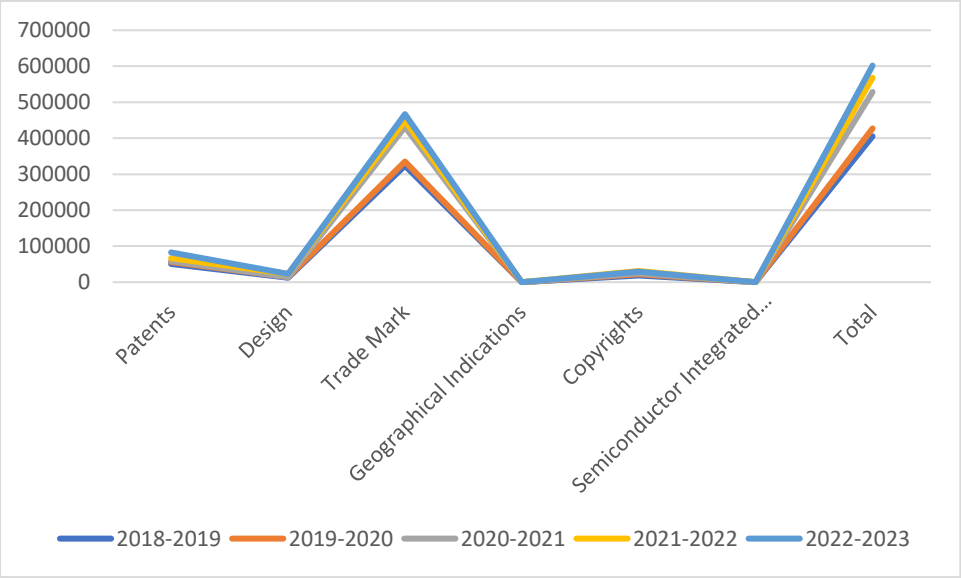

Fig. 1 Trends in last five years with respect to filling of IP Applications (Annual Report Intellectual Property India 2022-23)

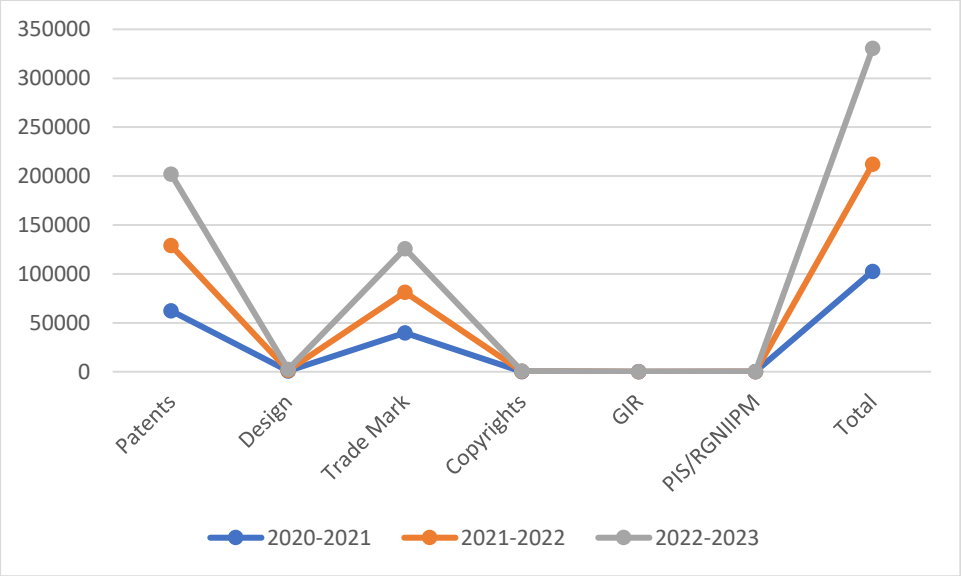

Fig 2: Comparison of Revenue (in lakhs) of the last three years due to the registration of IP application forms in India (Annual Report Intellectual Property India 2022-23)

Types of IPR

In general, IPR can be divided into two types: copyright and industrial related rights. Under the latter category, there are other rights like patents, trademarks, industrial designs, geographical indications and trade secrets (Fig 3). University research is focused on theoretical concept-based research and generally ends up with copyrighted scholarly publications. Industrial research is experimental research and focuses on the development of new products or processes and generally ends up with patent. Copyright and patents are the two important intellectual property rights (IPR) that a university can generate through innovations in improved research-based curriculum and also by compulsorily involving undergraduate and postgraduate students into research activities steered by guidance of the faculty members (Aithal and Aithal, 2020b). In the year 2022-23, out of the top 5 applicants who filed for patents in India, three major positions were occupied by universities i.e., Lovely Professional University, Jain University and Galgotias University (Annual Report Intellectual Property India, 2023).

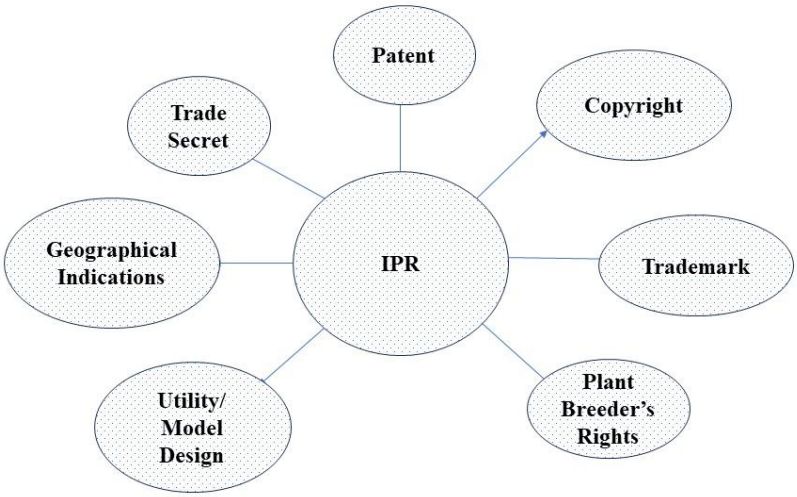

Fig. 3: Types of Intellectual Property Rights in India

Copyright and its role in education

Copyright is an essential IPR, that involves idea in a tangible medium, which are related to literary works, music, art, cinematography and computer software for a period of time. This IPR has been considered to be very essential for education sector. Without proper education of this subject, the students do not realize their rights upon the poems, stories and articles written by them. Moreover, teachers and students use the copyrighted material for preparing their notes and assignments, respectively. Though, education sector is quite blanketed from copyright infringements, yet unknowingly, many cases tend to be produced in courts. India, had first signed the last revision of Berne's Convention, in year 1971 (Alikhan, 1986), which specifically allows exemption for 'teaching purposes' in Article 10 (2). However, the amount or extent of utilization depends upon "the extent justified by the purpose," "compatible with fair practice" and "by utilization of illustrations". Article 10 (2) will allow any amount of work to be reproduced, if these three requirements are met (Strba, 2012). Education is incomplete, without books and articles. Any good institution and their educators, tend to utilize books of renowned writers across borders. Some tend to be so costly, that the only source stays to be one or few copies in libraries. A general trend observed in these books is the price fluctuation, depending upon the country the buyer belongs to. A disparity is created amongst the buyers and users. Most students, cannot afford such overpriced books, thereby, borrowing and photocopying, is the only resort for them. Even some adverse situations like the 2019 pandemic also created a gap between the

books and the students. But ignorance is no escape, students must be made aware and recognize the copyright laws associated with all this.

A very famous case of University of Delhi happened in the year of 2012 and was fought for four long years. A copyright infringement case was filed against Rameshwari Photocopy Service and the University of Delhi in the Delhi High Court by Oxford University Press, Cambridge University Press (UK), and Taylor & Francis Group (UK), as well as Cambridge University Press India Pvt. Ltd. and Taylor & Francis Books India Pvt. Ltd. It was against the photocopy shop for copying and distributing portions of published book without any license. In 2016, Delhi High Court ruled in a landmark decision that the photocopies and its compilation did not constitute a copyright infringement, under the Copyright Act, 1957 (Suresh, 2021).

As, 'right to education' is considered to be a fundamental right under the Indian constitution (Alston and Bhuta, 2005), citizens cannot exercise their own rights unless educated, thereby making it essential for all the educational institutions to provide platforms for basic need of Indians. In NEP this has been the main target by utilizing distance education and ICT tools, so that any Indian student, sitting anywhere in the country can benefit out of it. But considering the Indian Copyright laws, not being totally open for all students and teachers, providing study material, without infringement, can be the quite challenging and a big hassle indeed in the upcoming days. The present Copyright Act and exemptions in education, is useful for traditional education policies only. With the introduction of NEP, a student is allowed to pursue two degrees at the same time and with advancement in distance education and e-learning, the same old copyright laws might fall short.

For sustainable development as countries are moving towards innovation and creativity, the need to understand the importance of IPR is increasing. Increasing focus on innovation, research and cross-border collaborations, one needs to learn more about the rules of intellectual property rights (IPRs) to safeguard own inventions. IPRs help in protecting as well as commercializing the inventions.

If the innovations are patented and taken up for commercialization by the start-ups it will give a competitive advantage to the inventors and entrepreneurs.

Industry based IPR and their role in education

Industries and industrial sectors are also trying to identify and grab young, energetic and vibrant graduates who can be innovative and develop new ideas and models to add standards and value to their products and services to survive and sustain in the present competitive business scenario. Thus, there is a pressure on the present education system, especially on the Universities to re-define the educational models, develop and offer skill and industry related curriculum so that these graduates can manage their time in a better way and identify as well as nurture their innate talent in the desired

fields. It will also improve their communication skills and allow for better professional networking (Aithal and Aithal, 2020b; Sinha, 2018).

Under the industry related rights, there are several IPRs like patent, trademark, industrial design, geographical indication, trade secret etc. A new invention can help an innovator to apply for patent. A patent not only protects the product and/ or process of the invention for 20 years but also it reaps benefits for the person. Moreover, if an entrepreneurship is started, the first right that must be exercised, is registering the logo/ word/ symbol, under the Trademark. This will help in promoting and safeguarding the business in future. Geographical indication can be applied for those products or a process which are from a designated place. This has proved highly beneficial for small scale industries of even small villages of India, thereby, improving the socio-economic conditions. IPR like industrial design will help students who are planning to be designers in future. The designs can be protected and can be safeguarded from infringements.

CONCLUSION

Universities play an important role as leaders in the teaching-learning process, research and technology; and also, as a key institution for providing employment. Therefore, it is their responsibility to provide innovative, liberal and multidisciplinary education to attract more students towards higher education levels. The innovation in higher education should be accomplished by a well-planned, drafted and attractive curriculum based on technology and research.

As the NEP aims at an inquiry driven, comprehensive, flexible, skill-based education that will provide holistic development for the youth, hence, IPR knowledge is essential for every student at base level of graduation to promote the venturing of students into entrepreneurship without any fear of employment. This will remove the mental frustration and further create a sense of security as they will shift from the mode of job providers rather than job seekers. This betterment of mental state of an entire society will have a huge impact on the socio-economic development of the country. Pedagogy must shift towards more experiential learning that is enjoyable as it's the need of the hour; giving equal importance to developing all aspects and capabilities of learners and building strong characters that will pave way in India's future. Thereby, it can be concluded that education related to the IPRs, the application process of registration of rights and benefits that can be reaped through them, are essential aspects that must be introduced with the new education policy (NEP) of India.

Despite improvement, the stake holders in India continue to face substantive challenges, especially when it comes to file a patent, as India's current policy continues to deny patent eligibility to a broad range of innovations. India needs to further reinforce the system for the innovators and creators through modifications to elucidate trade secrets protection, exclusion of bureaucratic barriers, and

passage of clean Cinematographic Law amendments to protect Indian creative content. There should be a movement from 'Made in India' to 'Invented in India' movement and when this changeover occurs, role of Intellectual property would be immense for India's position as global power house of knowledge creation. In the coming decades, our nation will have majority of youth as workforce and directed education can actually help our country to leave a mark at the global arena. It is a progressive swing and if implemented in a true manner, this new education system can help India to lead as a major "global knowledge super power" along with the other countries of the world.

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SUSTAINABLE PEOPLE MANAGEMENT PRACTICES IN HIGHER EDUCATIONAL INSTITUTIONS WITH REFERENCES TO FARIDABAD AND GURGAON

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ABSTRACT

Promoting sustainable employee practices through the interface of all employees at educational institutions is known as "green human resource practices." The concept "green human resource or sustainable people management practices" mentions to HR initiatives that are ecological friendly, support the renewable use of resources in educational institutions, and increase faculty productivity in higher education. It leads to more efficiency, lower expenses, and improved faculty management. In order to increase the productivity of faculty members in higher education institutions, this article's contribution consists of compiling the body of existing literature in the field, outlining the landscape, and proposing innovative methods to rationally use scarce resources to prevent pollution of the environment, aid in waste management, and cut down on preventable carbon emission.

The purpose of this research work is to quantify the presence of green HRM practices in colleges and the use of these practices by faculty members in higher education institutions in Faridabad and Gurgaon .Although a comprehensive understanding of the processes and mechanisms by which sustainable people management practices effect college faculty members' behavior is needed and by delivering a well-structured questionnaire to teaching faculty members in higher education institutions, this study gathers primary data and provides a basic understanding of how GHRM procedures affect employee green behavior prediction.The study gives us an overview of the fundamentals of GRM procedures and how employees use them in their daily work at institutions.

KEYWORDS

Sustainable People Management, GHRM, Green HRM Practices, Teaching Faculty.

INTRODUCTION

One wise field that emphasizes the significance of creating and fostering an organization's work culture is human resource management. Capability management, leadership development, employee well-being, diversity and inclusion, and digital HR technology are among the topics that HR prioritizes. A hallmark of contemporary HR is the transition from routine tasks like payroll and timekeeping to strategic ones like employee development and workforce planning. These days, People Management has a significant effect on how an institute's culture, employee engagement, and overall human resource development and performance are shaped. As we go toward industrialization, sustainable

people management has emerged as a key issue in the modern world. Several countries' governments are creating terrain operation initiatives with the assistance of organizations that operate on both a profit and service basis. One of the emerging nations in education is India. Educational institutions must do their share by providing green resources to students and employees and holding them accountable for environmental preservation.

An HRM practice is any activity that focuses on improving the organization's culture, commitment, competencies, and level of satisfaction. The practice may be a system, a procedure, an activity, a rule, a norm, or just a method of carrying out tasks. "Actions that reduce the environment impact, such as eco-purchase and recycling," are referred to as "green practices." The phrase "green human resources management" describes a set of policies, practices, and frameworks that motivate staff members to act in a way that is socially, environmentally, and resource-conscious. Every educational institution uses green practices for a number of reasons, including improving their reputation, aiding in employee retention, promoting social responsibility, increasing enrollment in the courses they offer, and maximizing the effectiveness of their faculty. Green HRM practices were being organized by a number of educational institutions to increase the efficiency of their faculty. One of the Indian states with a variety of culture-based educational options is Haryana. One of Haryana's most densely inhabited districts is Faridabad and Gurgaon, which are home to a large number of higher education institutions. Numerous organizations use carbon footprints extensively in their daily operations, which is detrimental to the ecosystem as a whole. Many multinational businesses, financial institutions including banks, and educational institutions have recently launched programs aimed at environmentally friendly practices, or "green practices."

NEED FOR THE STUDY

Sustainable People Management Practices in Education Sector

Around the world, both developed and emerging countries—such as Australia, the US, China, Brazil, and others—are feeling immense pressure to adopt a more ecologically friendly and sustainable agenda. For this reason, immediate adjustment and the adoption of eco-friendly procedures are required. Growing global environmental concerns have made businesses more conscious of the need to use green practices in order to become competitive and environmentally friendly. HR has adopted green HR practices as a result of growing awareness of the environmental issue, with an emphasis on waste management, digitalization, and lowering carbon dioxide emissions.

Numerous educational institutes have started green enterprises to enhance scholars' and workers knowledge about green activities and make them responsible for terrain protection. However, it will produce mindfulness among the operation and staff to reduce waste operation, unwanted assets and

maintain the cleanliness of the lot. The implementation of an effective Green HRM system would ultimately result in the satisfaction of many stakeholders, including employees, and inspire them to increase their productivity. The report has made a sincere effort to investigate the amount to which the various teaching staff in Gurgaon and Faridabad City have learned and used working skills

STATEMENT OF THE PROBLEM

This study's main goals are to create a research framework and identify the key variables affecting the functioning skills of teaching faculty. The study identifies the efficacy of the colleges' Green HR practices and focuses on the teaching faculty's implementation and adherence to these practices in higher education institutions. The study will assist in understanding how green HR practices improve institutions' reputations. Along with highlighting green HR practices and the difficulties they provide for teaching faculty, the study will also determine how effective these practices are in higher education colleges, namely in Faridabad and Gurgaon.

OBJECTIVES OF THE STUDY

1. To evaluate staff members' knowledge and comprehension of Green HRM practices in a few chosen educational institutions in Faridabad and Gurgaon.
2. To investigate how employee perceptions of environmental sustainability are affected by green HRM practices.

HYPOTHESIS OF THE STUDY

1. There is no association between teaching faculty's awareness regarding sustainable people management practices implemented in selected educational institutes in Faridabad and Gurgaon.
2. Green HRM techniques have no effect on employee attitude.

RESEARCH METHODOLOGY

Nature of the study

With particular reference to Faridabad and Gurgaon, the current study focuses on sustainable people management methods among higher education colleges' teaching faculties.

Research Design

Primary and secondary data form the empirical basis of the design. The primary data used in the main study came from faculty members of government, government-aided, and private colleges who answered questions on a five-point Likert scale in well-structured, standardized questionnaires. Journals, magazines, reports, periodicals, newspapers, articles, research papers, websites, and library intranets were among the publications from which the secondary data was gathered.

Sample Size and Design

A sample of 304 responders is selected from the Gurgaon and Faridabad institutions. Thus, 304 replies make up the study's sample size. The purpose of the sample design is to identify the unique characteristics of the teaching faculties' Sustainable People Management Practices. Depending on the faculty members' availability and willingness to engage in the survey, convenience sampling was used to gather data from the respondents for the current study.

LITERATURE REVIEW

The review studies pertaining to green people management practices and their attitude towards that is subdivided and discussed in the table 1 & 2, covering both demographic and psychological influences.

Table1: Demographic Variables

S.No.	Parameters/ variables	Researchers (Year)	Findings
1.	Gender	R. Bhagyalakshmi, M. Priyanka, Dec.2019	Women teaching faculty need to increase their job efficiency, which is significantly lower than that of male faculty.
		Jaid, Roshna Ramdas, 2021	The participation of Male gender is higher than female
2.	Standard of living	Deepak Bangwal and Prakash Tiwari17 (2015) i	As we progress toward industrialization, business output, technology, and other business operations increase. Additionally, the standard of living has grown.
3.	Online training program	S.R. Sharanya and R. Radhika26 (2016)	In order to boost employee engagement and participation and lower employee turnover, management should offer online training courses on environmental problems and hire staff members who

			are knowledgeable about green human resource management.
4.	Different Organization	Jaid, Roshna Ramdas, 2021	It was originated that the Green Banking facilities and its implementation followed at banks satisfied at high level as the satisfaction level has reached more than 70%
		Soo-Cheng Chuah*, Idaya Husna Mohd, Juliana Noor Binti Kamaruddin, Nadia Md No, 2021	Employees at the UniversitiTeknologi MARA Puncak Alam Campus performed better on the job once GHRM workplace standards were implemented.
		Jing Yi Yong, M.-Y. Yusliza, Olawole Olanre Fawehinmi,, 2019	Compared to established nations, developing nations—which are primarily rising economies—tend to engage in more manufacturing and organizational human activities that inevitably harm the environment.
		pallavi mehta1 & khushbu mehta,2017	Green HR practices were successfully applied in Udaipur's private sector. Promoting corporate social responsibility, enhancing organizational culture, and enhancing the firms' reputation were the primary drivers of the adoption of HR practices.
		Mr. Subhodeep Mukherjee1, Dr. Soumendra Bhattacharjee2, Ms. Nabanita Paul3, Ms Urvashi Banerjee4, 2020	It is very important in current situation to upgrade the HR practices which is aligned with environment friendly practices in case of NIT Silcher.

		Qasim Ali Nisar, Shahbaz Haider, Faizan Ali, Samia Jamshed, Kisang Ryu, Sonaina Saif Gill, 2021	It was discovered that among Malaysian hospitality workers, green intellectual capital was linked to the use of green HRM techniques.
5.	The company's environmental and economic performance;	Davide Luzzini and Marco Guerci11 (2014)	Both directly and indirectly, the GHRM bundle—which is conceived as a formative construct of hiring, training and involvement, performance management, and compensation—improves economic and environmental performance;

Table 2: Psychological Variables

S.No.	Parameters / Variables	Researchers (Year)	Findings
1.	Environmental knowledge	Udhayageetha Veerasamy1, Michael Sammanasu Joseph2 and Satyanarayana Parayitam3,2022	Employee engagement and participation in green environmental initiatives are positively correlated with their EGB training and development.
		Shoab Ahmed, 2015	Organizations have been forced to adopt environmentally friendly HR practices with a particular focus on waste management, recycling, limiting carbon footprints, and starting to produce green products as a result of growing awareness of the importance of green issues.

2.	Green Structural Capital	Saqib Yaqoob Malik, Yukum Cao, Yasir Hayat Mughal, 2021	Green Structural Capital has a positive effect on sustainable performance
3.	Green relational Capital	Ghulam Mohammad Kundi, 2022	Gaining a competitive edge and achieving long-term success are facilitated by intellectual capital.
4.	Knowledge	International Journal of Recent Technology and Engineering (IJRTE) ISSN: 2277-3878, Volume-8 Issue-4S3, December 201, R. Bhagyalakshmi, M. Priyanka	A significant portion of responders are men with postgraduate degrees who have similar positions as assistant and associate professors, make a respectable living of over one lakh, and are unaware of green practices.
5.	Culture	Sajjid Hosain, 2016	The process of creating and sustaining a green HRM culture takes a lot of effort and time.
6.	Competitive Advantage	Sadiqur Rahman, 2016	By properly comprehending and implementing the breadth and depth of green HR practices, a company can gain a competitive edge by improving its organizational and social performance.
7.	Attitude	Togherson(20150)	Attitude of employers and employees and lack of green perceptions barriers in Green HRM implementation.
8.	Employee awareness	Udhayageetha Veerasamy1, Michael Sammanasu Joseph2 and Satyanarayana Parayitam, 2022	It is crucial to raise employees' understanding of sustainability in addition to enhancing the working environment.

9.	WorkLife Balance	Dr. Sireesha Rani Vasa, Dr. T Sowdamin 2017	To encourage eco-friendly conduct in both the private and professional spheres, the "green work-life balance concept" is proposed.

RESEARCH GAPS

Prior research on employee green behavior and green HRM has primarily been conducted in developed countries, illustrating their attitudes and perspectives on implementing green practices. In contrast, there aren't many studies that have examined how employees in developing countries like India behave environmentally when making purchases. According to Fawehinmi, Yusliza, Mohamad, Faezah, and Muhammad (2020), this study looks into green staff practices in higher education institutions that haven't received much attention in the past. Large volumes of garbage, including paper, plastic, and environmental pollutants, are produced by higher education institutions (Fawehinmi et al., 2020). By emphasizing the development of employees' environmental capabilities, skills, and attitudes, educational institutions can improve their environmental performance. So, the present research intends to assess the employee's green behavior and perceptions shaping their attitude towards Environment-friendly practices relative their counterpart's traditional practices through HR policy.

DATA ANALYSIS

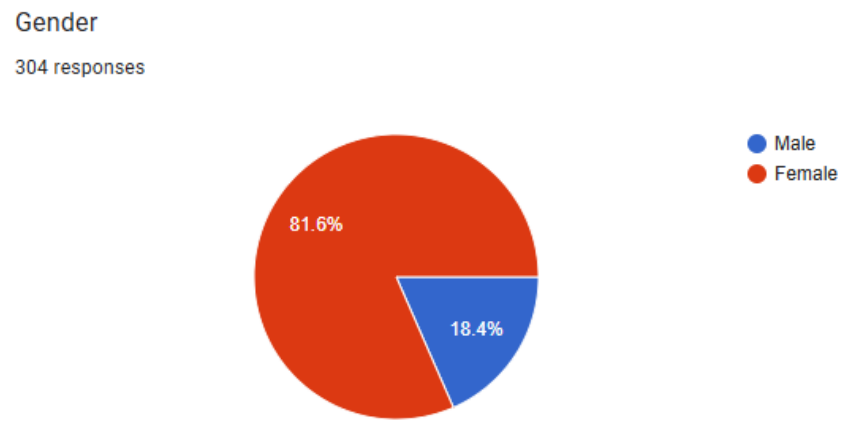

Figure 1: The proportion of men and women who responded

The figure depicts that 81.6% are the female respondents who are willing to be the part of the survey.

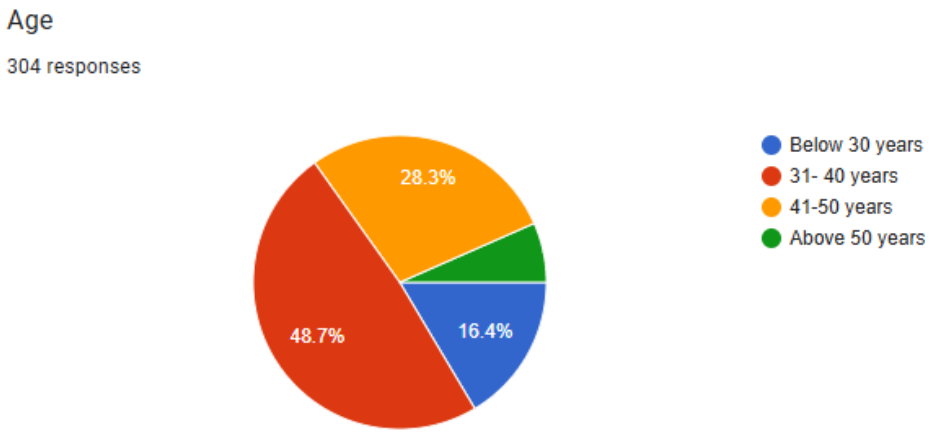

Figure 2 Percentage of age group of respondents

It has been clearly shown that 48.7% respondents are between 31-40 age group

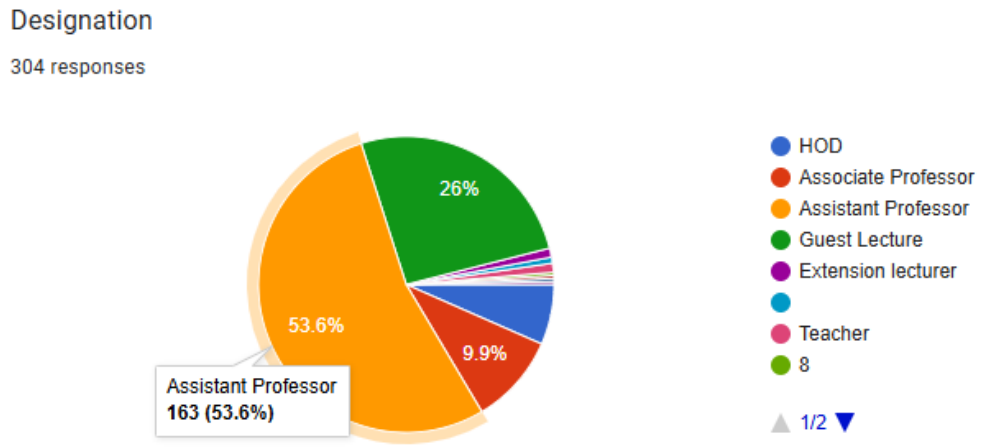

Figure 3 Percentage of designation of the respondents.

It has been observed that 163 out of 304 respondents i.e.53.6% are assistant professor who gave their idea about green HRM.

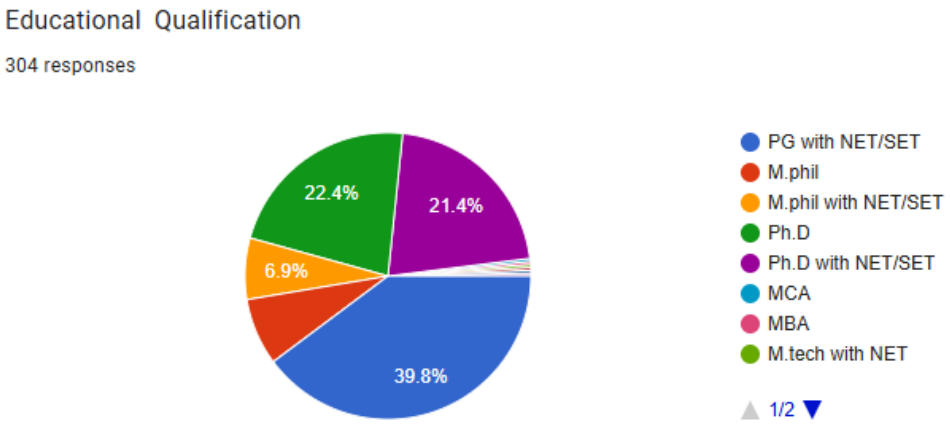

Figure 4 Percentage of educational qualification

It has been observed that 22.4% respondents are Post Graduate with NET qualified.

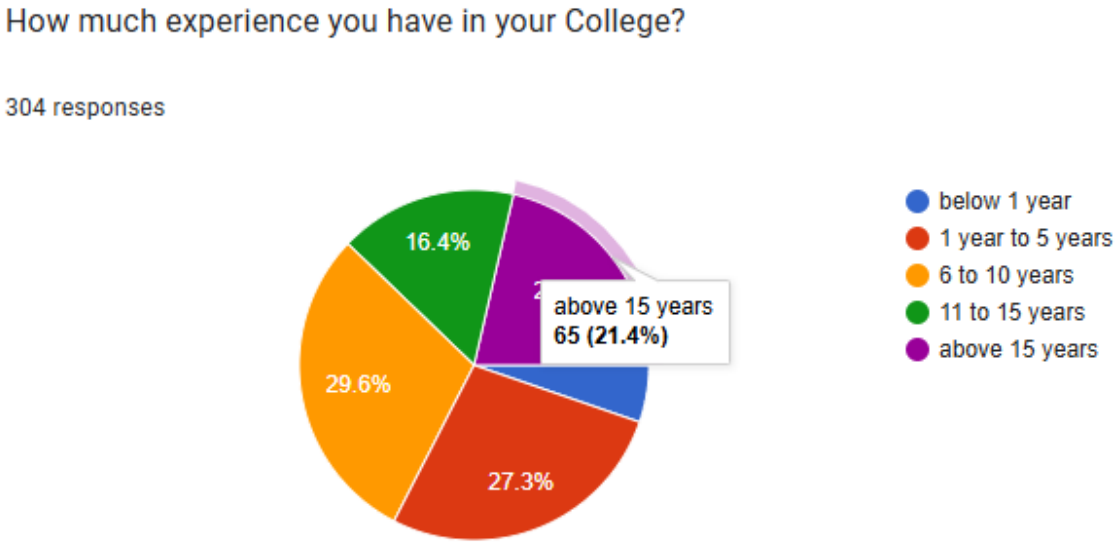

Figure 5: Percentage of experience of the respondents

It has been clearly visible that 29.6% respondents are having the experience of 6-10 years who gave their opinion about Green HRM survey.

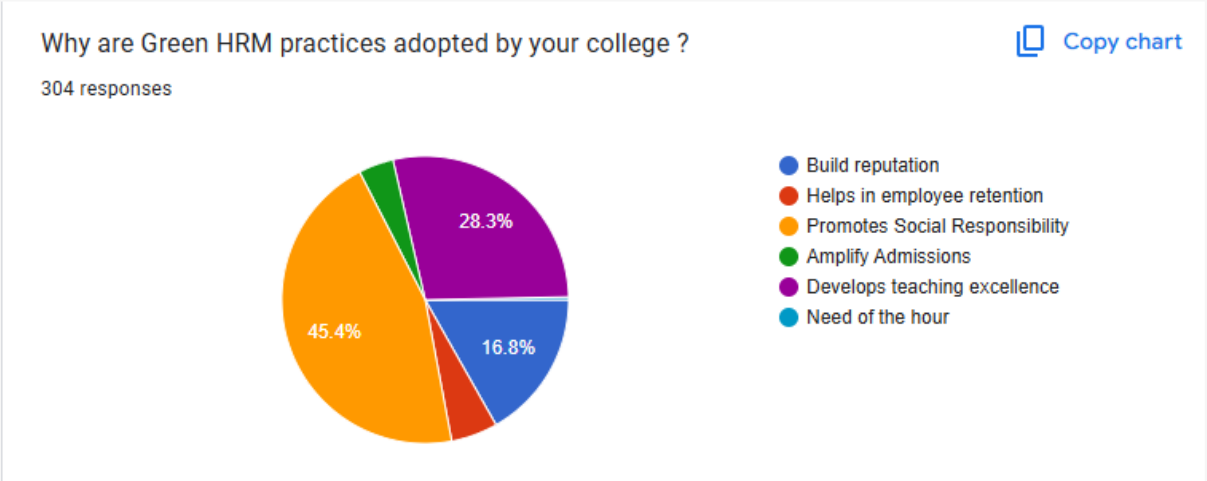

Figure 6 Institute's percentage of Green Percentage HRM Practices

It is clearly evident that 45.4% respondents think that it is the organization's social responsibility to follow the environment friendly practices.

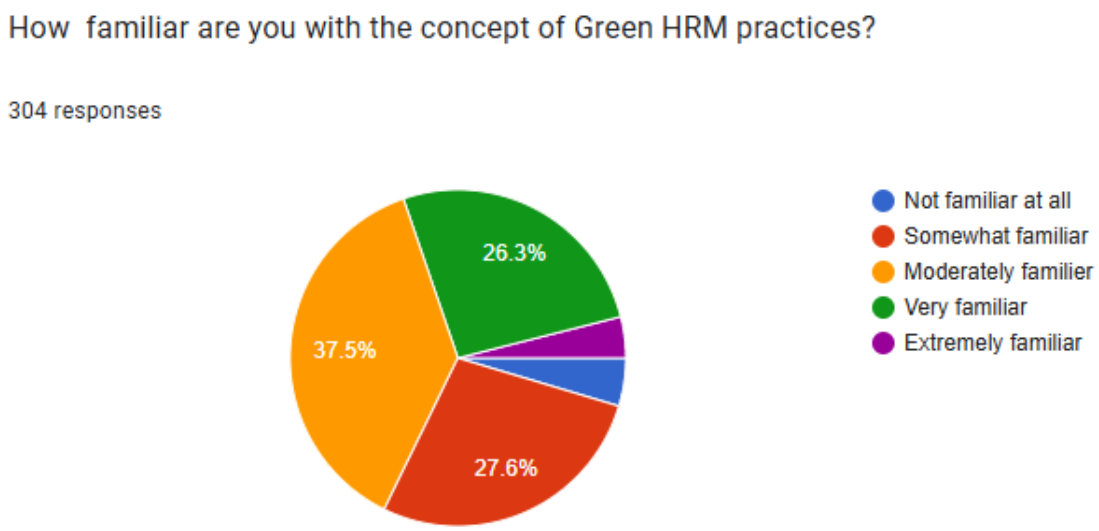

Figure 7 Proportion of the familiarity of the concept

It has been seen that 37.5% respondents are not very familier with the concept. They are only moderately familier with the concept of Sustainable People Management when they are asked.

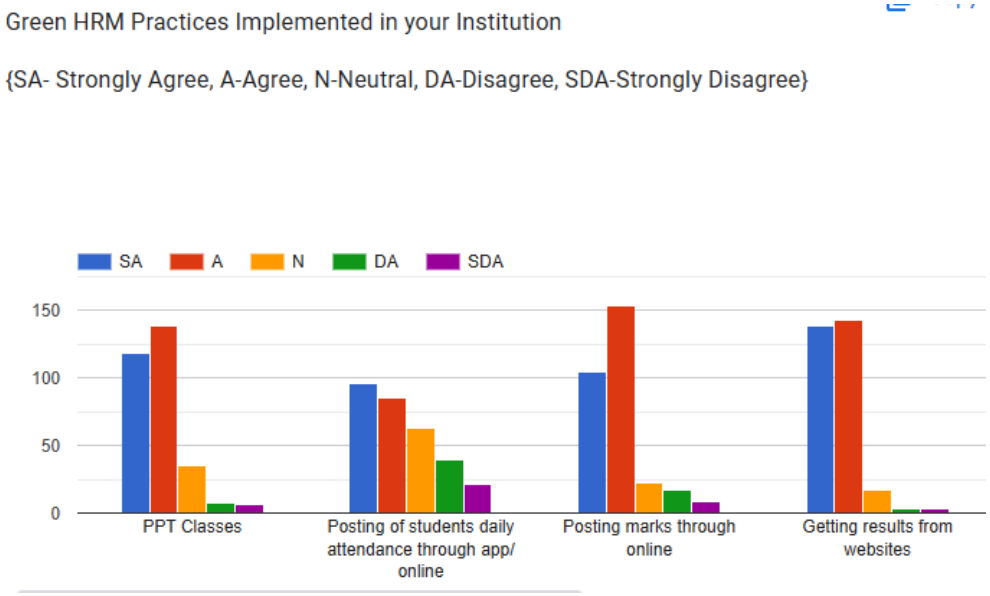

Figure 8 Percentage of the use of various practices by the faculty members in the institute In educational colleges, majority the respondents are using Green Practices only in the form of taking PPT classes, posting student's marks through online and taking results from websites for filing their ACR.

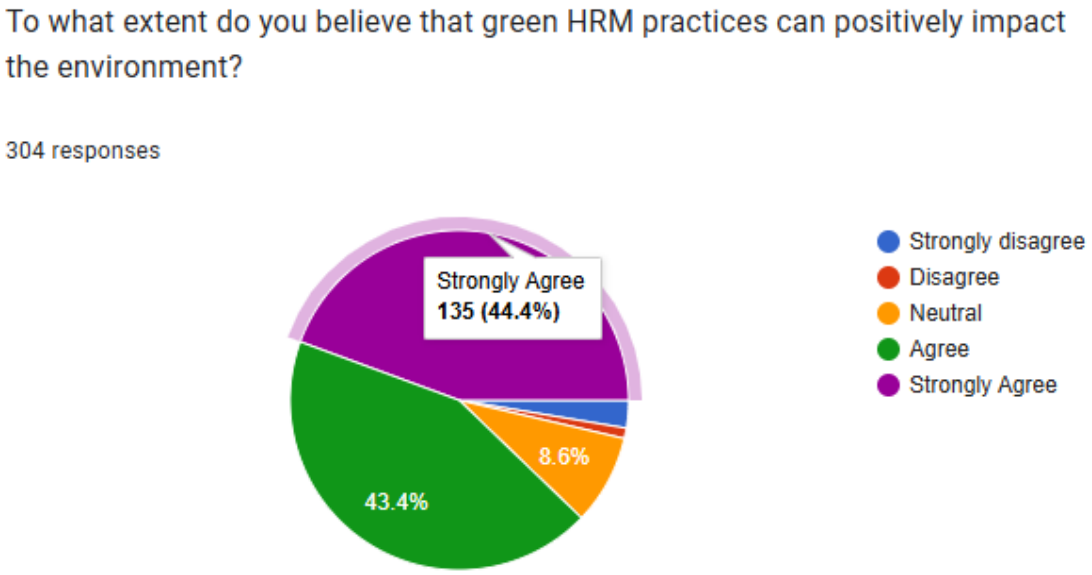

Figure 9 Percentage of respondent's view regarding Green HRM impact on environmrnt

It has been observed that 135 out of 304 respondent (44.4%) believe that influence of Green HRM Practices on the environment is positive.

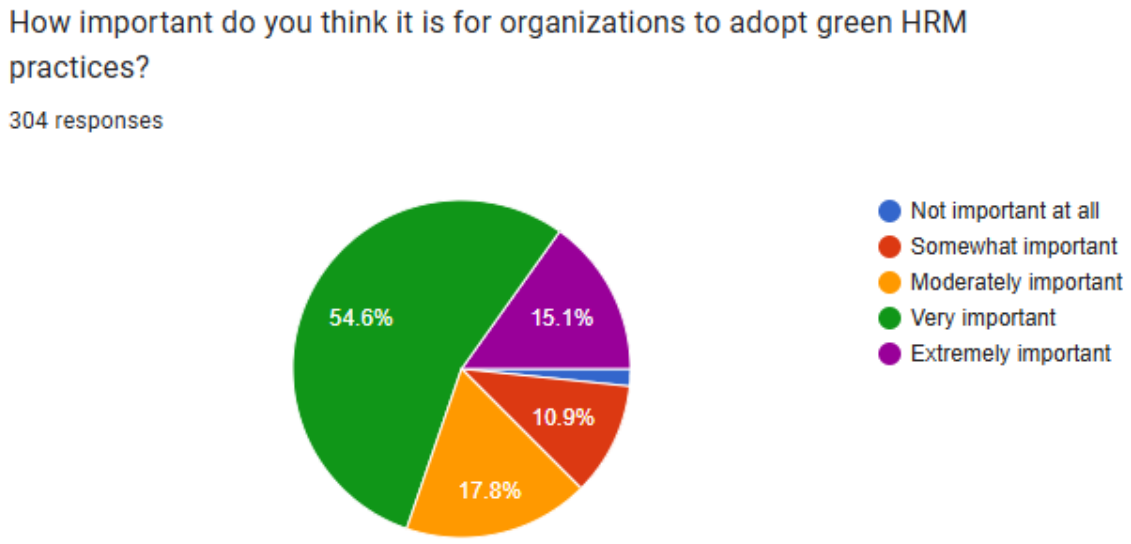

Figure 10: Percentage of importance of Green HRM Practices adoption in the colleges

According to the figure, 54.6% of respondents believe that implementing green HRM practices is crucial for the firm to protect the environment.

CONCLUSION

An overview of Green HRM practices in Higher Education Colleges is given in the aforementioned paper**.** Most of the respondents 45.4% are thinking that green practices are adopted by the colleges only for working on the part of fulfilling their social responsibility. They don't think that it is the demand of the hour. Among the respondents 37.5% are moderately familiar of the concept, not having complete knowledge of the concept. The Green Practices which are being followed by the college faculty members are posting marks through online portal, taking PPT classes for the students and also getting results from websites for the filing of ACR.

Green HRM practices can have a good environmental impact, according to 43.4% of respondents. Regarding awareness and the advantages of adopting green practices, the remaining respondents have no opinion. Given the significance of protecting the environment, 54.6% of respondents believe that implementing green practices within the company is crucial.

Thus, it can be said that Green HRM is a relatively new idea in educational institutions, particularly in Faridabad and Gurgaon colleges. College faculty members are not very much aware of the concept. They don't know how important it is for upcoming time to save the environment. Faculty members are practicing some green practices but not willingly, only due to the compulsion from the institution. So, there is a great need to make the faculty members understandable and aware about the significance

of practicing Green People Management Practices in the colleges. They should be motivated monetary as well as by giving them awards so that they would start doing green practices willingly by themselves.

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STUDY OF TRANSFORMATIONAL PRACTICES AMONG HUMAN RESOURCES WITH REFERENCES TO FACULTY OF EDUCATIONAL INSTITUTIONS OF FARIDABAD

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ABSTRACT

The process of incorporating digital technologies into all facets of education, such as teaching strategies, learning management systems, administrative duties, and student support, is known as "digital transformation in education institutions." This is done to improve student learning and optimise operations within educational institutions, frequently with the use of tools like interactive software, online learning platforms, and data analytics.

In higher education, digital transformation refers to the application of digital technology to alter the administrative, instructional, and learning processes. This can make faculty members' work more productive and efficient. Through the use of tools like Learning Management Systems (LMS), online collaboration platforms, data analytics, and interactive digital content, faculty members can provide students with more effective, personalised, and engaging learning experiences. This process is known as "digital transformation in education institutions for faculty members." The ultimate goal is to improve the teaching and learning process in an educational institution as a whole.

This research will serve as a digital transformation report card. Examining and comprehending a phenomena or topic in-depth is part of descriptive analysis through literature study (journal, conference proceedings, doctoral theses, dissertations, presentations, articles). The primary survey's structured questionnaire is a systematic method for collecting information from a sample of people. It is intended to assess the influence of different elements and analyse how human resources perceive the role of digitalisation in the education sector.

KEYWORDS

Digital transformation, teaching faculty, human resources, techniques adaptation

INTRODUCTION

By transforming corporate processes into digital format, digital transformation (DT) is the process by which an organisation embraces and uses digital technology to develop new goods, services, and activities, or alter existing ones.

Using digital technology in all aspects of teaching, learning, and administration is known as "digital transformation" in education. It is more than just the use of new technologies; it signifies a profound shift in the way educational institutions operate and engage with students. In order to improve learning results, promote accessibility, and get students ready for a digital future, the education

industry must undergo digital transformation. This will provide individualised learning, higher engagement, and more efficient procedures.

- **Early Adoption (Pre-2000s):**

Basic technologies like computers and the internet were employed for administrative duties and some basic instructional resources in the early phases of the digital revolution of education.

- **Rise of Online Learning (Post-2000s):**

The development of Massive Open Online Courses (MOOCs), Learning Management Systems (LMS), and other online learning platforms sparked a significant shift in education towards digitalisation.

- **Pandemic Acceleration (2020-Present):**

Schools and colleges quickly adopted online learning and remote teaching techniques as a result of the COVID-19 epidemic, which accelerated the digital transition.

- **Focus on Personalized Learning:**

Teachers can customise learning experiences to meet the requirements and learning preferences of each individual student thanks to digital technologies.

- **Data-Driven Decision Making:**

Institutions may better assess student performance, pinpoint areas for development, and allocate resources with the use of data analytics technologies.

- **Emerging Technologies:**

Emerging technologies like artificial intelligence (AI), virtual and augmented reality (VR/AR), and others have the potential to significantly change the educational landscape by opening up new avenues for instruction and learning.

- **Digital Literacy:**

Initiatives to enhance digital abilities have arisen as a result of the growing recognition of the value of digital literacy for both educators and students.

- **Global Accessibility**:

Geographical boundaries have been eliminated by digital revolution, enabling students in far-flung places to get high-quality instruction from any location in the world.

- **Increased Efficiency:**

Digital tools may increase communication, expedite administrative procedures, and boost overall productivity at educational establishments.

- **Challenges and Considerations:**

While there are many advantages to digital transformation, there are drawbacks as well, such the need to address issues of data security and privacy, provide fair access to technology, and prepare teachers for the new digital environment.

NEED FOR THE STUDY

One of the main pillars of the Sustainable Development Agenda of the United Nations for 2030 is high-quality education. It seeks to guarantee universal access to inclusive, superior education. For this, digital technology has become an essential instrument. According to studies showing the advantages of flexible, technology-enhanced, and customised learning strategies, the education industry must modify its teaching strategies to accommodate a variety of student demands and improve learning results. Digital technology use in education has become even more ingrained as a result of the on-going COVID-19 pandemic. Compared to a pile of notes, an iPad is comparatively light and serves as a mentor, assessor, and co-creator of material in addition to being a source of knowledge. A bulky paperback is harder to navigate than an e-book. These techniques help to raise curiosity about research. In addition to discussing the main uses and difficulties that teachers face in the classroom, the research has really attempted to investigate the necessity of digital technology in education.

STATEMENT OF THE PROBLEM

The primary objectives of this study are to establish a research framework and pinpoint the critical factors influencing the ability of teaching faculty to operate. The effectiveness of the college's digital practices is determined by the research, which also focuses on how teaching faculty members at higher education institutions apply and adhere to these practices. Understanding how digitisation enhances an institution's reputation will be made easier by the study. in addition to stressing the challenges of digitisation.

OBJECTIVES OF THE STUDY

To understand the awareness level of educational institutions regarding transformational practices.

To analysis the effects of transformation practices on human resources special reference to faculty members of educational institutions

To examine the frequent usage and recommendation of transformational practices.

HYPOTHESIS OF THE STUDY

Theories for the Digital Transformation of Educational Institutions' HR Procedures

1. The Impact of Perceived Utility (PU) on the Adoption of Digital Tools

H0 (Null Hypothesis): Perceived utility has little bearing on the uptake of digital HR solutions in educational institutions.

H (Alternative Hypothesis): Perceived utility has a significant impact on the uptake of digital HR

solutions in educational institutions.

2. The Impact of Perceived Ease of Use (PEOU) on the Adoption of Digital Tools

H_{o2}: Perceived ease of use has little impact on the uptake of digital technology in educational institutions.

H_{12}: Perceived ease of use has a significant impact on the adoption of digital HR technology in educational institutions.

3. The Impact of Relative Advantage (RA) on the Adoption of Digital Tools

H_{o3}: Relative advantage has little effect on the adoption of digital technology.

H_{13}: Relative advantage has a significant impact on the adoption of digital technology.

4. The Impact of Compatibility (COM) on the Adoption of Digital Tools

H_{o4}: The interoperability of digital technology with existing processes has little effect on adoption.

H_{14}: How efficiently digital HR solutions integrate with existing processes has a big influence on adoption.

5. The Impact of Complexity on the Adoption of Digital Tools (CPLX)

H_{o5}: The difficulty of understanding and using digital technologies has little effect on adoption.

H_{15}: The difficulty of understanding and using digital technologies has a significant influence on adoption.

6. Impact of Trialability (TRI) on Adoption of Digital Tools

H_{o6}: Trialability of digital tools does not significantly influence adoption.

H_{16}: Trialability of digital tools significantly influences adoption.

7. Impact of Observability (OBS) on Adoption of Digital Tools

H_{o7}: Observability of digital tools' benefits does not significantly influence adoption.

H_{17}: Observability of digital tools' benefits significantly influences adoption.

Moderating Effects:

8. How Facilitating Conditions (FC) Modify the Adoption of Digital Tools

H_{o8}: Facilitating settings do not substantially modify the relationship between independent variables and the use of digital technologies.

H_{18}: Facilitating circumstances significantly modify the relationship between independent variables and the use of digital technologies.

9. How Social Influence (SI) Modifies the Adoption of Digital Tools

H_{o9}: Social impact does not significantly modify the relationship between independent variables and the usage of digital technology.

H_{19}: Social impact significantly moderates the relationship between independent characteristics and digital technology use.

RESEARCH METHODOLOGY

Research Design

Primary and secondary data form the empirical basis of the design. The primary data used in the main study came from faculty members of government, government-aided, and private colleges who answered questions on a five-point Likert scale in well-structured, standardized questionnaires. Journals, magazines, reports, periodicals, newspapers, articles, research papers, websites, and library intranets were among the publications from which the secondary data was gathered.

Problem statement

The research will help to encounter the issue of the educational institution in the digital era.

Nature of the study

With particular reference to Faridabad, the current study focuses on transformational practices among higher education colleges teaching faculties.

Sample Size and Design

A sample of 245 responder of Faridabad institutions. Thus, 245 replies make up the study's sample size. The purpose of the sample design is to identify the unique characteristics of the teaching faculties' transformational Practices. Depending on the faculty members' availability and willingness to engage in the survey, convenience sampling was used to gather data from the respondents for the current study.

LITERATURE REVIEW

Higher education institutions' operations and curricula are changing dramatically. Numerous forces are driving these important shifts. Micro and nano degrees, digital transformation, online learning, students that are digitally savvy, and operating costs are a few examples of these impacts. Students employ the many tools that digital technology offer to expand their knowledge and integrate formalised learning settings into higher education training. Due to technological improvements brought about by the Industrial Revolution, higher education institutions (HEIs) are being compelled to deal with the digital transformation (DT) in all of its dimensions. 4.0. Since it enables us to characterise the many interactions between stakeholders in a digitally enabled teaching and learning context, the application of digital transformation approaches to the education sector is a recent field that has attracted attention. This study aims to provide an overview of the distinctive features of the digital transformation process in higher education establishments. Additionally, how digital learning fits into the modern higher education landscape. More study is needed to determine how higher

education institutions can meet the goals of the fourth Industrial Revolution while comprehending digital transformation.

According to McCowan et al. (2022), quality in higher education has become an increasingly pivotal issue. "Quality online teaching considers evaluating course characteristics, including the design of learning materials, the virtual environment, and the alignment of curricular components with learning outcomes" (Lobos et al., 2022, p.815564). In addition to introducing these pedagogical interventions, HEIshave focused on changing the curricula and disciplines and engaging with and creating possible affiliations with professional bodies. Various structural issues frequently impede the execution of academic development programs, such as the absence of robust, clear national laws, a shortage of facilitators, and faculty members' full teaching workloads, which leaves little time for professional development and restricted finance. This may be due to a general lack of funding in higher education or a priority placed on initiatives other than improving instruction (Hudson, 2017).3.2.1Teaching and LearningThe model by Berge (2008) aptly describes the changing role of the academic, albeit over a decade earlier. The model illustrates the transition from in-person to online with components of an instructor's involvement in social, managerial, technical, and pedagogical roles. Furthermore, the model is relevant in the current academic landscape as the aspects analysed fall under social, pedagogical, managerial, and technical roles. Therefore, the role of an academic is to serve as a mentor, guide, and coach in an online environment, a social role of creating a social environment online that promotes student cohesiveness and human relationships, a pedagogical role that involves keeping engagement on track and interacting and ensuring students contribute to the body of knowledge in the field, and the managerial role refers to monitoring and maintaining online teaching and learning interaction. Lastly, in a technical role, academics need to be confident in using information communication technology.

Adoption of Information Technology in Higher Education

Rogers (2003) defines innovation as new ideas, products, or techniques that the intended audience or group finds innovative. Often seen as a creative undertaking, e-learning makes use of web-based instructional resources. A conceptual framework for analysing the spread of innovations in this sector was developed from the Rogers et al. (2005) hypothesis (Hoehle et al., 2015; Alone, 2017). E-learning is one technology that is reliant on the IT infrastructure. One possible explanation for the adoption of e-learning technologies is the adoption model for information and communication technology. Davis released many models through T.A.M. that describe and forecast how people would utilise the technology. The technology acceptance model (T.A.M.) proposes two elements to depict technology usage: perceived usefulness and ease of use (Zhu et al., 2018). According to T.A.M., perceived

usefulness (P.U.) is the extent to which consumers think that using a certain invention will improve their performance. Perceived ease of use (P.E.O.U.) clients recognises that creativity enhances both mental and physical engagement. (2015) Hole et al. Martins and Nunes (2016) show how technology acceptance models affect e-learning systems' perceived usefulness, usability, and willingness to utilise them.

Motivation and Adoption of E-Learning

The disclosure to use e-learning technologies is illustrated in this study using Expectancy Theory. According to El-Seoud et al. (2014), the expectancies theory has two linked force and valence models, with the valence model showing how to achieve the crucial outcome. According to Ansong et al. (2017), e-learning technology adoption will often be more successful when the innovation is seen as beneficial to wellness and has the potential to convey value. According to Yilmaz (2017), motivation is the result of both internal and external factors that create a desire to pursue and maintain particular actions. With a fair amount of work, create a successful reception (Chen et al., 2016). The anticipation hypothesis on come can help users think more deeply about adoption behaviour and attitudes, according to earlier study by Zhu et al. (2018). By tracking customer views about e-learning technology and reasons for adopting it, Chen et al. (2016) used expectancy theory. Zhu and colleagues (2018); Chen and colleagues (2012). offer a better setup that allows inspiration to accurately predict the uptake of innovative e-learning. According to Meriem & Al Meriouh (2020), the adoption of e-learning technology may also be influenced by the motive for utilising it.

Perceived Ease of Use and Trust

The two primary individual trusts that influence technology adoption behaviour are perceived usefulness and ease of use, according to the Technology adoption Model. The T.A.M. model will integrate the Theory of Reasoned Action (T.R.A.) model, which was developed by Tarhini et al. (2017). The premise is that an individual's conduct and attitudes are influenced by their perceptions and reactions to situations. The term "P.E.O.U." refers to an individual's personal belief system that embracing technology is either easy or requires a lot of effort. Usability awareness and practicality influence the settings. Assess people's willingness to adopt technology (Serdyukov, 2017). The ability to employ innovation with ease is an indication or antecedent of trust (passionate and social attitudes), according to Dwivedi et al. (2017). The reasoning behind this is that customers are more inclined to trust a new product if they think it's simple to use, which in turn increases their willingness to utilise it. Furthermore, Mehta et al. (2019) show a relationship between perceived trust, adoption of new technology, and usability.

Trust and E-Learning Adoption

A key component in receiving progress is trust. Regard for information will increase with trust (Serdyukov, 2017). According to Kattoua et al. (2016), trust is linked to the veracity of the information source about developments. According to Almajali & Al-Lozi (2016), trust is a predictor of technology adoption. According to Pham et al. (2019), trust may also be defined as the belief that the technology will function as the customer has assumed. Accordingly, it is anticipated that clients would use technology more frequently the more they trust it to complete their workouts. Additionally, prior research supports a beneficial relationship between technology usage and trust. Sugandini et al. (2018a) and Zhu et al. (2018). According to Meriem & Al Meriouh (2020), the belief in the value of e-learning is one factor contributing to the adoption of e-learning technology.

Technology Readiness (T.R.) and E-Learning Adoption

Institutions can develop frameworks and systems that align with the measurement results for effective implementation by estimating e-learning readiness. However, generally speaking, e-learning readiness refers to an institution's preparedness to embrace e-learning, which entails being both physically and psychologically prepared to use e-learning technology (Markus & Cheng, 2020). Ling and Moi (2007) define technology readiness as people's propensity to adopt and use new technologies to accomplish tasks at work. T.R. is described as users' propensity to adopt new technology (Markus & Cheng, 2020). These beliefs fall into four categories, according to Parasuraman and Colby (2015): insecurity, discomfort, innovation, and optimism. According to Arani, Napitupulu, Jati, Kadar, and Syafrullah (2018), optimism and creativity may be seen as affirmative/contributor aspects on the other hand. According to Parasuraman & Colby (2015) and Ariani et al. (2018), the various aspects of T.R. influence adoption willingness independently of one another. The conclusions of a number of scholars, including Lai (2008) and Parasuraman & Colby (2015).

RESEARCH GAPS

Based on the study, the author has identified the following research gaps:

Impact of Digital Transformation on HR Practices

- While digital transformation is recognized as a global phenomenon, there is limited research specifically focusing on its impact on HR practices in educational institutions in Faridabad. Existing studies lack localized insights into how digital transformation influences recruitment, training, employee engagement, and retention in this region. (Localized Gap: Lack of region-specific insights into digital transformation in HR practices.)

Identification of Specific Digital Tools and Platforms

- There is insufficient research identifying the specific digital tools and platforms adopted by HR departments in educational institutions. While generic studies exist, the lack of detailed

exploration into tools tailored for the education sector limits the understanding of their effectiveness and usability. (Tool-Specific Gap: Insufficient focus on identifying and evaluating digital tools for HR in education.)

Understanding Challenges and Opportunities in Digital HR Integration

- Research on the challenges and opportunities faced during the integration of digital HR practices in the education sector is scarce. Particularly, studies fail to address region-specific challenges such as resistance to change, budget constraints, skill gaps, and infrastructure limitations in Faridabad's educational institutions. (Integration Gap: Minimal research on challenges and opportunities in digital HR integration in educational institutions.)

Providing Recommendations for Enhancing HR Effectiveness

- While there are generalized recommendations for HR effectiveness in the digital age, there is a gap in actionable and context-specific strategies for enhancing HR practices in Faridabad's educational institutions. The current literature lacks input from HR professionals, educators, and administrators in this localized setting. (Actionable Recommendations Gap: Need for tailored recommendations to improve HR effectiveness in the context of Faridabad's education sector.)

DATA ANALYSIS

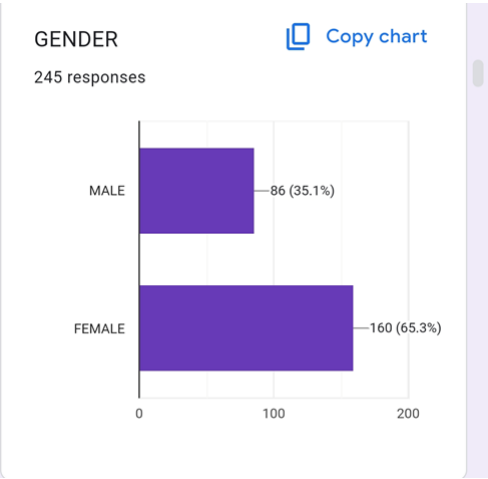


Figure 1 Percentage of respondents

It has been clearly shown that 65.3 % respondents are female who were interested to be the part of survey.

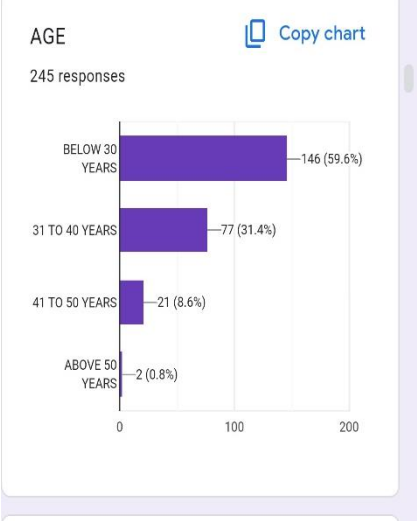


Figure 2 Percentage of age group of respondent

It has been clearly shown that 59.6% respondents are below 30 age group

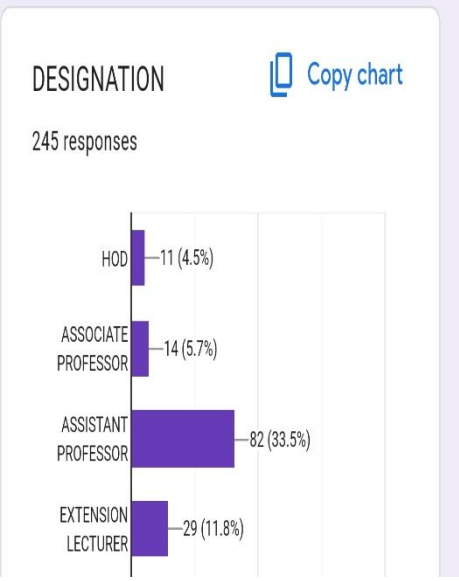


Figure 3 Percentage of designation of the respondents.

It has been observed that respondent 33.5% are assistant professor who gave their idea about digitalization

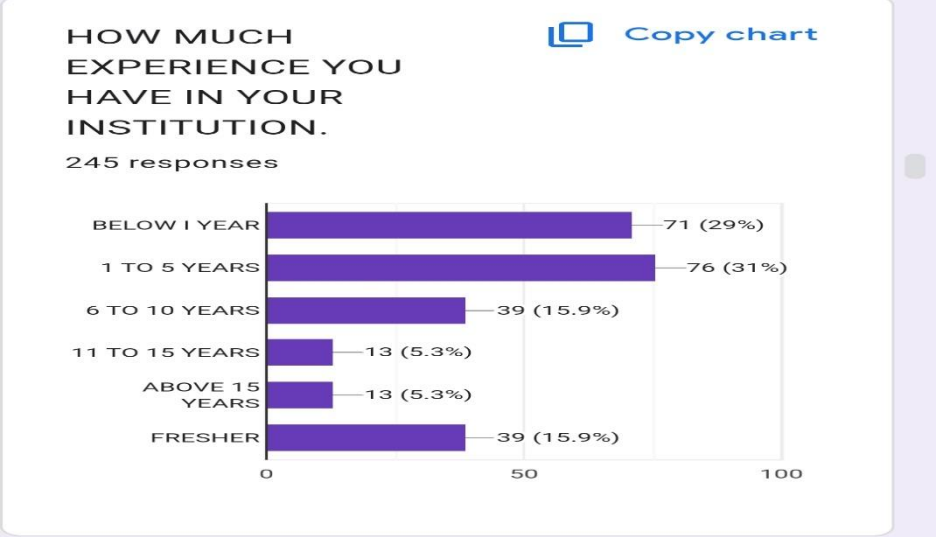


Figure 4 Percentage of expeience of the respondents.

It has been observed that 31% of the respondent having Experience from 1to 5 years

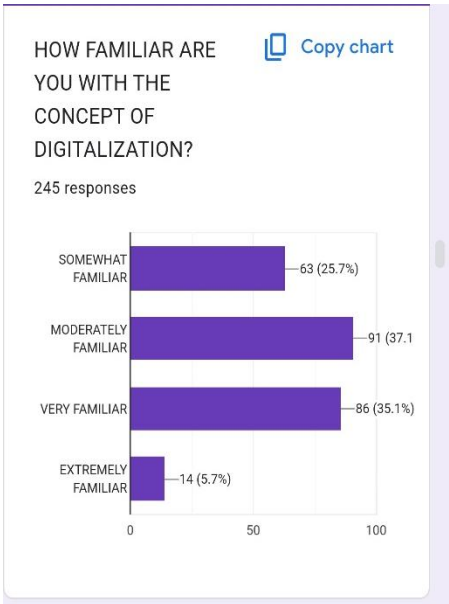


Figure 5 Percentage of respondent's familiarity about the concept of digitization,

It is clearly show that 37% respondents are moderately familiar with this concept.

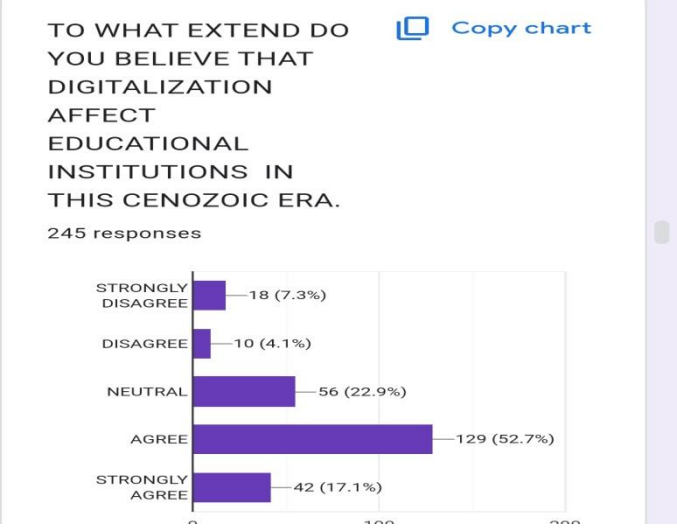


Figure 6 percentage of respondents who believes digitalization affects institutions

It is clearly shows 52.7% respondents believe that digitalization affects institutions

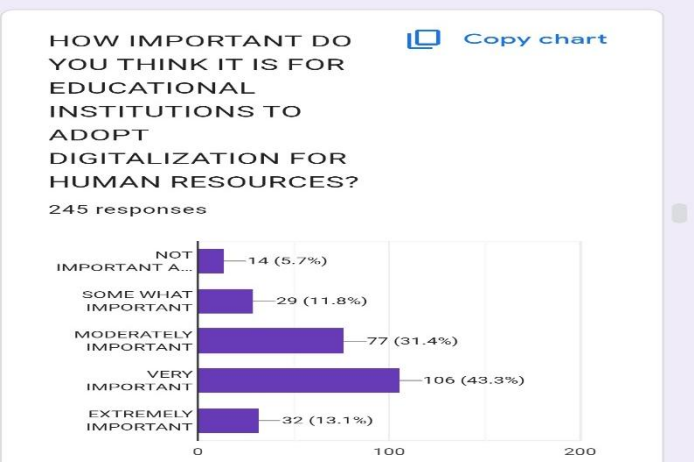
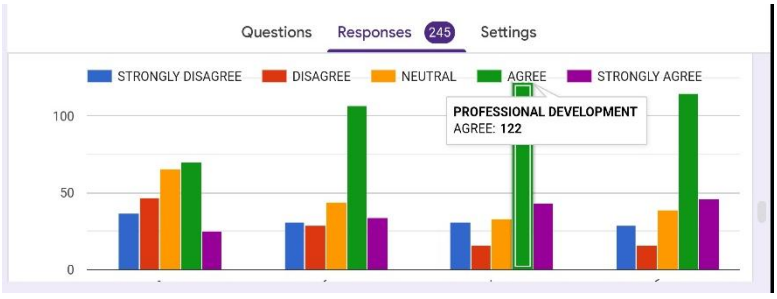


Figure 7 percentage of respondents who thinks digitalization should be adopted in institutions

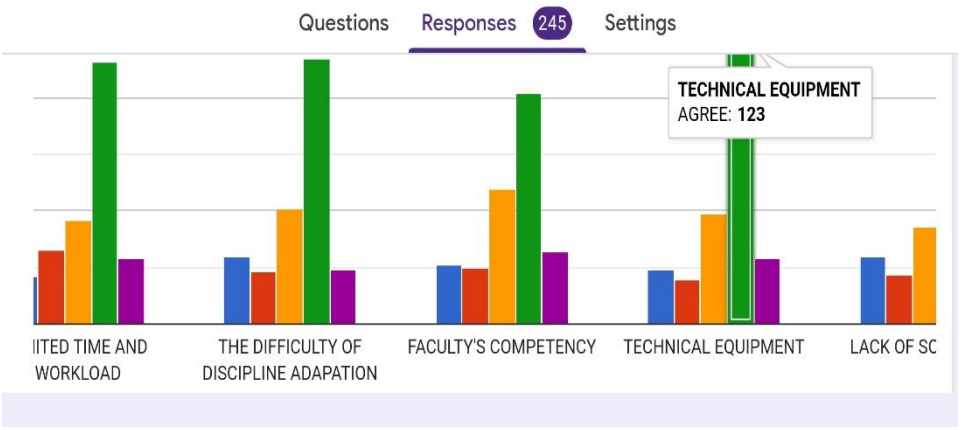
According to 43.3% of the respondents, digitalization is very important for the institutions

WHY DIGITALIZATION SHOULD BE ADOPTED BY YOUR INSTITUTIONS



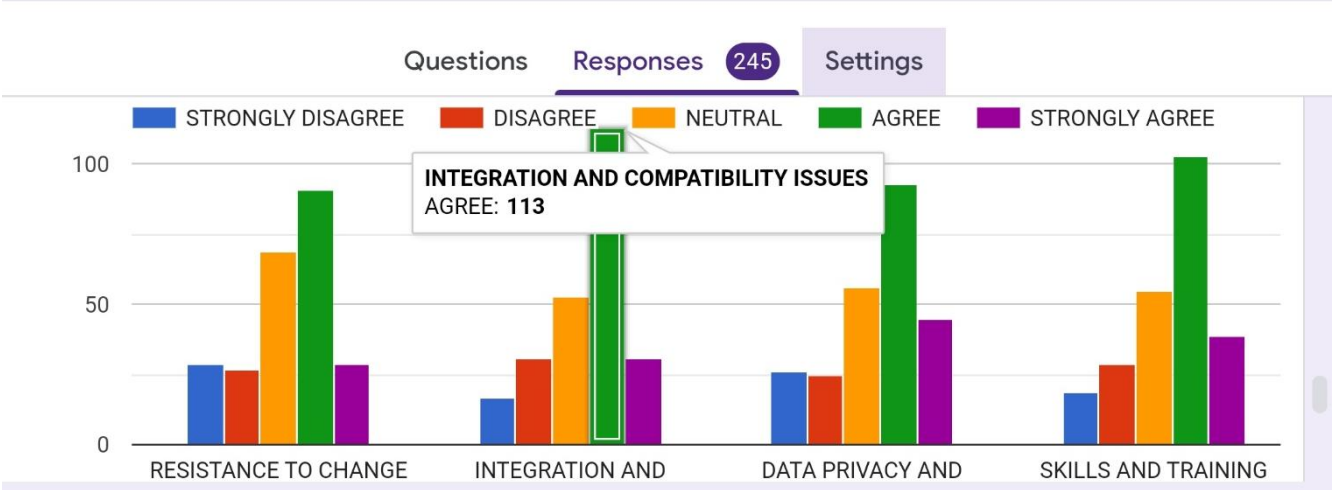
Out of 245, 122 respondents believe that for professional development of faculty digitalization in important to adopt.

RISK OF TRANSITION FROM TRADITIONAL TO DIGITAL TRANSFORMATION OF EDUCATIONAL INSTITUTIONS.



Out of 245, 123 respondent feels that lack of technical equipment create risk of transition in educational institutions.

POTENTIAL ROADBLOCK FACED BY TEACHING FACULTY DURING DIGITAL TRANSFORMATION IN EDUCATIONAL INSTITUTIONS



OUT OF 245, 113 respondents feels that integration and compatibility issues is the major roadblock faced by faculty members in educational institutions

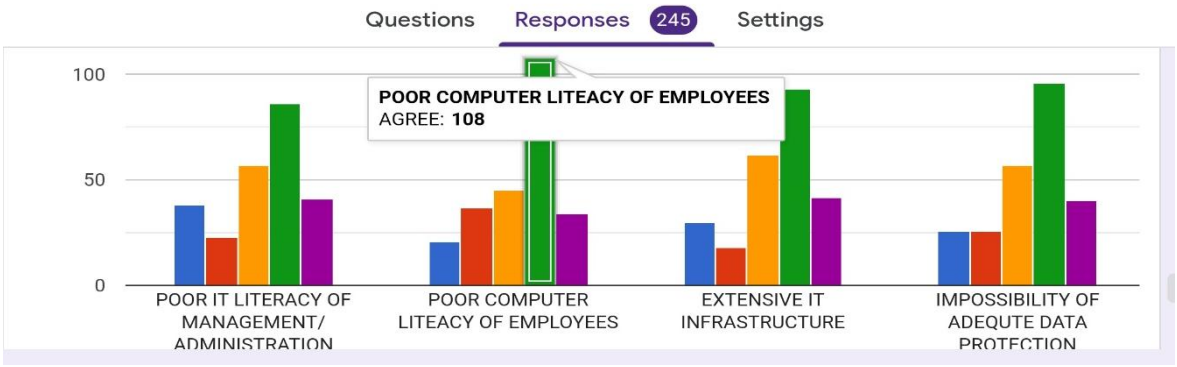
MAJOR TECH -ENHANCED PRACTICES IN EDUCATION INSTITUTIONS

Out of 245, 114 respondents believe that regular assessment of effective employees Performance can be major tech-enhanced practice for faculty in educational institutions

ENGA*GEMENT TIPS TO HELP WOKFORCE KEEP UP WITH DIGITAL TRANSFORMATION I EDUCATIONAL INSTITUTIONS*

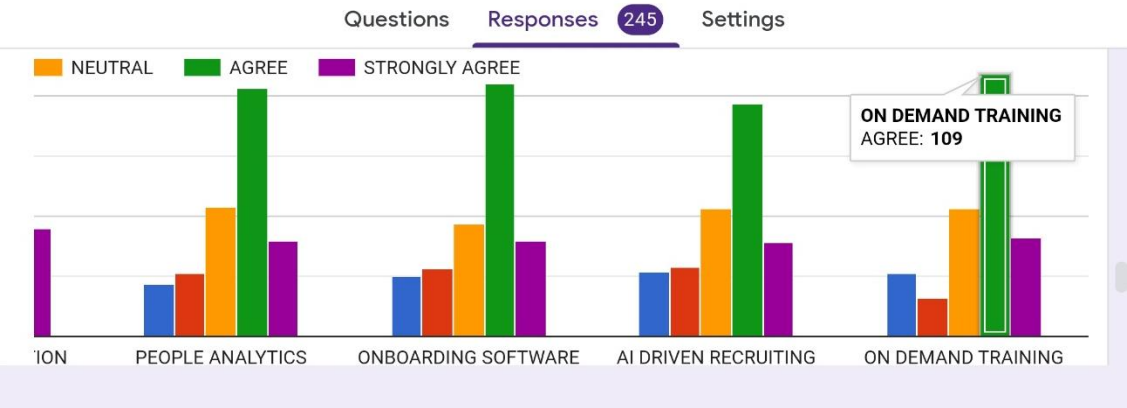
Out of 245, 120 respondents believes that investment in employees experience can be helpful for workforce to adopt digitalization

CHALLENGES FACED BY FACULTY IN ADOPTATION OF DIGITAL TECHNOLOGIES



Out of 245, 108 respondents believe that poor computer literacy is a big challenge faced by faculty members to adopt digitalization

ACCORDING TO YOU, WHICH FACTORS ARE NECESSARY FOR SUCCESSFUL IMPLEMENTATION OF DIGITALIZED HUMAN STRETEGY AT YOUR WORKPLACE.



Out of 245, 109 respondents believe on-demand training is a necessity for the successful implementation of digitalization for faculty at the workplace

Contribution of the study

In terms of elucidating the key elements, this study will be important. Organisations are becoming so digitally advanced that this role can outperform other support services. This revolution is changing how people view the value that human resources (FACULTY) offer to an organisation while also making sure that human resources play a bigger part in educational institutions. For organisations and suppliers of post-secondary education, this study offers several implications and suggestions. This study aims to investigate the digital transformation of human resources within the framework of the digital economy. It is underlined that while digital transformation helps businesses grow, its possible effects cannot be disregarded.

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CHARACTER DEVELOPMENT: DIVERGENCES AND CONVERGENCES IN A SONG OF ICE AND FIRE' AND 'GAME OF THRONES'

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ABSTRACT

This paper examines the differences and similarities in character development and arcs between George R.R. Martin's books "A Song of Ice and Fire" and the television series "Game of Thrones." This comparative analysis, which focuses on major characters like Jon Snow, Daenerys Targaryen, and Tyrion Lannister, looks at how narrative decisions made in both media affect character motives, portrayals, and overall plot arcs. The study intends to emphasize the challenges of turning a highly detailed literary work into a television series and the consequent impacts on character development by using a comparative textual analysis.

KEYWORDS

Character, Divergence, Convergence, George RR Martin, Game of Thrones

INTRODUCTION

Television series adaptations of literary texts provide an intriguing prism through which to study modifications to character and story structure. George R.R. Martin's epic fantasy series "A Song of Ice and Fire" is the inspiration for HBO's "Game of Thrones," one of the most well-known examples of such an adaptation. Due to their enormous popularity, positive reviews, and passionate fan bases, both the television show and the novels would be excellent subjects for comparison research.

Character arcs will always vary and become similar as a result of the many narrative choices made when converting an extensive and intricate book series into a television format. Tyrion Lannister, Daenerys Targaryen, and Jon Snow are the three main characters that this essay will be examining in order to examine these divergences and convergences. All of these characters go through a great deal of development in both the books and the TV show, but there are some noticeable differences in how their travels are presented in each media.

George R.R. Martin uses deep introspective inner monologues and nuanced characterizations in his novels to show the complexity of his characters. Over the course of multiple novels, this literary technique enables a leisurely, in-depth investigation of motivations, internal conflicts, and progressive development. Readers are able to examine and comprehend the thoughts and feelings of characters such as Tyrion, Daenerys, and Jon, as they are portrayed with layers of psychological complexity. The

novels' intricate plotlines and different points of view enhance the way these characters are portrayed by providing a variety of viewpoints on their development and challenges.

On the other hand, "Game of Thrones" on television reduces and modifies these vast stories to meet the limitations of episodic storytelling. Character development on television requires a different strategy, one that frequently puts dramatic action, dialogue, and visual storytelling ahead of internal monologues. Consequently, the arcs of the characters can be more succinctly written, emphasizing important plot aspects and character attributes to keep the audience interested and move the story along in a condensed amount of time. Variations in character representation are also a result of the collaborative nature of television production, which involves writers, directors, performers, and producers. Each of these parties gives their unique interpretation and creative vision to the adaptation. Through a comparative analysis of the character arcs of Jon Snow, Daenerys Targaryen, and Tyrion Lannister, this essay aims to show how narrative choices made in the television series and the novels impact character motivations, growth, and overall storylines. We will examine how the particular potential and limitations of each media influence the presentation of these characters through a thorough comparative examination, ultimately adding to the larger knowledge of adaptation as a dynamic and transformational process. This investigation will shed light on the challenges involved in adapting a well-loved literary work for a new media, emphasizing the tension that exists between maintaining the original work's integrity and using creative license to fit the new format.

REVIEW OF THE LITERATURE

The literature review will look at previous studies on adaptations, with a particular emphasis on character development and narrative adaptation theories. Important texts are "Adaptations: From Text to Screen, Screen to Text," by Deborah Cartmell and Imelda Whelehan, "Literature Through Film," and "A Theory of Adaptation" by Linda Hutcheon. Scholarly analyses of "A Song of Ice and Fire" and "Game of Thrones" will also lay the groundwork for comprehending critical viewpoints on character adaptation.

OBJECTIVES

- Analysis of character development theories and how they apply to literary and screen adaptations.
- Examination of scholarly articles and essays on 'A Song of Ice and Fire' and 'Game of Thrones' character portrayals.

METHODOLOGY

A comparative textual analysis method is used in this study. We will find and examine the main character development divergences and convergences by focusing on particular scenes, dialogues, and interactions in both the novels and the television series. All of the published books in the "A Song of

Ice and Fire" series and every episode of "Game of Thrones" will be used as primary sources. Fan analyses, creator interviews, and critical writings will all be used as secondary materials.

ANALYSIS

Jon Snow

1. **Novels**

- In the novels, Jon Snow's character path is incredibly introspective, with inner monologues disclosing his inner conflicts, uncertainties, and developing sense of responsibility.
- Important connections, like those with Stannis Baratheon and Ygritte, are thoroughly examined, which helps him develop as a leader.
- Readers are left wondering about Jon's future function because the novel's (up to the most recent novel published) depictions of his resurrection are left open-ended.

2. **Television Series**

- Jon Snow's persona in 'Game of Thrones' is characterized as a conventional hero, with a great deal of focus on his choices and deeds.
- A significant departure from the books is his relationship with Daenerys Targaryen, which gives his character's motivations and allegiances a more nuanced depth.
- More details are revealed about Jon's resurrection and ensuing leadership arc, which set up his eventual destiny in the series finale.

Daenerys Targaryen

1. **Novel**

- Over the course of the novels, Daenerys transforms from a shy young woman into a strong and frequently brutal commander.
- Through in-depth inner monologues and conversations with her advisors, her psychological struggles and moral quandaries are examined.
- Numerous subplots are included in her storyline, including her marriage to Hizdahr zo Loraq and her battles to keep control of Meereen.

2. **Television Series**

- 'Game of Thrones' Daenerys's arc is primarily about her ascent to power and her goal of turning the tyrannical wheel.
- Her connection with Jon Snow and her increasingly erratic decision-making, which culminated in her contentious turn towards destruction, are highlighted throughout the series.
- Her more gradual evolution in the novel’s contrasts with her sudden transformation into a despotic dictator in the last season.

Tyrion Lannister

1. **Novel**

- The novels' portrayal of Tyrion's character delves deeply into his psychological complexity, examining his intelligence, fears, and wants for vengeance and recognition.
- After Tywin's death, he embarks on a trip that entails extensive wandering, introspection, and allegiance with several factions.
- Along with his dark humor and psychological conflicts, Tyrion's intellect and strategic thinking are constantly emphasized.

2. **Television Series**

- While Tyrion in "Game of Thrones" still possesses a great deal of wit and intelligence, the show's hurried pace occasionally obscures his character's complexity.
- His character evolution is influenced by his relationships with other important characters, including as Varys and Daenerys, who receive greater screen time.
- His personal struggles and political ploys are occasionally oversimplified in the series, especially in the later seasons.

DISCUSSION

This section explores the causes of the character development differences and similarities between the television show and the novels. Considerations include the collaborative nature of television production, viewer expectations, and narrative limits. It is also examined how these variations affect the main plot and how the audience responds to it.

Factors Influencing Divergences:

1. **Narrative Constraints:**

Television series often condense and simplify plotlines due to time limitations.

Time Restrictions: Television shows must adhere to strict time restrictions. A season can only have a certain amount of episodes, and each episode usually lasts between 45 and an hour. On the other hand, novels have no set length and can contain hundreds of pages, which means that characters and subplots can be explored in greater detail.

Plotline Condensation: Because of these time limits, complicated plotlines are frequently streamlined and simplified in television programs. This may result in the novels' supporting casts, subplots, and in-depth backstories being left out. Character development might therefore be sped up or changed to accommodate the allotted screen time.

Example: For instance, several character relationships and storylines are simplified or eliminated entirely in the television series "Game of Thrones." For example, Jon Snow's

relationships with different Night's Watch members and his intricate political schemes at the Wall are covered in greater detail in the novels. But in order to concentrate on the main story, the television show distills these exchanges, which occasionally oversimplifies Jon's character development.

2. **Audience Expectations:**

Adapting for a broader audience can lead to changes in character arcs to enhance viewer engagement.

Broader Audience Appeal: Compared to novel readers, television adaptations are meant to appeal to a larger and more varied audience. Viewers with different cultural origins, varying degrees of knowledge with the original material, and different tastes for pacing and storytelling styles can all be part of this larger audience.

Enhanced Viewer Engagement: Television shows frequently modify character arcs to increase drama, conflict, and emotional effect in order to sustain high viewership and engagement. To make characters more likable or interesting for the audience, this may entail emphasizing particular characteristics, establishing new relationships, or changing motivations.

Example: In the television series, Daenerys Targaryen's persona is mostly focused on her romantic connections and her aspiration to the Iron Throne. She has a relationship with Jon Snow, but their relationship is not as developed in the novels. This relationship is a major storyline aspect that the television viewers will find emotionally charged and dramatic.

3. **Collaborative Nature:**

Television adaptations involve multiple creators and actors, leading to variations in character portrayal.

Multiple Creators and Influences: The process of adapting a television show involves a team effort amongst writers, directors, producers, and performers, all of whom contribute to the final character portrayals. Character growth may vary as a result of this partnership depending on various creative interpretations and perspectives.

Actor Influence: How characters are viewed and developed can be greatly influenced by the portrayals of actors. Different interpretations of a character or charismatic performances may result in departures from the original work. Character dynamics and relationships can also be influenced by the chemistry between actors.

Impact on Storytelling:

Character Complexity: The depth of character development in novels is often reduced in television adaptations.

Narrative Pacing: Television series may accelerate or alter character arcs to fit episodic structures.

Viewer Reception: Differences in character portrayal can influence audience perception and critical reception.

CONCLUSION

The intricate relationship between creative reinterpretation and narrative integrity is exemplified by the transformation of "A Song of Ice and Fire" into "Game of Thrones." The television series adjusts these character arcs to match the visual and temporal limits of the medium, whereas the novels offer a highly introspective and nuanced representation of characters. Comprehending these differences and similarities enhances our understanding of this epic saga's written and televised versions.

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MATHEMATICAL MODELING IN BIOLOGY AND MEDICINE: INFECTIOUS DISEASE SPREAD, TUMOR GROWTH, AND BRAIN ACTIVITY

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ABSTRACT

Mathematical modeling plays a crucial role in understanding complex biological and medical phenomena. In this paper, we explore three significant applications: (1) modeling the spread of infectious diseases using SEIR (Susceptible, Exposed, Infected, Recovered) models with stochastic components, (2) tumor growth modeling using partial differential equations (PDEs), and (3) neural field models for brain activity. Each topic demonstrates how mathematical approaches can provide insights into disease dynamics, cancer progression, and neural interactions. By employing both deterministic and stochastic methods, we highlight the adaptability of mathematical models to real-world data and their utility in medical decision-making.

KEYWORDS

Mathematical modeling, SEIR, Tumor Growth, neural field.

INTRODUCTION

Mathematical modeling has become an indispensable tool in understanding and predicting biological and medical systems. It enables researchers and healthcare professionals to simulate real-world phenomena, test hypotheses, and design effective interventions. This paper discusses three major areas of applied mathematics in biology and medicine: infectious disease dynamics, tumor growth, and brain activity.

1. Modeling the Spread of Infectious Diseases (SEIR Models with Stochastic Components)

Infectious diseases continue to pose significant challenges to public health systems across the globe. The ability to accurately model and predict the spread of such diseases is crucial for designing effective intervention and control strategies. Mathematical models, particularly compartmental models such as the SEIR (Susceptible-Exposed-Infected-Recovered) framework, have been widely used in epidemiology to understand disease dynamics. These models divide the population into discrete compartments based on disease status and use differential equations to describe the rate of movement between compartments.

The classical SEIR model assumes a deterministic environment where the parameters governing disease transmission and progression remain fixed over time. While this provides a foundational understanding of disease spread, it often falls short in capturing the inherent randomness and

variability observed in real-world outbreaks. Factors such as individual behavior, environmental influences, random contacts, and heterogeneity in susceptibility contribute to unpredictable patterns in disease transmission.

To address these limitations, **stochastic SEIR models** have been developed by incorporating random variables and probabilistic transitions into the model structure. These models allow for the simulation of multiple possible outbreak scenarios, thereby offering a more nuanced understanding of the uncertainty and variability associated with infectious disease spread. Stochastic modeling techniques such as continuous-time Markov chains and stochastic differential equations introduce random noise into the system, enabling researchers to assess the likelihood of extreme outcomes, evaluate the impact of control measures under uncertainty, and improve the robustness of public health planning.

1.1 SEIR Model Overview

The SEIR model is a compartmental model used to represent the dynamics of infectious diseases. It divides the population into four compartments:

- **S (Susceptible)**: Individuals who have not yet contracted the disease.
- **E (Exposed)**: Individuals who have been exposed to the disease but are not yet infectious.
- **I (Infected)**: Individuals who are capable of spreading the disease.
- **R (Recovered)**: Individuals who have recovered and are immune.

1.2 Deterministic SEIR Model

The standard deterministic SEIR model can be expressed using the following system of differential equations:

$$\frac{dS}{dt} = -\beta.\frac{S.I}{N}$$
$$\frac{dE}{dt} = \beta.\frac{S.I}{N} - \sigma.E$$
$$\frac{d\mathrm{I}}{dt} = \sigma E - \gamma I$$
$$\frac{dR}{dt} = \gamma I$$

Where:

- β: Transmission rate
- σ: Rate of progression from exposed to infected
- γ: Recovery rate
- N: Total population size

1.3 Incorporating Stochasticity

In reality, biological systems often exhibit randomness due to factors such as population size and variation in individual behaviors. To account for this, we modify the SEIR model with **stochastic components**:

- **Stochastic Differential Equations (SDEs)** are used to model the random fluctuations in the spread of disease. For example:

$$dS = -\beta SIdt + \sigma_s dW_S(t)$$

Where $dW_S(t)$ represents a Wiener process (random noise), and σ_S is a parameter controlling the noise intensity.

1.4 Applications and Insights

Stochastic SEIR models are crucial in predicting the spread of infectious diseases, especially during outbreaks. They help to estimate the likelihood of disease spread, inform public health policies, and evaluate intervention strategies.

2. Tumor Growth Modeling Using Partial Differential Equations (PDEs)

Cancer remains one of the leading causes of mortality worldwide, posing complex biological and clinical challenges. Understanding the mechanisms behind tumor development and progression is crucial for improving diagnosis, treatment, and patient outcomes. While experimental and clinical studies provide essential insights, mathematical modeling has emerged as a powerful complementary approach to investigate tumor dynamics in a systematic and quantitative manner.

Among various mathematical tools, **partial differential equations (PDEs)** have proven particularly effective in modeling tumor growth. PDEs allow for the description of spatial and temporal changes in cell density, nutrient concentration, and other key biological factors. These models capture the diffusion, proliferation, and interaction of tumor cells within their microenvironment, providing a framework to study the spatial heterogeneity and invasive behavior characteristic of many solid tumors.

PDE-based tumor models can range from simple reaction-diffusion systems to complex, multiphase models that incorporate angiogenesis (blood vessel formation), tissue mechanics, and immune responses. They offer the ability to simulate tumor expansion, predict patterns of invasion, and evaluate the efficacy of therapeutic strategies. Importantly, these models can be calibrated with experimental or clinical data to reflect patient-specific tumor behavior, opening avenues for personalized medicine

2.1 Overview of Tumor Growth Models

Cancer growth is a complex, nonlinear process involving cell proliferation, death, and interaction with the surrounding tissue. Mathematical models are used to describe tumor growth dynamics and predict the progression of cancer.

2.2 PDE Models for Tumor Growth

A commonly used model for tumor growth is the **reaction-diffusion equation**, which accounts for the movement of tumor cells through tissue and the competition between cell growth and death:

$$\frac{\partial u}{dt} = D\nabla^2 u + ru(1 - \frac{u}{K})$$

Where:

- $u(x, t)$: Tumor cell density at location xxx and time ttt
- D: Diffusion coefficient of tumor cells
- r: Growth rate of tumor cells
- K: Carrying capacity (maximum number of cells the tissue can support)
- ∇^2 : Laplacian operator (accounts for cell movement)

2.3 Tumor Invasion and Treatment

PDE models can also include terms representing the effects of treatments like chemotherapy, radiation, or immune system response. Tumor invasion models help to simulate the spread of tumor cells to other parts of the body, such as lymph nodes or distant organs, providing insight into metastasis.

2.4 Numerical Simulations and Clinical Relevance

Using computational tools, we can simulate tumor growth in 3D space and predict the outcome of different treatments. These models are crucial for personalized medicine, where treatments can be tailored to the individual patient's tumor dynamics.

3. Neural Field Models for Brain Activity

Understanding the complex dynamics of brain activity is one of the most important and challenging goals in neuroscience. The brain operates as a highly interconnected system where electrical signals propagate across populations of neurons, producing patterns that underlie cognition, perception, and behavior. To study these large-scale neural interactions, researchers often turn to **neural field models** a class of mathematical models that describe the evolution of brain activity over continuous spatial domains.

Neural field models are based on integro-differential equations or partial differential equations (PDEs) that represent the average activity of large ensembles of neurons across regions of the brain. Unlike discrete neuron models that focus on individual cells, neural field models take a **mesoscopic** approach,

capturing the **spatiotemporal dynamics** of neural populations. These models account for important neurobiological features such as synaptic connectivity, transmission delays, and cortical geometry.

One of the key strengths of neural field models is their ability to reproduce and analyze a wide range of brain phenomena, including **wave propagation, oscillations, pattern formation,** and **seizure dynamics**. They are used to explore fundamental questions in brain science, such as how visual hallucinations arise, how memory is stored, and how pathological states like epilepsy emerge. Additionally, neural field theory provides a mathematical framework for interpreting data from techniques like EEG, MEG, and fMRI.

3.1 Introduction to Neural Field Models

Neural field models are used to study the collective dynamics of large-scale neural activity in the brain. These models describe how neural activity spreads and interacts across regions of the brain.

3.2 Mathematical Framework

A common form of neural field model is based on the **integral-differential equation**:

$$\tau \frac{\partial u(x,t)}{\partial t} = -u(x,t) + \int_{\mathbb{R}} K(x,y) f\big(u(y,t)\big) dy + I(x,t)$$

Where:

- $u(x,t)$: Neural activity at position xxx and time t
- τ: Time constant
- $K(x,y)$: Connectivity kernel that defines how activity at location y influences activity at location x
- $f(u(y,t))$: Nonlinear activation function (e.g., sigmoid or Heaviside function)
- $I(x,t)$: External input (e.g., sensory stimuli)

3.3 Applications

- **Cognitive Processes**: Neural field models help in understanding how brain regions interact during cognitive tasks such as memory, perception, and motor control.
- **Epilepsy**: These models can also be used to simulate seizures and develop potential treatment strategies.
- **Neural Oscillations**: Studying oscillatory brain activity (such as alpha, beta, and gamma waves) can help identify abnormalities in neural synchronization.

3.4 Numerical Simulations and Visualization

Neural field models are often solved numerically using finite difference methods or spectral methods to simulate brain activity patterns. These simulations help in understanding spatial and temporal patterns of brain waves and provide insights into neurological diseases.

CONCLUSION

Mathematical modeling in biology and medicine provides invaluable insights into complex systems such as infectious diseases, cancer, and brain activity. By using a variety of techniques, from stochastic differential equations in epidemic modeling to partial differential equations in tumor growth and neural field models in brain research, mathematical models help to bridge the gap between theory and clinical applications. These models not only advance scientific understanding but also play a crucial role in decision-making and treatment planning in healthcare.

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GASTROINTESTINAL NEMATODE INFESTATION PROFILE OF GOAT AND SHEEP IN AND AROUND CHALISGAON TAHASIL IN NORTH MAHARASHTRA

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ABSTRACT:

The dairy products, meat and the related livestock are the important part of the economy of any country. The dairy products and meat are the major source of most of the nutrients including proteins. Therefore it becomes necessary to take care of livestock which provide nutrition to human being and some other animals' also. Rearing of livestock and the products produced from them forms the economic backbone of any country. But the parasitic infections in all the ruminants including goat and sheep are major problem. These parasites are of two types: Endoparasites and Ectoparasites among which Helminth Parasites cause ill effects on health of goats and sheep. This results in causing different diseases in them which is responsible for vast economic loss of all the stakeholders. Gastrointestinal Nematodes amongst the helminthic group are having significant role in causing this economic loss. Different GIN nematodes can infect sheep and goat including Haemonchus, Trichostrongylus, Bunstomum, Nematodirus, Oesophagostomum, Trichuris etc. The overall prevalence of gastrointestinal nematode infections of goat and sheep is found more as compared to other helminthic parasites in the present study area. The seasonal influence was found more effective on the prevalence of Nematode infection in goat and sheep from the present study area. The results found in above study will surely help the farmers and related stakeholders for proper management practices which can be used further for adopting different preventive control measures in rearing of goats and sheep.

KEYWORDS

Livestock, sheep, goat, parasite, endoparasite, ectoparasite, ruminant, gastrointestinal ruminants, prevalence, management, preventive.

INTRODUCTION

A parasite is an organism that lives in or on the host and takes it's nourishment from host animal. In case of farm animals these parasites play an important role which is related with the health and hygiene of animals, economical condition of farmer, and other stakeholders. Wide range of parasites including helminthes (worms), arthropods (lice, tick, mite, mosquito), cestodes (tapeworms), protozoans, trematodes are causing infection in farm animals. Over 1000 species of parasites are

affecting the domesticated animals all over the world which are classified as Endoparasites and Ectoparasites.These parasites are responsible for vast impediment to livestock production (Hoste et.al.2006). In different countries various types of studies were done on the parasites and their effects and consequences on the farm animals. In Andhra Pradesh, India, 42%of cattle and buffaloes were reported having helminthes infection (Sreedhar et al.2009). Along with helminthes other different endoparasites are also there. Many are observed in intestine of ruminents.These intestinal parasites are more difficult to manage in small farm ruminant animals due to increased resistance to many antihelminthics (S.S.Eke,I.,C.J.Omalu,J.E.Ochagubu et al.,"Prevalence of Gastrointestinal parasites of sheeps and goats slaughtered in Minna Modern Abattoir, Niger State,Nigeria",Journal of animal Science and Veterinary medicine,Vol.4,No.2,P.p.65-70,2019 ,View at :Publisher site I Google Scholar.).Gastrointestinal infection in farm animals (ruminants) affects abruptly.

On feed intake, growth rate, carcass weight and composition, wool growth, fertility and milk yield (J.L.Fitzapatricle,"Global Food Security; the impact of Veterinary parasites and parasitologitics", Veterinary parasitology, Vol.195, No.3-4.P.P.233-248, 2013, view at publisher site 1 Google Scholar).

Rural livestock population mostly reared on grazing based system due to which these animals get continuously reinfected in a series(Kumar,N.,Rao,T.K.,S.,Varghese,A.,Rathor V.S.(2013),Internal parasite management of grazing livestock J.Parsit.Dis.37(2):151-157).Instead of 1% annual growth only 0.5% growth rate is observed in case of cattle, this decreased growth rate is due to helminthes infections(Swapna S. and Nithinya R.,2015)Prevalence of Gastrointestinal nematode ant Trematode parasites of Cattle in Northern Kerala,India,int,J,Sci,Eng.30;132-136).Some of the endoparasites and ectoparasites of of farm animals are of public health significance due to their zoonotic property e.g. Canines and felines. In case of bovines the various infections play an important role in reducing animal production including decreased working potential, stunted growth, decrease in body weight and milk yield (Choubisa and Jaroli 2013; Panigahi et al.2014).Many epidemiological surveys of Gastrointestinal parasite infections are carried out in India (Samanta and Santa 2007; Jyoti et.al.2011, Singh Et al, 2021 a; Rahman et al.2012; Krishnamurthy and D'Souza 2014, Maske et. Al.1990).Epidemiology of gastrointestinal parasite depends upon climatic condition, management practices of that local region (Maharana B.R.et al.2016).

The intensity of pathogenesityis different amongst the helminth parasites.Small ruminants are the habitat for different helminth parasites like Paramphistomum spp.,Faciola spp.,Dicrocoelium dpp.,Haemonchus spp.,Trichuris spp.,Chabertia spp.,Dictyocaulus spp.,Moneizia spp.,Stilesia spp.,(Lone et.al.,2012:Palanivel et.al.2012;Khajuria et.al.,2013).Many Gastrointestinal Nematodes amongst the helminthic group are having significant role in causing gastroenteritis in small ruminants

like Haemonchus contortus,Trichostrongylus spp.,Oesophagostomum spp.,Bunstomum spp.,Cooperia spp.,and Strongyloides spp.(Jeyathilakan et.al.,2003:Easwaran 2004;Yadav et.al.,2006).Different GIN nematodes can infect sheep and goat including Haemonchus, Ostertagia/Teladorsagia, Trichostrongylus, Cooperia, Nematodirus ,Oesophagostomum ,Chabertia and Bunstomum(Kaplan,2020;Matthews et al.,2016).The nematodes cause mechanical actions like irritation,injuiry,feeding tissue of the host,producing toxic metabolic byproducts,produce changes in blood,enzymes,vitamins,harmone activities and reduction in growth rate.Along with this other effects are also there like impropogation of infectious diseases of the host,acting as carrier or vectors of other pathogenic diseases to body covergills and other organs forming wounds,ulcers through pathogenic bacteria and fungi,enter the host (Mrs.Neeru Naiyer; Nematode Parasites of Vertebrates;1992).Additionally the continuous use of antihelminthics in a resistant populations of gastrointestinal nematodes may be responsible for overall financial loss of the farmers(Chandrawathani et.al.,2013;Rialch et.al.,2013,Holm et.al.,2014).

Thus, the study of parasitic biodiversity of various species of nematodes in above study area can be used further for adopting different preventive and control measures and in turn to prevent the possible financial loss of farmers and stakeholders.

MATERIALS AND METHOD

Study Area- Chalisgaon is second largest city and municipal council in Jalgaon district of the Indian state of Maharashtra. It is located in the Khandesh division of the state. And is located about 100 km (62 miles) from Jalgaon and about 330 km (210 miles) from Maharashtra's capital Mumbai.

Geography:Chalisgaon is located at 20.47°N 75.02°E. It has an average elevation of 344 metres (1128 feet).

For the study the samples of intestine of slaughtered sheep and goat were collected from the study area over a period of 2 years from June 2022 to June 2024. The intestines collected were cut open in the normal saline water in petridishes and were observed under binocular microscope for testing whether infected or non-infected. If infection is there the worms were collected ,washed in distilled water to make them free from intestinal contents.The nematode parasites were fixed in hot 70% alcohol and were preserved in 10% glycerin-alcohol (10 parts of glycerin and 90 parts of 70% alcohol).Small specimens were cleared in glycerin and larger ones were cleared in lactophenol or clove oil. The nematode parasites were mounted in glycerine glycerine jelly.

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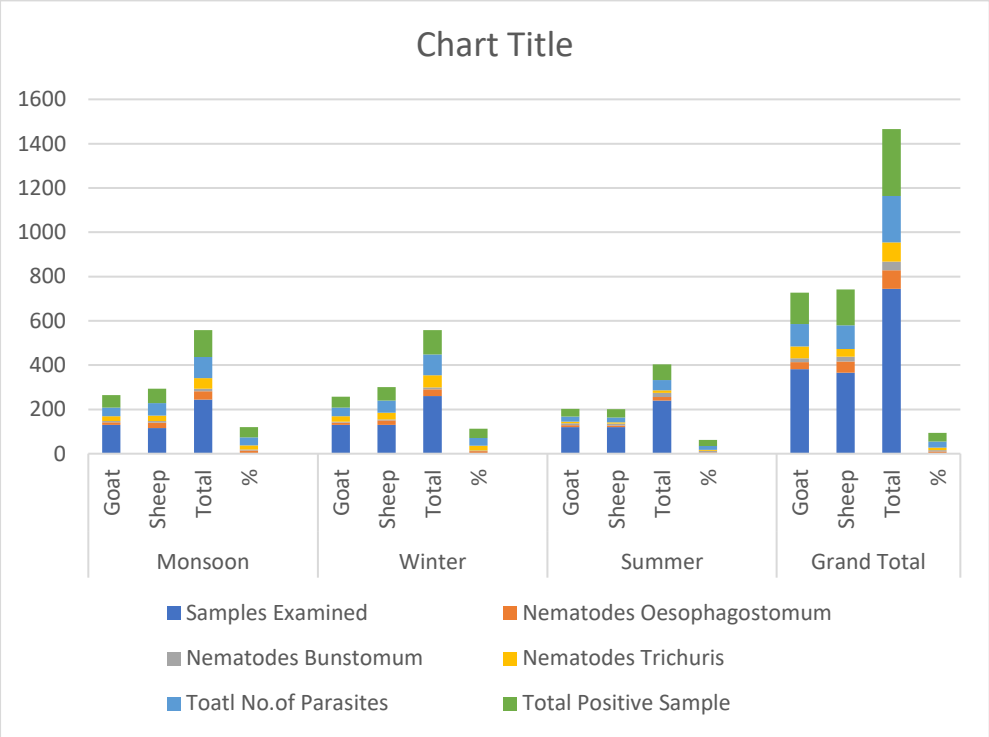
Fig.1. Study Area

RESULTS DISCUSSION

In the above studies results are presented in Table 1. Total 745 samples, 382 of goats and 365 of sheep were collected, 303 (39.39%) were found infected with different species of Nematode parasites.Amongst various infections, maximum incidence was of Trichuris spp. followed by Oesophagostomum spp. and Bunstomum spp.The result showed higher prevalence in sheep,162 than in goats, 142.The higher helminthic,Nematode infection was observed in monsoon,14.6% in Oesophagostomum,4.56% Bunstomum,17.86% in Trichuris.During winter the Nematode infection prevalence was 11.6% in Oesophagostomum ,4.56 in Bunstomum and 17.86 in Trichuris.Nematode infection prevalence observed during winter season was 11.4% in Oesophagostomum,3.42% in Bunstomum and 20.9% in Trichuris.Total parasitic infection noted was 36.48% in Monsson,35.72% during winter and 17.48% during summer season. Total percentage of infection throughout the study was 27.17 % ,10.79% in Oesophagostomum, 5.07% in Bunstomum, 11.37% in Trichuris.During Monsoon out of 245 samples 121 samples found infected with 45.98%, during winter out of 260 samples 110 found infected with 41.8% and during summer season out of 240 ,72 samples with 27.36% found infected.

Season	Animal	Samples Examined	Nematodes			Toatl No.of Parasites	Total Positive Sample
			Oesophagostomum	Bunstomum	Trichuris		
Monsoon	Goat	130	12	5	22	39	56
	Sheep	115	25	7	25	57	65
	Total	245	37	12	47	96	121
	%		14.6	4.56	17.86	36.48	45.98
Winter	Goat	130	10	4	25	39	50
	Sheep	130	20	5	30	55	60
	Total	260	30	9	55	94	110
	%		11.4	3.42	20.9	35.72	41.8
Summer	Goat	120	9	9	6	24	35

	Sheep	120	7	9	6	22	37
	Total	240	16	18	12	46	72
	%		6.08	6.84	4.56	17.48	27.36
Grand Total	**Goat**	382	31	18	53	102	141
	Sheep	365	52	21	34	107	162
	Total	745	83	39	87	209	303
	%		10.79	5.07	11.37	27.17	39.39



DISCUSSION

In the present study the higher Nematode infection during the monsoon observed may be due to increased concentration and contamination of the grazing area with infective larval stages of the parasites.This may have increased the chances of contact between the host and larvae.(Anish Yadav,J.K.Khajuria and A.K.Kha.;Journal of vet.Parasitology,18(2)2004:167-169).Higher parasitic burden on host as well as on pasture was also noted by Sanyal(1998) and Agrawal et.al.(2002).The analysis of results indicates that the occurrence of helminth parasites is variable according to seasons.Higher incidence of infection occurred during monsoon.The temperature,humidity,rainfall and feeding habitats of hosts,availability of infective host and parasite maturation may be responsible for influencing parasitic infections.

CONCLUSION

After the analysis of data it can be concluded that high population of nematode parasites have occurred during monsoon followed by winter and summer.This may be due to the environmental factors and feeding habitats influencing the seasonality of parasitic infection directly or indirectly.

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USE OF E-RESOURCES BY THE FACULTY MEMBERS AND RESEARCH STUDENTS OF MAHATMA PHULE KRISHI VIDYAPEETH, RAHURI

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ABSTRACT

The study titled "Use of E-Resources by the Faculty Members and Research Students of Mahatma Phule Krishi Vidyapeeth, Rahuri" examines the adoption and utilization of electronic resources within the university's academic community. It highlights the pivotal role of digital platforms in enhancing research and educational activities. This research investigates the extent to which faculty members and research students at Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri engage with electronic resources. The university's library has significantly expanded its digital offerings, including access to the Consortium for e-Resources in Agriculture, which provides a vast array of agricultural journals and databases. The study reveals that while there is a growing awareness and usage of these e-resources, challenges such as limited digital literacy and infrastructure constraints persist. Recommendations include targeted training programs to enhance digital competencies and strategies to improve infrastructure, ensuring that the academic community can fully leverage electronic resources for research and learning.

KEYWORDS

E-Resources, databases, digital literacy.

INTRODUCTION

The dawn of 21st century witnessed the digital revolution and gained an extraordinary significance as an indispensable tool in pursuit of knowledge and information. The Internet has remarkably come up as the most powerful medium of storage and retrieval of information needed for various purposes.

The Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri is the premier Agricultural University in Maharashtra that renders services to the farmers through Education, Research and Extension Education. Mahatma Phule Krishi Vidyapeeth, Rahuri is established in 1969 for the western Maharashtra having jurisdiction spread over 10 districts viz. Jalgaon, Nandurbar, Dhule, Nashik, Ahilyanagar, Pune, Solapur, Satara, Sangli and Kolhapur. The University is named after the great social reformer 'Mahatma Jyotiba Phule'.

In today's rapidly evolving academic landscape, electronic resources (e resources) such as e journals, e books, databases, institutional repositories, and digital archives have become indispensable tools for

research scholars and faculty members. "Electronic resources (e-resources) are digital materials accessible via electronic devices, primarily through the internet." They encompass a wide range of formats and serve as vital tools in education, research, and information dissemination. Faculty members and research scholars utilize e-resources extensively for various academic and research purposes. These include accessing scholarly articles, e-books, databases, and other digital materials to support their teaching, research, and professional development. E-resources offer convenient, timely, and cost-effective access to a vast amount of information, making them essential tools in modern academic settings.

SCOPE & LIMITATIONS

The present study has been restricted to the use of E-Resources by faculty members and research students at Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri. It will also give the general idea about the use e-resources by the overall faculty members and research scholars of university.

OBJECTIVES

The main objectives of the present study are as follows:

1. To find out the users' awareness about e-resources.
2. To study the level of satisfaction and availability of e-resources.
3. To find out the barriers and problems faced by the users while accessing e-resources.
4. To suggest suitable recommendations to improve facilities and services related to the use of e-resources.

METHODOLOGY

Keeping in view the above objectives in mind, a structured questionnaire was prepared to collect data from the users of Mahatma Phule Krishi Vidyapeeth, Rahuri. For fulfilling the objectives, a survey was conducted with the help of the structured questionnaire containing various questions pertaining to the awareness and use of e-resources. A total of 250 questionnaires were distributed among faculty members and research scholars of Mahatma Phule Krishi Vidyapeeth, Rahuri. Out of 250 questionnaires distributed, 230 valid questionnaires were collected and then data was analysed, tabulated, interpreted and presented in the form of this paper.

DATA ANALYSIS

The findings of any study depend upon proper analysis of collected data through the application of various techniques. The data collected for the present study was analysed with the help of Microsoft Excel and presented in tabular and graphical forms.

1.1 Use of internet to collect information:

Respondents were asked about the use of the Internet by teachers and researchers, their opinions are presented in the table below.

Table 1.1 Use of internet to collect information

Sr. No.	Response	Number of Respondent	Percentage
1.	Yes	230	100
2.	No	00	0.00
	Total	230	100

Table 1.1 shows that in Mahatma Phule Krishi Vidyapeeth, Rahuri, 100% of respondents make use of the Internet. From this, it is clear that in the age of technology, both teachers and researchers use internet to access information.

1.2 Frequency of internet use:

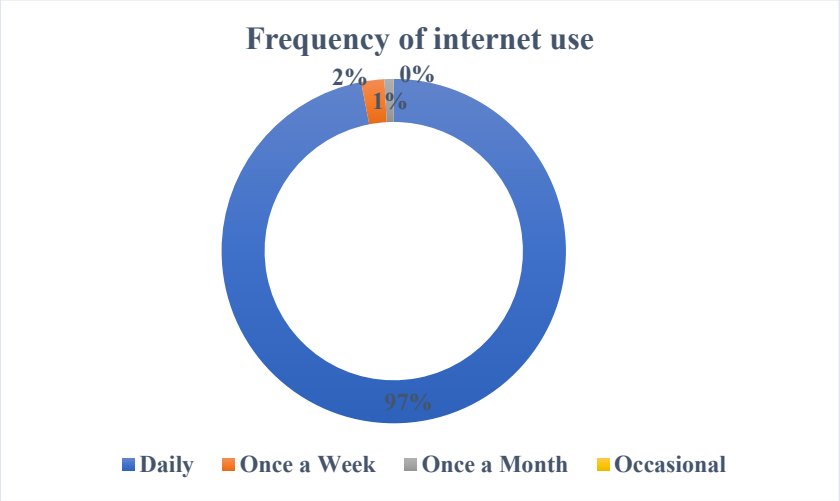
Focusing on the idea of Internet usage in daily life, the respondents were asked how frequently they use the Internet. Their responses have been classified in Table No. 1.2 below.

Table 1.2 Frequency of internet use

Sr. No.	Response	Number of Respondent	Percentage
1.	Daily	223	96.96
2.	Once a Week	05	2.17
3.	Once a Month	02	0.87
4.	Occasional	00	0.00
	Total	230	100

Table No. 1.2 shows that at Mahatma Phule Krishi Vidyapeeth, Rahuri, a vast majority of respondents 96.96% use Internet services regularly, on a daily basis. Only a small minority are occasional users, 2.17% use the Internet once a week, and 0.87% use it only once a month.

Figure No. 1.2: Frequency of internet use



From this, we can conclude that the Internet is a part of daily life, and that it provides the facility to access information.

1.3 Internet facility:

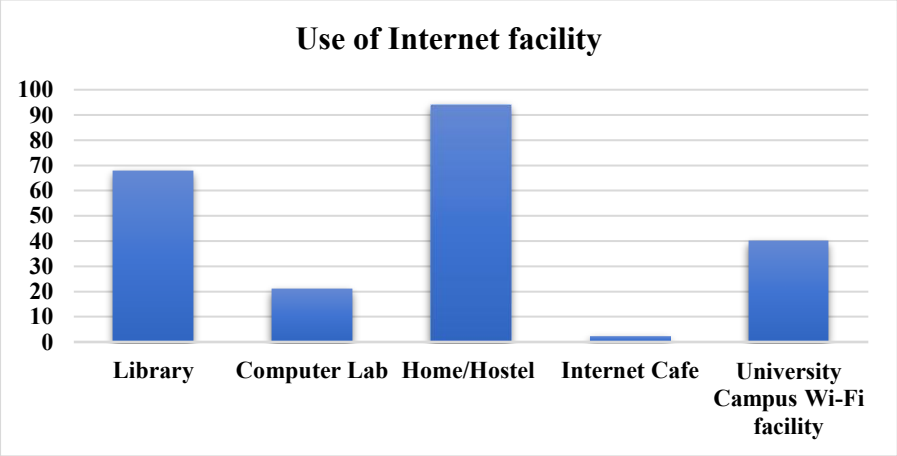
Respondents were asked where they take advantage of Internet services, and their responses have been categorized in table no. 1.3.

Table No. 1.3. Use of Internet facility

Sr. No.	Response	Number of Respondent	Percentage
1.	Library	156	67.83
2.	Computer Lab	48	20.87
3.	Home/Hostel	216	93.91
4.	Internet Cafe	05	2.17
5.	University Campus Wi-Fi facility	92	40

From the above Table No. 1.3, it can be seen that 67.83% of respondents reported that they use Internet facilities in the university library. 20.87% of respondents appear to have taken advantage of Internet facilities in the computer lab. A majority 93.91% of respondents search for information via the Internet from home, 2.17% use Internet cafés for information searches, and 40% take advantage of the university campus Wi Fi facility.

Figure No. 1.3: Use of Internet facility



1.4 Awareness about E-resources:

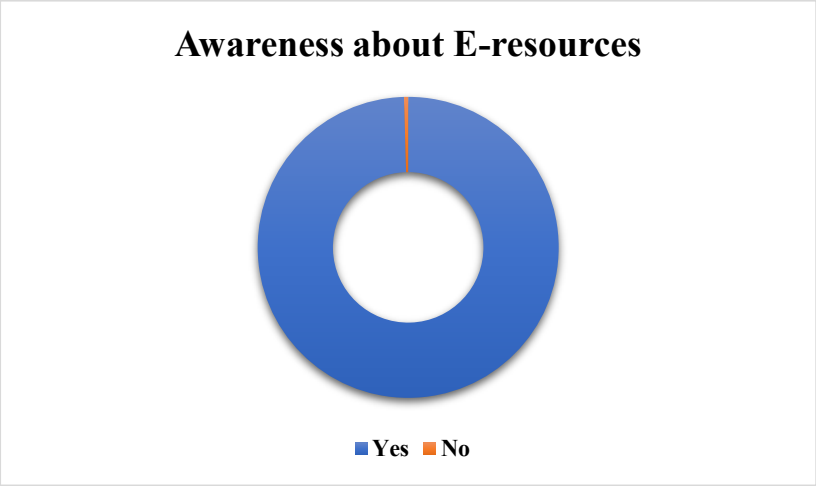
Respondents feedback on the awareness about e resources by teachers and researchers to obtain information in the library is presented in the following table.

Table No. 1.4 Awareness about E-resources

Sr. No.	Response	Number of Respondent	Percentage
1.	Yes	229	99.56
2.	No	01	0.44
3.	Total	230	100

Table No. 1.4 shows that at Mahatma Phule Krishi Vidyapeeth, Rahuri a majority of teachers and researchers 99.56% are aware of the e-resources. However, 0.44% are not aware of them.

Figure No. 1.4: Awareness about E-resources



1.5 Electronic Information Sources Used by Respondents:

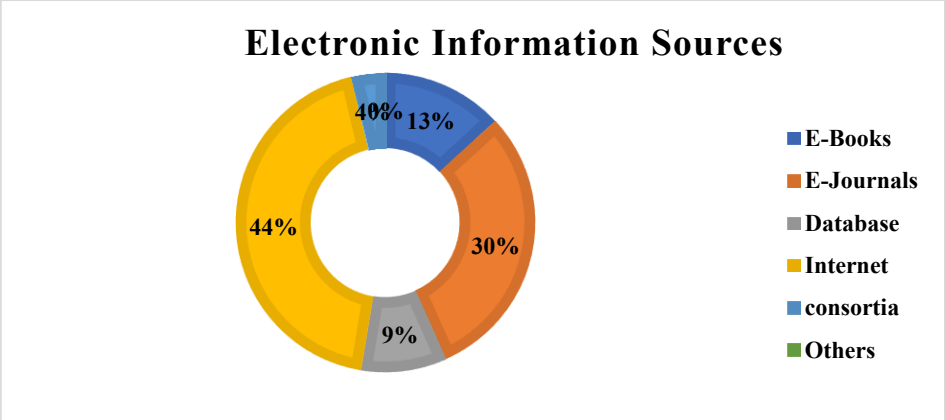
Respondents' feedback on the e resources used by teachers and researchers to obtain information in the library is presented in the following table.

Table No. 1.5 Electronic Information Sources Used by Respondents

Sr. No.	Response	Number of Respondent	Percentage
1.	E-Books	68	29.57
2.	E-Journals	156	67.83
3.	Database	48	20.87
4.	Internet	226	98.26
5.	Consortia	19	8.26
6.	Others	00	0.00

Table No. 1.5 shows that at Mahatma Phule Krishi Vidyapeeth, Rahuri, a maximum of 98.26% of respondents prefer the Internet as an electronic information source. 67.83% of respondents use e journals for research and study, 29.57% use e books, 20.87% use databases, and 8.26% use electronic information sources from consortia.

Figure No. 1.5: Electronic Information Sources Used by Respondents



1.6 Preferred option for information source:

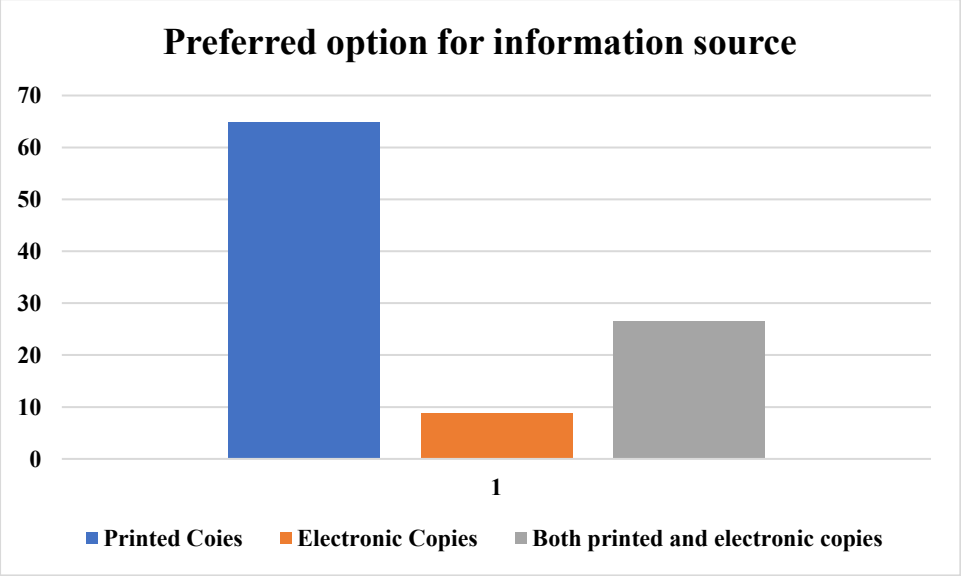
The preferences of the respondents regarding information sources are classified in Table No. 1.6

Table No. 1.6 Preferred option for information source

Sr. No.	Response	Number of Respondent	Percentage
1.	Printed Copies	149	64.78
2.	Electronic Copies	20	8.70
3.	Both printed & electronic copies	61	26.52
	Total	230	100

Table No. 1.6 shows that at Mahatma Phule Krishi Vidyapeeth, Rahuri, 64.78% of respondents prefer using printed copies of journals or reference materials while preparing for research and lectures. 26.52% of respondents use both printed and electronic copies. Only 8.70% of respondents prefer electronic copies of journals (e-journals) or reference materials.

Figure No. 1.6 Preferred option for information source



1.7 Usefulness of Electronic Sources:

The selected respondents were asked about the usefulness of electronic sources. Their responses regarding whether it is easy or difficult to collect information while using electronic sources have been classified in Table No. 1.7

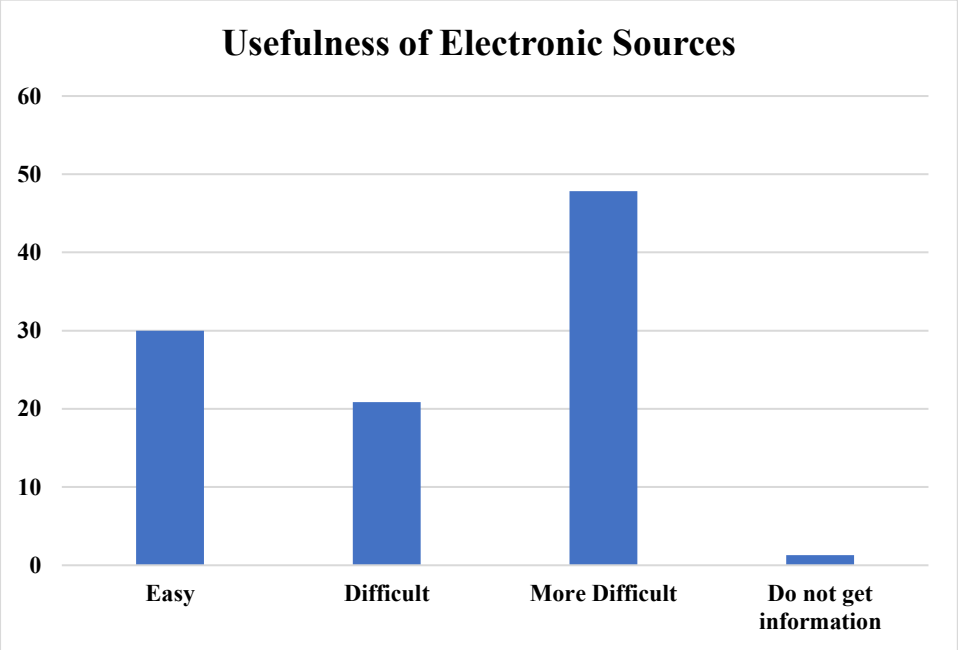
Table No. 1.7 Usefulness of Electronic Sources

Sr. No.	Response	Number of Respondent	Percentage
1.	Easy	69	30
2.	Difficult	48	20.87
3.	More Difficult	110	47.83
4.	Do not get information	03	1.30
	Total	230	100

Based on the above table, it is evident that 30% of respondents from Mahatma Phule Krishi Vidyapeeth, Rahuri, find using e-resources easy. However, 20.87% believe that gathering and utilizing information through e-resources is more challenging compared to other methods. A majority of 47.83% face greater difficulties in obtaining necessary information using e-resources. This indicates

that information collection and storage is a highly skilled task. Additionally, 1.30% of respondents struggle to find the required information, leading to their inability to access essential data.

Figure No. 1.7 Usefulness of Electronic Sources



1.8 Problems faced while using E-resources

There are many problems associated with the accessing of e-resources by respondents. While getting information from the respondents, they were asked to mention the problems faced by them during the searching of information by utilizing e-resources.

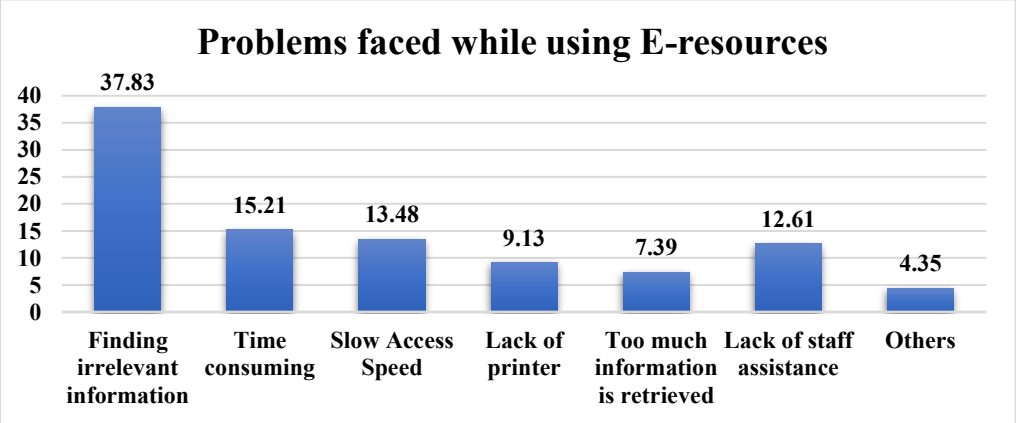
Table No. 1.8 Problems faced while using E-resources

Sr. No.	Response	Number of Respondent	Percentage
1.	Finding irrelevant information	87	37.83
2.	Time consuming	35	15.21
3.	Slow Access Speed	31	13.48
4.	Lack of printer	21	9.13
5.	Too much information is retrieved	17	7.39
6.	Lack of staff assistance	29	12.61
7.	Others	10	4.35
	Total	230	100

Table shows that at Mahatma Phule Krishi Vidyapeeth, Rahuri, 37.83% respondents faced problems related to getting irrelevant information followed by 15.21% who found the process time consuming,

further followed by 13.48% who complained of slow speed, 12.61% complained of lack of staff assistance, 9.13% with lack of printer facility, 7.39% were bogged down by excess retrieval of information and only 4.35% faced other types of problems.

Figure No. 1.8 Problems faced while using E-resources



SUGGESTIONS

1. Faculty members and researchers' orientation programmes should be organized on a regular basis to apprise them about advanced search strategies and the use of controlled vocabulary to make electronic search process much easier.

2. The university library should be using electronic bulletin board in library for inform to faculty members and researchers about new arrivals and library information & services.

3. There is a need to increase the internet access facility and speed of internet for improving the use of digital resources.

4. In faculty members and researchers' awareness levels should be increased for maximizing the usage of online journals for procuring the current and required information.

5. To join the consortium for maximum usage of digital resources.

CONCLUSION

The study on the "Use of E-Resources by the Faculty Members and Research Students of Mahatma Phule Krishi Vidyapeeth (MPKV), Rahuri" reveals a high level of awareness and widespread use of electronic resources among the academic community. All respondents use the Internet, with the majority accessing it daily, indicating its integral role in academic and research activities. Most users rely on the university library, personal devices, and campus Wi-Fi for access. Internet and e-journals emerged as the most preferred digital information sources. Notably, 47.83% of respondents found using e-resources more difficult than traditional methods, underscoring a gap in digital literacy. Furthermore, while a significant portion still prefers printed materials, there is a growing tendency to use both digital and print formats. This hybrid approach suggests a transition phase where users

recognize the value of e-resources but still rely on conventional materials due to usability issues. To bridge these gaps, the study recommends focused initiatives such as digital literacy training programs, enhanced user support services, and improvements in IT infrastructure. Addressing these barriers will enable faculty members and research students at Mahatma Phule Krishi Vidyapeeth, Rahuri to make more effective and confident use of e-resources.

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ACCESSING THE ROLE OF GCCS IN INDIA'S ECONOMIC DEVELOPMENT: OPPORTUNITIES AND CHALLENGES

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ABSTRACT

Global Capability Centers (GCCs) are playing an increasingly vital role in India's economic development by driving innovation, creating high-value jobs, and contributing significantly to the country's GDP. Currently, India has over 1,800 GCCs, employing about 1.9 million professionals. Forecasts show that by 2030, India's GCCs will reach between 2,900 and 3,500, employing around 2.5 to 2.8 million, a major push in driving employment in the country. While offering numerous opportunities for growth, GCCs also face challenges related to talent acquisition, infrastructure, and evolving global dynamics. India, with its rich pool of skilled talent, has emerged as the leading destination for these centres. The establishment of GCCs not only contributes to job creation but also stimulates economic development by fostering innovation and enhancing operational efficiency. As these centers continue to flourish, they will play an increasingly important role in shaping India's economy and job market, driving growth across multiple sectors. This paper is accessing the role of GCCs in India's economic development.

KEYWORDS

Global Capability Centres (GCCs), Driving innovation, Driving employment, Talent acquisition, Infrastructure, Operational efficiency, GDP.

INTRODUCTION

Global Capability Centers (GCCs), also known as Captive Centers or Global In-house Centers (GICs), are fully owned subsidiaries or offshore units established by multinational corporations (MNCs) to centralize and manage key business functions and processes. The prime objective that GCCs aim to achieve is to leverage the skills of the local workforce to enhance global operations, stimulating infrastructure and real estate development, mainly in Tier-I and II cities such as Bengaluru, Hyderabad, and Pune, where the majority of GCCs are set-up. These centers not only provide direct employment but also create indirect jobs in the supply chain and related sectors.

They are driving economic activity and contributing to the GDP of the country with a large pool of skilled talent present in India. Global Capability Centers (GCCs) have become a vital part of India's economic growth and employment landscape. As we move toward 2025 and beyond, their significance

is expected to rise even further. GCCs, are established by multinational corporations (MNCs) to centralize various operations like IT, analytics, finance, and research in cost-effective regions.

OBJECTIVES

1. To know the role of GCCs in India's Economic Development.
2. To study the challenges faced by GCCs in India.

METHODOLOGY

This research paper is based on secondary data available through various books, articles, reports and websites.

Role of GCCs in India

India, with its rich pool of skilled talent, has emerged as the leading destination for these centers. The establishment of GCCs not only contributes to job creation but also stimulates economic development by fostering innovation and enhancing operational efficiency. As these centers continue to flourish, they will play an increasingly important role in shaping India's economy and job market, driving growth across multiple sectors.

Market Size and Growth:

The GCC market in India reached $60 billion in 2023, a significant increase from $19.6 billion in 2014-15 (NASSCOM -KPMG Report)

GCCs now contribute around 1% of India's GDP and are projected to contribute $121 billion in total revenue by 2030, approximately 3.5% of India's current GDP (Economic Survey 2024)

Export Contribution:

- Out of the projected $121 billion revenue by 2030, $102 billion is expected to come from exports, enhancing India's position in the global market. Industry Impact and Employment:
- Currently, India has over 1,800 GCCs, employing about 1.9 million professionals. Forecasts show that by 2030, India's GCCs will reach between 2,900 and 3,500, employing around 2.5 to 2.8 million, a major push in driving employment in the country.
- The revenue generation from GCCs was estimated at $35.9 billion in FY 2022, and this is expected to grow exponentially, reaffirming their long-term importance in the Indian economy.

Competitive Advantages:

- India's large pool of skilled labor, cost competitiveness, and capacity to deliver high- quality services have motivated MNCs to expand their GCCs in the country.
- GCCs now span diverse industries, including healthcare, banking, IT, and retail,
- further strengthening India's role in the global supply chain.

India's emergence as a hub for Global Capability Centres (GCCs) is a testament to its growing significance in the global business landscape. Multinational corporations (MNCs) from around the world have recognized the advantages of establishing GCCs in India, leveraging the country's extensive talent pool, cost efficiencies, and robust technological infrastructure. This post explores the major players in India's GCC ecosystem, highlights successful case studies, and discusses the operational and strategic advantages, as well as the challenges and risks associated with running GCCs in India.

Major Players in GCC Ecosystem Microsoft

Overview:

Microsoft's India Development Centre (IDC) stands as one of the company's largest R&D centres outside the United States. Established in 1998, the IDC has become pivotal in Microsoft's global innovation strategy.

Capabilities:

The IDC focuses on cutting-edge technologies such as AI, cloud computing, and enterprise solutions. Its contributions are integral to Microsoft's global product development, including major projects like Azure, Office 365, and Dynamics 365. Microsoft Chairman and CEO Satya Nadella has highlighted India's unique potential to advance AI, emphasizing the IDC's role in pioneering research and development across various domains. Google

Overview:

Google's GCC in India, with centres in Bangalore and Hyderabad, plays a crucial role in supporting the company's global operations.

Capabilities:

These centres drive innovations in machine learning, cloud services, and search
algorithms. By capitalizing on India's technological expertise and innovative culture, Google

Amazon

Overview:

Amazon operates multiple GCCs in India, predominantly located in Hyderabad and Bangalore.

Capabilities:

These centres are instrumental in developing Amazon Web Services (AWS), enhancing customer experience, and optimizing supply chain technologies. India's tech talent and strategic investments in technology infrastructure have enabled Amazon to support its global expansion and innovation initiatives effectively.

Goldman Sachs

Overview:

Goldman Sachs' Bengaluru office, established in 2004, is a cornerstone of the firm's global strategy.

Capabilities:

The Bengaluru centre specializes in technology development, finance, and risk management. Its success is attributed to its strategic location, skilled workforce, and integration into Goldman Sachs' global operations, enhancing the firm's financial technology and risk management capabilities.

Indian Companies Operating GCCs Tata Consultancy Services (TCS)

Overview:

TCS operates several GCCs that serve global clients across various industries. Capabilities: TCS's GCCs excel in IT services, consulting, and business solutions, with a strong focus on digital transformation. TCS leverages its deep understanding of global best practices and the local market to deliver comprehensive and innovative solutions.

Infosys

Overview:

Infosys has established GCCs that contribute significantly to its global delivery model.

Capabilities:

These centres focus on software development, engineering services, and technology consulting. Infosys's strategic placement of GCCs enables it to provide high- quality services and solutions to its global clientele.

Wipro

Overview:

Wipro's GCCs are central to its global IT services and consulting operations.

Capabilities:

Wipro's GCCs excel in AI, cyber security, and digital solutions. Recent acquisitions, such as a majority stake in insurtech firm Aggne and a minority stake in automotive software marketplace SDVerse, underscore Wipro's commitment to expanding its technological capabilities and market presence.

Operational and Strategic Advantages of GCCs in India

- **Cost Advantages**

India offers substantial cost benefits for GCCs, making it a preferred location for multinational companies. The operational costs in India, including labour, infrastructure, and real estate, are significantly lower compared to developed countries. A study by NASSCOM reveals that companies can achieve cost savings of up to 60% by setting up GCCs in India. Lower salaries for skilled professionals and favourable currency exchange rates contribute to these savings. Additionally, the competitive

business environment and cost-effective support services, such as legal process outsourcing (LPO) and IT services, further enhance cost efficiency. These advantages enable companies to allocate resources more effectively and focus on strategic growth initiatives.

- **Talent Pool and Skill Availability**

India's vast and diverse talent pool makes it an attractive destination for GCCs seeking specialized skills. The country produces over 1.5 million engineering graduates and approximately 5 million graduates across various disciplines annually. This steady stream of highly skilled professionals provides GCCs with access to a wide range of expertise, particularly in engineering, IT, finance, and law.

- **Technological Infrastructure**

India's technological infrastructure has advanced significantly, positioning it as a global technology hub. The country boasts a robust IT and telecommunications infrastructure, with extensive broadband and mobile network coverage. Initiatives like Digital India and the Smart Cities Mission have further strengthened the technological ecosystem, ensuring reliable and high-speed internet connectivity. Technology parks and innovation hubs across the country offer state-of-the-art facilities, including data centres, cybersecurity solutions, and research and development centres. The presence of leading IT companies and start-ups fosters a collaborative environment that encourages innovation and knowledge sharing.

- **Government Policies and Incentives**

The Indian government has implemented several policies and incentives to attract and support GCCs. The Special Economic Zones (SEZ) policy provides tax benefits, simplified regulatory procedures, and infrastructure support, including exemptions from customs duties and income tax holidays. Additionally, initiatives like Make in India and Start-up India promote investment and entrepreneurship by offering financial incentives, skill development programs, and access to funding. These supportive regulatory frameworks and proactive government policies create a favourable environment for GCCs to thrive and expand their operations in India.

Challenges faced by GCCs

- **Regulatory and Compliance Challenges**

Operating GCCs in India involves navigating a complex regulatory landscape. The country's regulatory framework is continually evolving, requiring GCCs to stay updated on changes to ensure compliance. This includes adhering to labor laws, taxation policies, and industry- specific regulations. Non-compliance can lead to significant financial penalties and damage to a company's reputation. The bureaucratic nature of the Indian legal system can also pose challenges in terms of dispute resolution

and contract enforcement. A robust compliance strategy and a thorough understanding of local laws are essential for managing these regulatory hurdles.

- **Talent Retention and Attrition Rates**

Despite India's vast talent pool, retaining skilled professionals can be challenging. High attrition rates in the IT and BPO sectors are a significant concern for GCCs. A Deloitte report indicates that the average attrition rate in India's IT sector ranges from 15% to 20%, with some companies experiencing even higher rates. Attracting and retaining top talent requires competitive compensation packages, career development opportunities, and a positive work environment. Investing in employee engagement initiatives, continuous learning programs, and clear career progression paths can help mitigate attrition risks.

- **Cybersecurity and Data Privacy Concerns**

As GCCs handle sensitive and proprietary information, cybersecurity and data privacy are paramount concerns. India has seen a rise in cyber threats, including data breaches, ransomware attacks, and phishing incidents. The increasing sophistication of cybercriminals necessitates robust cybersecurity measures to protect organizational assets. Compliance with data privacy regulations, such as the Personal Data Protection Bill (PDPB), adds another layer of complexity. GCCs must implement stringent data protection policies, conduct regular security audits, and invest in advanced cybersecurity technologies to safeguard against potential threats.

- **Economic and Geopolitical Risks**

India's economic and geopolitical landscape can present challenges for GCCs. Economic fluctuations, such as inflation, currency volatility, and changes in government policies, can impact business operations and profitability. For instance, fluctuations in the Indian Rupee can affect the cost structure of GCCs, particularly for companies with significant foreign exchange exposure. Geopolitical tensions, both within the region and globally, can also pose

risks. Trade disputes, political instability, and regulatory changes in other countries can create uncertainties for GCC operations. Companies must adopt a proactive approach to risk management, including scenario planning and diversification strategies, to mitigate the impact of these risks.

CONCLUSION

Global Capability Centres have become integral to multinational corporations' growth strategies. By leveraging India's talented workforce, cost advantages, and supportive ecosystem, companies can establish successful GCCs that drive innovation and transformation. Challenges such as regulatory compliance, talent retention, cyber security, and economic and geopolitical risks must be carefully

managed. By addressing these challenges proactively, GCCs can leverage India's strengths while mitigating potential downsides, ensuring sustainable growth. With careful planning and execution, these centres can deliver global impact from regional levels, contributing significantly to both the parent organisation's success and India's economic development. As the GCC landscape continues to evolve, it presents an exciting opportunity for companies to tap into India's potential and drive their next stage of business growth. As these centers continue to flourish, they will play an increasingly important role in shaping India's economy and job market, driving growth across multiple sectors.

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PHYTOPLANKTON AND ZOOBENTHOS DIVERSITY AT BORI DAM IN NALDURG OF DISTRICT DHARASHIV (M.S).

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ABSTRACT

Present investigation has been done for the study of phytoplankton and zoobenthos diversity at bori dam- 2024. The taxa observed in the water body were classified under four categories: (1) Consistent-present for 9-12 months (Aeruginosa, Diatoms, Microcystis and Synachocystiss.p) (2) Subconsistent-present for 6-8 months (Microcystisrobusta and Synachococcussp) (3) Inconsistent-present for 2-5 months (Anabaena sp, Anabaena circularis, chlorococcum sp., chlorella sp., Cosmarium botrytis, Eucapsisminuta, Raphidiopsis sp. and Scenedesmuusbijugatus and (4) Sporadic-present for one month only. Among algae 6 taxa were pollution tolerant, Number of Zoobenthos increased in the summer months while decreased in the winter months. Different groups of zoobenthos exhibited their distinct peaks in different months of the year.

KEYWORDS

Bori Dam, Phytoplankton , Zoobenthos diversity.

INTRODUCTION

The phytoplankton population in any aquatic system is biological wealth of water for fishes and constitute a vital link in the food chain, whereas the zoobenthos is an important source of food for fish in a water body. It is evident that some fishes are typically active feeders on the plankton while others feed upon zoobenthos throughout their life. So basically all the fishes are plankton feeders at some stages of their life cycle. The knowledge of plankton composition, abundance and distribution helps to evaluate their significance as fish food. For proper growth and maintenance of a water body, phytoplankton and zoobenthos have their definite roles. Real picture of any phytoplanktonic mass and zoobenthos in a water body at micro level can be understood only when adequate data of the above two planktonic biomass are available.

The selected water body is a rectangular, shallow and perennial one having concave basin and is used for the culture of fishes, especially major carp. The water body is getting eutrophicated fastly and blooming phytoplanktonic taxa, especially Cyanophyceae which emits foul smell during summer.

MATERIALS AND METHODS

Zoobenthos were sampled with mushroom shaped scooping bottom sampler which collected a sample of about 10 x 10 cm. The entire collections were brought to laboratory for further investigation. A sample of 200 ml was taken out and passed through guarded sieves and washed with plenty of water. The organisms collected in sieve were transferred to a bottle filled with water. The zoobenthos were first identified in living condition and then preserved in 5% formaldehyde solution. The collection of phytoplankton was made by hauling 2-3 liters of water through the plankton net (Bolting silk no. 0.50, mesh size 0.03-04 mm).

TABLE - 1: Various categories of taxa as per the classification.

Sr. No	Trophic Status	Existence status			
		Consistent	Subconsistent	Inconsistent	Sporadic
1	Pollution Tolerant	Microcystisaeruginosa Diatoms	Microcustisrobusta Synachococcus sp.	Anabaena sp. Chlorella sp. Chlorococum sp. Scenedesmusbijugatus	Stigeoclonium sp.
2	Moderately Pollution Tolerant	Synachocystis sp.		Raphidiopsis sp.	Chroococcus sp. Oocystisla custris Oscillatoria subbrevis
3	Clear water form			Anabaena circularis Cosmariumbotrystis Eucapsisminuta	Cladophora sp. Raphidobema sp. Rivularia sp. Stishococcusminatus

RESULTS AND DISCUSSION

The overall algal spectrum of the water body consists of 20 taxa (Table-1). Out of these 9 belonged to Chlorophyceae, 10 to Cyanophyseae and one to Bacillariophuseae. All these taxa never appeared simultaneously at one time. The recorded algal spectrum was found to be of variable size owing to either appearance of new taxa or disappearance of pre-existing taxa. Under the classification as per Table-1, it was observed that Microcystisaeruginosa, Synachocystis sp. and Bacillariophyceae fall under consistent; Microcystisrobusta and Synachococcus sp. under sub-constistent; Anabaena sp., Chlorocossum sp., Scenedesmusbijugatus, Chlorella sp., Raphidiopsis sp., Casmarium botrytis, Anabaena circularis and Eucapsisminuta fall under inconsistent while Stigeoclonium sp., Chroococcus

sp., Oocustislacustis, Oscillatoriasubbrevis, Stichococcusminuta and Cladophura sp. were recorded in only one month of the year, hence grouped under Sporadic category. As per data in Table-1, Microcustisaeruginosa, Chlorella sp., Microcustisrobusta and Oocystislacustris are pollution tolerant and Synachocystis sp., Oscillatoriasubbrevis, Synachococcus sp., Chlorococcum sp. and Raphidiopsis sp. are moderately tolerant species, while Anabaena sp., Stichococcus sp., Raphidonema sp., Cosmarium botrytis, Cladophara sp., Anabaena circularis, Eicapsosminuta and Chroococcus sp. are clean water forms. The regular association of diatoms as observed in the water body with pollution tolerant forms can be considered as pollution tolerant.

Zoobenthos of the investigation water body were collected in the year 2024 and their percentage were calculated in Table-2. Altogether 31 species of zoobenthos were collected durinig the entire period of investigation and their fluctuations were recorded in the range of 1459 and 4285m2. Highest value was recorded in the month of May(4285/m2) and lowest in the month of February (1459/m2). Their increasing trend was found to be from February to May and again in September. Their decreasing trend was recorded from October to March and from May to September. Thus, two maxima in May and October and two minima in February and September were recorded. The total number of Zoobenthos were found to be 38601/m2 of which major consistent were insects (47.27%) followed by Oligochaetes (31.30%), Gastropods (7.11%), Branchiopods(5.13%). Bivalves (2.93%), Ostracods(2.70%) and Leeched(2.54%). Among insects Stico-Chironomus sp. and Chironomus sp. were found to be regular and abundant. Some insects were found to be irregular in shallow depth zones but were completely absent in the deeper zones. The various zoobenthos were not equal in deeper zones but some were equal in both the zones in their abundance.

Adhering to be prevailing conception of the algal indices of pollution, the taxa constituting the be consisted of 9 pollution tolerant, 5 moderately pollution tolerant and 7 clean water forms. This finding is in agreement with the earlier reported6,9,13. Taking into consideration, both pollution tolerant and moderately pollution tolerant forms together, the percentage of clean water from in the present water body left pretty low throughout the year depcting eutrophic nature14. The predominance of Cyanophyceae has been taken as an indicator of autrophication10,14. During the investigation presence of zoobenthos was maximum in the summer months (May) and the minimum in the spring month(February). This is not in conformity with the earlier findings3,4 wherein maximum zoobenthos were in April and minimum in September in an American lake, while other worker15 observed maximum in the month of June and minimum in the month February from a lake of Lucknow (U.P.). Another worker8 concluded the peak period in the months of January and April but others2,5,7 found maximum peak during summer months which is quite in conformity to the findings of this

investigation. The differences in the occurrence of peaks in zoobenthos might be due to the composition of abiotic factors of water, soil and the variations in the productivity of different water bodies. Some workers1,11correlated bottom community with the fish productivity and accordingly this water body is most suitable for the pisciculture.

TABLE-2 : Quantitative analysis of Zoobenthos at Bori Dam (values are expressed in percent)

Zoobenthos	Insect	Oligochaetes	Gastropods	Bivalves	Ostracods	Branciopods	leeches	Total(per m2)
January	57.90	18.18	7.40	4.10	7.51	2.28	2.15	2682
February	51.11	19.08	9.15	5.16	8.71	4.10	2.93	1459
March	54.20	26.16	5.10.	3.70	2.51	5.08	2.35	3390
April	54.02	29.17	4.15	1.17	1.40	5.30	3.39	3841
May	56.07	30.12	4.80	1.30	0.33	4.77	1.05	4285
June	48.02	38.18	3.0	1.41	0.35	7.33	2.72	4060
July	26.18	45.11	11.16	4.22	0.62	3.32	3.09	3761
August	22.00	52.14	12.12	4.45	0.30	4.09	3.70	3379
September	22.30	49.12	13.00	3.61	0.50	6.58	4.31	2679
October	50.20	25.17	9.10	3.00	0.73	7.79	2.68	3175
November	63.60	19.17	2.20	1.40	3.16	7.49	1.21	3019
December	61.70	20.00	4.15	1.19	6.36	3.47	0.97	2871
Average	**47.27**	**31.30**	**7.11**	**2.93**	**2.70**	**5.13**	**2.54**	**3216.7**

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A STUDY OF TEMPLE ARCHITECTURE IN NEWASA TALUKA

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ABSTRACT

Wonderful architecture Temple is situated at Newasa Taluka. One of them is Shri Mohiniraj temple. The elegantly designed Mohiniraj Temple is dedicated to lord Vishnu. Another Famous TemplesisShriShidheshwar is located on the confluence of the rivers Pravara and Godawari Known as pravarasangam which is built during the period of the Peshwas in 1767 A.D. Lord Dattatreya temple and 'PaisKhamb' temple, is on the river of pravara and having the cultural heritage of in the 12th century. Another Unique world famous ShaniTempel is specially famous village having no door to home and culturalyreleted to shaniplanet. These excavation explored the culture sequence ranging from the stone age to the Medieval Period. This relief model illustrates the importance of stratigraphy in archaeological excavations.

KEYWORDS

Temple architecture, Temples in Newasa taluka.

INTRODUCTION

Newasa is small town of the river Pravara in Ahemednagar district and is associated with the famous 13th century saint-poet Shri Dnyaneshwar. It was excavated by the Deccan Collage under the guidance of Prof. H.D. Sanklaiya from 1954-59. Newasa taluka has religious heritage. Most of these religious centers Attractive life Shingnapur, Newasa, Devgad, etc. Newasa is a well-known region in the District of Ahmednagar. Newasa town is talukaplace. The city is located on the bank of the PraveraRiverThere iswonderful Templearchitecture in Newasa taluka.One of this The Shri Mohiniraj Temple Complex in Newasa city. The elegantly designed Mohiniraj Temple in is dedicated to lord Vishnu.The Shri Shidheshwar temple Complex in Toka Village is another finest example off Yadava Architecture during 12th -13th century in Maharatwada region. Deogad, a holy temple It is Datatreya. It is situated on the bank of river Pravara. Newasa is having great cultural heritage of 'PaissKhamb" temple, in the 12th century. Tha small Village of shanishinganapur has came into light recent year due to the temple of God Shani whose curse supposed to the dangerous and so it was worshipped widely. The historical Newasa city is the taluka place.

OBJECTIVES OF RESEARCH

1. To study of historical architecture in Newasa taluka.

2. To overview on historical architecture.

3. To Overview on Temple architecture in Newasa taluka.

RESEARCH METHODOLOGY

For the purpose of this study used social science research methodology. To study the research topic Used scientifically analysis. In this method used secondary data tools. In this secondary data tool used reference book. Research articles, newspapers, journals, published and unpublished materials and also taken help of internet facilities.

Shri Mohiniraj Temple:

The 75 ft.temple is decorated all over with ornamental work consisting of the image of Mohiniraj. Also, in the sabhamandap (Meeting Room), several images of other gods and goddeses such as Ganesh, Shiv-parvati , Shani and Hanuman are displayed for their devotees.

Newasa PaisKhamb:

Newasa is famous for medieval sank- poet shri Dnyaneshwar, who wrote 'Dnyaneshwari' the Marathi translation of 'BhagvatGita' here in 1290 A.D Dnyaneshwari is very famous holy book of Hindus in Maharashtra. The pillar on which he used to sit while writing is well known as 'pais'. The Dnyaneshwar temple is actually temple of the pais.

Siddhewshwar temple, Toka:

The shrisiddheshwar temple complex in Toka village is another finest example of Yadava architecture during 12th -13th century in Marathwada region. After the establishment of the Marathi state, new temples were built during the Peshwa period. There are plenty of sculptures out there. The temple consists of many sculptures from many epic stories of character like Ramayan, Mahabharata, Puranas, Susrasundari, Vyal-Sharbha. However, it is not as delicate and diverse as the temple sculptures during the Yadav period. The temple has a big Shivlingam inside the sanctum, with the brass snake and the idol of Parvati in the back wall. Lord Vishnu's avtar Like Matsyavatar, Kurmavatar, Varaha Avatar, Nrusinhavatar, Vamana Avatar, Parashuram Avatar, Rama Avatar Krishna avatar, Buddhavatar, Kalki avatar can be seen here. The spire of the main temple is made up of small peaks, designed as a sabhamandap. The pillars of the temple are of Peshwa style. There is a beautiful Nandi in front of the shiva temple which is very similar to Bhuleshwar Nandi the Beautiful rope carvings on Nandi's back , the chains, the snake's fence, the embroidered stripes, the small bell vines are very beautiful. Jai Vijay is the gatekeeper at the entrance of the temple andYaksha is the bearer in the sabhamandap and sanctum. There are shrines on the side of temple in the sculptures on the outer wall. Figures from Epics Like Ramayana, Mahabharata and other puranasare engraved on the wall on all sides of the temple. On the front side of the temple, a very beautiful Dashavatar Plaque is carved. There is a

sculpture carved on the right and left side wall of the main temple, on the left side the king is visiting this temple and on the right side there is a beautifull sculptures, Draupadi. Apart from this, Balakrishna's events in Gokul, Krishna's leela with Gopikas, Arjuna's pride, Bhim's pride, Hanuman Sita's visit to Ashoka forest. There are also soe interesting sculptures, carved on the plaque while playing various instruments like women's bhavmudras, nrityamuydras, tal, mridang etc., while doing hairdo and playing veena.

CONCLUSION

Newasa is small town of the river Pravara in Ahemednagar district and is associated with the famous 13th century saint-poet Shri Dnyaneshwar. It was excavated by the Deccan Collage under the guidance of Prof. H.D. Sanklaiya from 1954-59.

The historical Newasa city is the taluka place.This taluka is known for the Village of associated with ShaniShingnapur with Shanidev, Devgad with lord Dattatreya, Belhekarwadi with GodessJagdamba, Newasa Budruk with lord Khandoba and Mhalsa Temple. Newasa and Sonaiis the largest Market Places in the taluka. Ghodegaon is Famous village for Onion and Animal Market. Two Sugar Factory Is located in Newasa taluka. Newasa taluka is a Irrigated due to Mula Dam, willsan Dam and backwater of Nathsagar Dam along with small bunds in Newasa taluka.

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BANKING SECTOR: DEVELOPMENT AND INNOVATION IN INDIAN

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ABSTRACT

India one of the developing country in the world, in which the promotion of the service sector has received the focus of attention in the economic development The key service sectors in India are Insurance, tele- communication, software, banking, healthcare and education. Among them banking has a pride of place and is one of fastest growing service industry in India. It plays a dominant role in the economic development of the country. Indian Banking Industry today is witnessing a drastic change. The Banking sector is a very important sector influencing the Indian Economy. Due to modern and latest technologies with innovation, the banking sector has made tremendous improvement during the liberalization period

One such modern technique of Information technology in the Banking sector is Internet Banking; this has changed the face of the Banking industry and its relationship. Internet Banking involves use of Internet facility for delivery of Banking products and services. Technology has opened up new markets, new products, new services, which involves efficient delivery channels for the Banking industry and its institutions. De-regularization has opened new doors for Banks to increase revenues by entering into investment banking, insurance, credit card, depository services, mortgage, securitization etc; Internet Banking is a cost-effective delivery channel for financial institutions.

KEYWORDS

IT, E banking, ATM, M banking, E -cheque, RTGS, EFT ECS

INTRODUCTION

The Banking sector has been immensely benefited from the implementation of superior technology during the recent past, almost in every nation in the world. Productivity enhancement, innovative products, speedy transactions seamless transfer of funds, real time information system, and efficient risk management are some of the advantages derived through the technology. Information technology has also improved the efficiency and robustness of business processes across banking sector.

India's banking sector has made rapid strides in reforming and aligning itself to the new competitive business environment. Indian banking industry is the midst of an IT revolution. Technological infrastructure has become an indispensable part of the reforms process in the banking system, with the gradual development of sophisticated instruments and innovations in market practices. These

innovations will prove an accelerating force in obtaining better productivity in banks. These innovations are as follows

OBJECTIVE OF STUDY

1) To understand IT in banking.

2) To understand concept of E banking and Internet banking.

3) To Understand New Trends in E- Banking

4) To Understand E-banking Transactions and Advantages of E –Banking

RESEARCH METHODOLOGY

The primary source of data collection in this research paper is the secondary data. The available information on E- Banking has been extensively used to complete the research paper. All the available Journals, Related books, Web, Articles, Publish and unpublished

Information Technology in Banking

Indian banking industry, today is in the midst of an IT revolution. A combination of regulatory and competitive reasons has led to increasing importance of total banking automation in the Indian Banking Industry. Information Technology has basically been used under two different avenues in Banking. One is Communication and Connectivity and other is Business Process Re-engineering. Information technology enables sophisticated product development, better market infrastructure, implementation of reliable techniques for control of risks and helps the financial intermediaries to reach geographically distant and diversified markets.

Two momentous decisions of the Reserve Bank in the 1990s changed the scenario for ever there are: one of The prescription of compulsory usage of technology in full measure by the new private Sector banks as a precondition of the license and Sector banks as a precondition of the license and other is The establishment of an exclusive research institute for banking technology institute for

Development and Invocation in Banking Technology

The bank which used the right technology to supply timely information will see productivity increase and thereby gain a competitive edge. To compete in an economy which is opening up, it is imperative for the Indian Banks to observe the latest technology and modify it to suit their environment. Not only banks need greatly enhanced use of technology to the customer friendly, efficient and competitive existing services and business, they also need technology for providing newer products and newer forms of services in an increasingly dynamic and globalize environment. Information technology offers a chance for banks to build new systems that address a wide range of customer needs including many that may not be imaginable today.

Following are the innovative services offered by the industry in the recent past:

1. Electronic Payment Services – E- Cheques

Nowadays we are hearing about e-governance, e-mail, e-commerce, e-tail etc. In the same manner, a new technology is being developed in US for introduction of e-cheque, which will eventually replace the conventional paper cheque. India, as harbinger to the introduction of e-cheque, the Negotiable Instruments Act has already been amended to include; Truncated cheque and E-cheque instruments.

2. Real Time Gross Settlement (RTGS)

Real Time Gross Settlement system, introduced in India since March 2004, is a system through which electronics instructions can be given by banks to transfer funds from their account to the account of another bank. The RTGS system is maintained and operated by the RBI and provides a means of efficient and faster funds transfer among banks facilitating their financial operations. As the name suggests, funds transfer between banks takes place on a 'Real Time' basis. Therefore, money can reach the beneficiary instantaneously and the beneficiary's bank has the responsibility to credit the beneficiary's account within two hours.

3. Electronic Funds Transfer (EFT)

Electronic Funds Transfer (EFT) is a system whereby anyone who wants to make payment to another person/company etc. can approach his bank and make cash payment or give instructions/authorization to transfer funds directly from his own account to the bank account of the receiver/beneficiary. Complete details such as the receiver's name, bank account number, account type (savings or current account), bank name, city, branch name etc. should

be furnished to the bank at the time of requesting for such transfers so that the amount reaches the beneficiaries' account correctly and faster. RBI is the service provider of EFT.

4. Electronic Clearing Service (ECS)

Electronic Clearing Service is a retail payment system that can be used to make bulk payments/receipts of a similar nature especially where each individual payment is of a repetitive nature and of relatively smaller amount. This facility is meant for companies and government departments to make/receive large volumes of payments rather than for funds transfers by individuals.

5. Automatic Teller Machine (ATM)

Automatic Teller Machine is the most popular devise in India, which enables the customers to withdraw their money 24 hours a day 7 days a week. It is a device that allows customer who has an ATM card to perform routine banking transactions without interacting with a human teller. In addition to cash withdrawal, ATMs can be used for payment of utility bills, funds transfer accounts, deposit of cheques and cash into accounts, balance enquiry etc.

Various facilities produced by ATMs-

1. cash withdrawals
2. Online account balance enquiry
3. Request for cheque book
4. Request for account statement.
5. Transfer of funds between accounts linked to one's card

6. Credit Cards

Credit card is another facility produced by E-banking. Credit card is a product. With the help of which a customer can avail various facilities or services without making immediate payment and that payment could be made at a later stage of time.

7. Point of Sale Terminal

Point of Sale Terminal is a computer terminal that is linked online to the computerized customer information files in a bank and magnetically encoded plastic transaction card that identifies the customer to the computer. During a transaction, the customer's account is debited and the retailer's account is credited by the computer for the amount of purchase.

8. Tele Banking

Tele Banking facilitates the customer to do entire non-cash related banking on telephone. Under this devise Automatic Voice Recorder is used for simpler queries and transactions. For complicated queries and transactions, manned phone terminals are used.

Services Provided by Tele Banking –

a) Accounts details
b) Stop payment services
c) Talk on phone banker
d) Cheque status inquiries
e) Cheque book or account statement requests.

9. Electronic Data Interchange (EDI)

Electronic Data Interchange is the electronic exchange of business documents like purchase order, invoices, shipping notices, receiving advices etc. in a standard, computer processed, universally accepted format between trading partners. EDI can also be used to transmit financial information and payments in electronic form.

Concept of Banking

Internet banking involves consumers using the Internet to access their bank account and to undertake banking transactions. At the basic level, Internet banking can mean the setting up of a Web page by a bank to give information about its product and services. At an advance level, it involves provision of

facilities such as accessing accounts, funds transfer, and buying financial products or services online. This is called ``transactional'' online banking

Banking services through Internet

(A) Levels of Banking services Broadly, the levels of banking services offered through INTERNET can be categorized in three types:

i) The Basic Level Services use the banks' websites which disseminate information on different products and services offered to customers and members of public in general. It may receive and reply to customers' queries through e-mail,

(ii) In the next level are Simple Transactional Websites which allow customers to submit their instructions, applications for different services, queries on their account balances, etc, but do not permit any fund-based transactions on their accounts,

(iii) The third level of Internet banking services are offered by Fully Transactional Websites which allow the customers to operate on their accounts for transfer of funds, payment of different bills, subscribing to other products of the bank and to transact purchase and sale of securities, etc. Most of the banks providing Internet banking products and services offer, to a large extent, an identical and standard package of banking services and transactional capabilities.

(B) Structure of Banking services In general, Internet banking products are offered in a two-tiered structure.

A basic tier of Internet banking products includes customer account inquiry, funds transfer and electronic bill payment.

A second or premium tier includes basic services plus one or more additional services such as

1) Brokerage.

2) Cash management.

3) Credit applications.

4) Credit and debit cards.

5) Customer correspondence.

6) Demat holdings.

7) Financial advice Foreign exchange trading.

9) Insurance.

10) Online trading.

11) Opening accounts

12) Requests and intimations.

13) Tax services.

14 E-shopping.

15) Standing instructions.

16) Investments.

17) Asset management services etc. In traditional banking, the customer has to visit the branch of the bank in person to perform the basic banking operations viz., account enquiry, funds transfer, cash withdrawing etc.,

E-banking Transactions

The following are some of the basic functions in Internet Banking: Account Enquiry Fund Transfer Payment of Electricity, Water and Telephone bills Online payment for transactions actually performed through Internet Request for issuance of cheque books, demand drafts etc., Statement of accounts Access to latest schemes Access to rates of interest and other service charges Models for E-Banking To implement effectively E-banking and augment the level of technology the following models have been suggested:

(i) Complete Centralized Solution (CCS)

(ii) Cluster Approach

(iii) High Tech Bank within Bank Complete Centralized Solution of the above three models, the Complete Centralized Solution (CCS) is the ideal branch network model on which E-banking and efficiently. Features of CCS The following are the features of Complete Centralized Solution:

1. The entire system software, data for the entire bank etc., are stored in a centralized server with its hot standby server being placed at a different location and connected through high speed and efficient network.

2. Branches are provided with online nodes to receive requests from customers and to provide services across the counter.

3. The nodes provided at remote branches are connected through effective satellite links with enough redundancy to provide reliability as well as adequate bandwidth.

4. Skilled manpower is required only at the Centralized location

Advantages of E –Banking

(i) Round the clock banking E-banking facilitates performing basic banking transactions by customers round the clock globally. In fact there is no restricted office hours for E-banking.

(ii) Convenient Banking Customers can perform basic banking transactions by simply sitting at their office or at home through PC or LAPTOP. No personal visit to the branch is required for routine basic transactions.

(iii) Low Cost Banking- The operational costs have come down due to technology adoption. The cost of transactions through internet banking is much less than any other traditional mode. There is also much saving on the cost of infrastructure as the banks can have access to a greater number of potential customers without the commitment costs of physically opening branches. Moreover, requirements of staff at the banks get reduced to a greater extent.

(iv) Profitable Banking The increased speed of response to customer requirements can enhance customer satisfaction and consequently can lead to higher profits as a result of handling more number of customer accounts.

(v) Quality Banking Internet banking allows the possibility of improved quality and an enlarged range of services being made available to customers.

(vi) Speed Banking -The increased speed of response to customer requirements will lead to greater customer satisfaction and handling a large number of transactions at a lesser time. Thus, it increases the customers' convenience to a greater extent and facilitates better customer retention.

(vii) Service Banking Banks can also offer many cash management products. Instant credit, one day credit, immediate payment of utility bills, instant transfer of funds etc., is possible under E-banking. Internet banking is widely used, especially by individuals and small and medium businesses, because it is easy and convenient, available 24 hours a day, seven days a week and typically incurs far less bank fees than going in to a branch to do banking.

CONCLUSION

The Modern Banking has become a wholly customer driven and technology driven. Technology has been dramatically transforming the banking activities in India. Driven by the challenges of competition, rising customer, expectations and shrinking margins, banks have been using technology to reduce cost and enhance efficiency, productivity and convergence.

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STUDY OF FRESHWATER HYPHOMYCETES FROM PARNER TEHSIL OF AHILYANAGAR DISTRICT (M.S.), INDIA

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ABSTRACT

Aquatic hyphomycetes play a vital role in freshwater ecosystems by contributing to leaf litter decomposition and nutrient cycling. Despite their ecological importance, information on their diversity and distribution in many regions of India remains limited. The present study documents freshwater hyphomycetes from Parner Tehsil of Ahilyanagar District, Maharashtra, India. Fungal samples were collected from foam, water, and submerged leaf litter at Lonimavala Dam, Nighoj Potholes, Tikhol Dam, and Rui Chondha Waterfall. Identification was based on morphological characteristics and conidial features. Seven species were recorded, namely Anguillospora longissima, Dwayaangam dichotoma, Flabellospora multiradiata, Flabellospora verticillata, Helicosporium phragmitis, and Lateriramulosa uni-inflata. This study enhances the understanding of freshwater fungal diversity in the region and highlights the need to conserve freshwater habitats supporting microfungal biodiversity.

KEYWORDS

Aquatic, Hyphomycetes, Lonimavala Dam, Nighoj, Maharashtra

INTRODUCTION

Freshwater hyphomycetes are a specialist category of asexual fungi that perform a critical ecological role in freshwater habitats. These fungi predominantly colonise and degrade submerged plant litter, such as fallen leaves and woody debris, in both flowing (lotic) and motionless (lentic) water bodies. Through the decomposition process, freshwater hyphomycetes reduce complex organic molecules into simpler forms, thereby releasing important nutrients into the aquatic environment. This nutrient release supports microbial activity and contributes to nutrient cycling, which is fundamental for maintaining the structure and functioning of aquatic food webs. As a result, freshwater hyphomycetes are key contributors to the productivity, stability, and ecological balance of freshwater habitats (Bärlocher, 1992; Suberkropp, 2003).

Despite their ecological importance, knowledge of freshwater hyphomycete diversity and distribution remains incomplete, particularly in tropical and semi-arid regions such as India. Most available studies are restricted to a few geographical areas, and comprehensive regional or locality-based surveys are limited. This lack of information is more pronounced at the local scale, where variations in climate, hydrology, and vegetation can strongly influence fungal community composition (Srivastava et al., 2013). Parner Tehsil, located in the Ahilyanagar District of Maharashtra, India, encompasses a range of freshwater habitats, including streams, seasonal rivers, ponds, tanks, and reservoirs. These water bodies are influenced by semi-arid climatic conditions, irregular rainfall patterns, and seasonal water availability, which together create unique ecological settings for freshwater fungi. However, systematic investigations on freshwater hyphomycetes from this region are scarce, and their diversity remains largely undocumented. The present study aims to investigate the diversity, occurrence, and distribution of freshwater hyphomycetes in various freshwater habitats of Parner Tehsil. By generating baseline data, this research seeks to enhance understanding of freshwater fungal diversity in semi-arid regions of Maharashtra. The findings will contribute to regional mycological knowledge and provide a valuable reference for future studies related to freshwater ecology, biodiversity assessment, and conservation of aquatic fungal communities.

MATERIAL AND METHOD

The present study was carried out to document the diversity and occurrence of freshwater hyphomycetes in Parner Tehsil of Ahilyanagar District, Maharashtra, India. Sampling was conducted from different freshwater habitats, including fast-flowing streams near dam sites, seasonal rivers, and associated aquatic environments. Standard methods commonly used for the study of freshwater hyphomycetes were followed with minor modifications to suit local field conditions. To record the hyphomycete flora, three major types of samples were analysed: naturally formed foam, water samples, and submerged plant debris such as leaves and twigs. Submerged leaves and small woody fragments were collected from running water using clean forceps and placed in sterile polythene bags. Care was taken to select partially decomposed leaves, as they are known to support higher fungal colonization. The samples were transported to the laboratory and incubated in sterile distilled water at room temperature (approximately 30 °C). During incubation, leaf blades, petioles, and small twigs were periodically examined on alternate days for the development of hyphomycete colonies. Portions of the incubated material were gently teased and mounted in lactophenol or water for microscopic observation. Emerging conidiophores and conidia were observed using a compound light microscope, and morphological features were recorded for identification.

Foam samples, which are known to concentrate conidia of freshwater hyphomycetes, were collected directly from the surface of flowing water at sampling sites. The foam was carefully transferred into clean bottles and immediately preserved in formalin–acetic acid–alcohol (FAA) solution to prevent decomposition. In the laboratory, preserved foam samples were thoroughly mixed, and aliquots were examined microscopically to detect and identify fungal spores. Water samples were also collected to supplement the study. Approximately two liters of water were collected from each test station in sterile polythene bottles and brought to the laboratory. The samples were allowed to settle, and the suspended matter was tested for the presence of fungal conidia. Identification of freshwater hyphomycetes was based mostly on conidial morphology, including form, size, septation, and branching pattern. Standard taxonomic keys, original species descriptions, and relevant literature were consulted for appropriate identification. Repeated observations were made to confirm species identity. The combined analysis of foam, water, and submerged plant material provided a comprehensive assessment of freshwater hyphomycete diversity in the study area, following established methodologies described in earlier studies (Ingold, 1975; Iqbal & Webster, 1973; Webster, 1975; Subramanian & Bhat, 1981; Sridhar & Kaveriappa, 1982, 1984, 1989; Chandrashekar et al., 1986; Sridhar et al., 1992).

RESULT AND DISCUSSION

1. Anguillospora longissima (Sacc. and Sydow) Ingold Trans. Br. Mycol. Soc., 25: 401, 1942.

= Fusarium elongatum De Wildeman Ann. Soc. Belge. Microsc., 17: 42, 1893.

= Fusarium longissimum (Dewild.) Saccardo and Sydow Syll. Fung., 14: 1128, 1899.

Description: Unbranched, elongated, 8-12 septate, sigmoid with curvature in more than one plane, 200-280 X 2.5-3.5 µm.

Matrix: Foam sample.

Loc: Lonimavala Dam, Parner

Date: April 2024

Note: The present fungus is commonly observed in the study area. The measurements and morphological characteristics of its conidia closely match the original description of Anguillospora longissima provided by Ingold (1942). Based on this agreement, the fungus is identified as A. longissima. This species was first reported from North Maharashtra by Borse and Patil (2007).

2. Dwayaangam dichotoma Mycotaxon. 24:217 (1985).

Description: Conidia tetraradiate, hyaline and white, main axis 10-13.8×4-2.5 µm, one to two (usually one) septate, branched dichotomously at the apex giving rise to 2 very small arms, resting in the same

plane as the main axis. Conidium with mainly 4 arms, occasionally 3, rarely 2, 20-28×2-4 µm, tapering towards the apex, 4-6 septate, bending slightly outwards.

Matrix: Foam sample.

Loc: Tikhol Dam

Date: April 2024

Note: The identification of the present specimen is based on morphological characters that closely match the original descriptions of the species. Sati et al. (2002a) reported this species from submerged leaves and foam samples and documented it as a new addition to the aquatic fungal flora of India. This species is being documented for the first time in freshwater from the research area.

3. Flabellospora multiradiata, Nawawi. Trans. Br. Mycol. Soc. 66:543. (1976).

Description: A conidium consists of a short obpyriform, main axis 9-13 µm long and 2-3 µm wide at the base, spreading above to form a globose structure 4-6.5 µm in diameter. Arms normally 9-20. Each arm is 90-140 µm length and 10-18 septate.

Matrix: Foam sample.

Loc: Kalu River, Takali Dhokeshwar

Date: Sep 2024

Note: The conidial measurements and morphological characteristics of the present collection closely match those described for Flabellospora multiradiata, and the specimen is therefore assigned to this species. Previous studies have reported its occurrence in freshwater habitats of the Western Ghats forest region (Sridhar & Kaveriappa, 1984, 1989) and in foam samples (Ramesh & Vijaykumar, 2005). In the present study, this species was rarely encountered in the study area of Ahilyanagar District.

4. Flabellospora verticillate Alasoadura. Nova Hedwigia. 15:419 (1968).

Description: Conidia multi-radiate, consisting of a main axis and 5-10 radiating arms; main axis 14.13×1.5-2 µm, 2-5 septate, with terminal cells obclavate; each arm 8-14 septate, 50-90×4.5-5 µm.

Matrix: Foam sample.

Date: Sep 2024

Loc: Dhoki Dam

Note: Subramanian and Bhat (1981), Sridhar and Kaveriappa (1988, 1989), and Ramesh and Vijaykumar (2005) reported the occurrence of this species from South India and described it as rarely encountered. The present study records this species for the first time from the study area.

5. Helicosporium phragmitis Honnel. Annals. Mycol. 3:338 (1905).

Description: Colonies raised cottony pale grey; conidiophores: branching, colourless to pale brown, 122-240 µm × 2.6-6 µm. Conidia: helically coiled 2-4 times in one plane, colourless, 12-20 µm in diameter and 1.2-2.6 µm thick, filamentous, with 7-15 septa.

Matrix: Conidia in foam sample and on submerged leaf litter.

Loc: Sep 2024

Date: Mandoval Dam Karjule Hyrya

Note: The present fungus was frequently encountered during the study period. The morphological characteristics of the collected specimens closely correspond to those described in the original species description; therefore, the fungus is assigned to the same species. This species was first reported from foam samples and leaf litter in Maharashtra State, India, by Shinde and Pawar (2008).

6. Lateriramulosa uni-inflata Matsush. "Microfungi of the Solomon Islands and Papua-New Guinea (Osaka)", pp. 34 (1971).

Description: Conidia: hyaline, detached by fission, 20-23 µm in diam. They appear as little triangles, which comprise of one main axis, 6.5-9 x 1.6-2 µm, and three branches measuring 7.5-10 x 3.5-4 µm; the lower two branches are made of a swollen basal section and a spike-like seta. The upper arm has only one half of its base enlarged. Marvanova (1973) said that it would be better to call this fungus as "water-borne".

Matrix: Foam sample.

Date: April 2024

Loc: Ruichonda water fall Mhasoba zap Parner

Note: The conidial measurements and morphological characteristics of the present collection closely correspond to those reported for Lateriramulosa uni-inflata by Matsushima (1971a). Accordingly, the specimen is assigned to this species. In the present study, the species was encountered occasionally in the study area.

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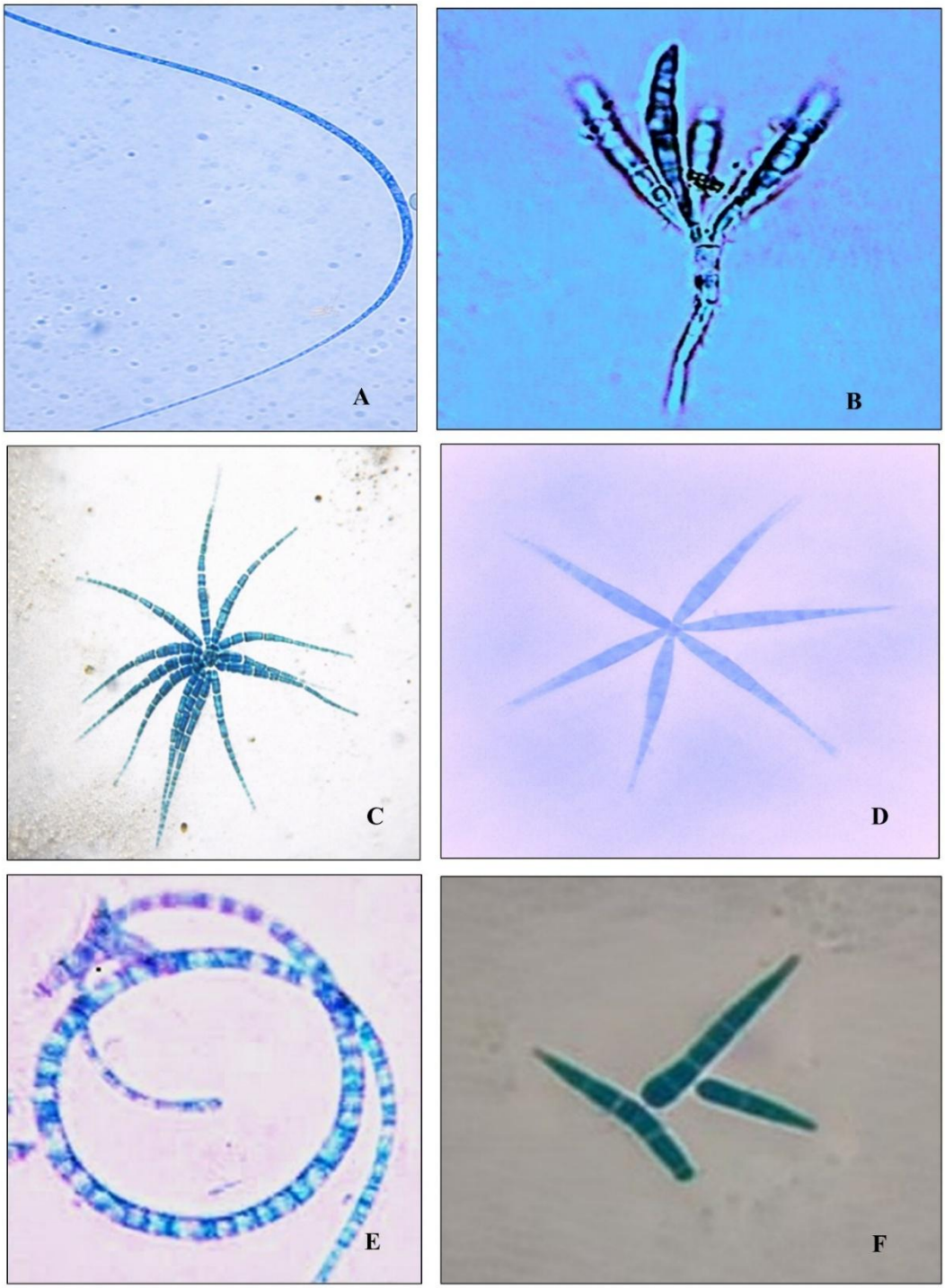

Plate 1. A. *Anguillospora longissimi* (Sacc. and Sydow) Ingold; B. *Dwayaangam dichotoma* Nawawi C. *Flabellospora multiradiata* Nawawi. D. *Flabellospora verticillate* Alasoadura; E. *Helicosporium phragmitis* Honnel F. *Lateriramulosa uni-inflata* Matsush.

Photograph:

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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

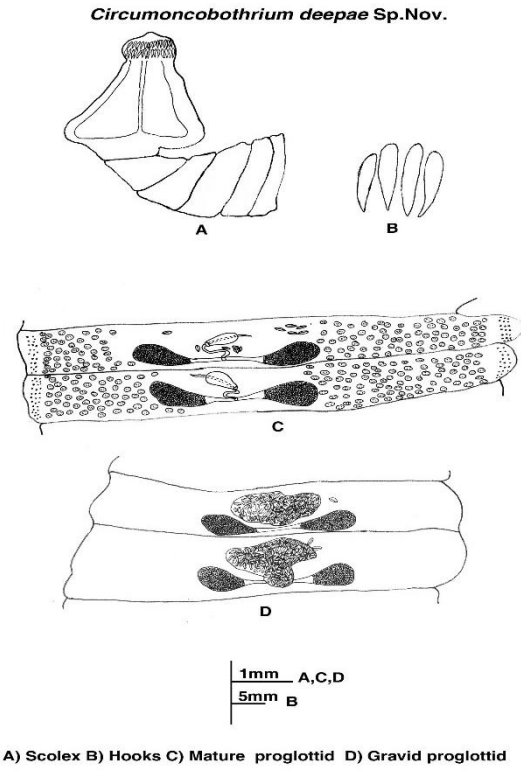
INTRODUCTION

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.

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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REIMAGINING FAITH AND POWER: RELIGION IN CHIMAMANDA NGOZI ADICHIE'S NARRATIVES

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ABSTRACT

This paper examines the role of religion in Chimamanda Ngozi Adichie's fiction, arguing that it operates not merely as a thematic backdrop but as a structural and ideological force shaping personal identity, communal belonging, and political consciousness. Through close readings of Purple Hibiscus, Half of a Yellow Sun, Americanah, and selected short stories, the analysis situates Adichie's portrayal of faith within broader postcolonial debates, drawing on theorists such as Frantz Fanon, Juliana Makuchi Nfah Abbenyi, Norma Alarcón, and Obioma Nnaemeka. Adichie's narratives reveal religion as dynamic, fluid, and deeply entangled with colonial memory, gendered hierarchies, and cultural survival, ultimately offering a pluralistic and dialogic vision of spirituality in contemporary African literature.

KEYWORDS

Ideological force, Political consciousness, Postcolonial debates, African literature

INTRODUCTION

Religion in postcolonial African literature often appears as a contested terrain a repository of trauma, cultural memory, and negotiated identity. Chimamanda Ngozi Adichie's writing exemplifies this complexity, embedding spiritual practices within the psychological, familial, and political matrices of her characters' lives. Rather than portraying religion in binary terms Christianity versus tradition, belief versus unbelief, Adichie foregrounds its social dynamism. Religious experience functions as both a stabilizing force and a site of conflict, shaping the moral economy of her fictional communities.

This article explores Adichie's representation of religion as a multifaceted entity: a colonial legacy, a familial ideology, a tool of patriarchal control, and a reservoir of indigenous resilience. By examining its role in character formation and sociopolitical critique, the study reveals Adichie's nuanced engagement with the spiritual dimensions of postcolonial identity.

Religion as Narrative and Social Structure

Religion in Adichie's fiction is not a passive motif; it actively structures narrative movement and character development. The moral rules, ritual practices, and inherited doctrines that govern her characters' worldviews provide the scaffolding for both conflict and transformation. By situating religious experiences within intimate family settings and broader national crises, Adichie shows how spirituality becomes a lived practice through which individuals negotiate their place in the world.

Importantly, she refuses to privilege a single system of belief. Christianity, Igbo cosmology, and diasporic religious forms coexist, clash, and hybridize. This pluralistic framing aligns with postcolonial theorist Frantz Fanon's claim that "reclaiming indigenous traditions is essential for cultural revival and resistance to colonial alienation" (Fanon 44). Adichie's work echoes this argument, illustrating how spiritual plurality becomes a space for reclaiming identity and resisting the homogenizing effects of missionary Christianity.

Indigenous Cosmologies and Colonial Christianity

A defining aspect of Adichie's religious discourse is her reclamation of African spiritual epistemologies. The Igbo worldview rituals, shrines, libations, ancestral veneration serves as a counter-narrative to Western religious orthodoxy. In Purple Hibiscus, Papa-Nnukwu personifies the endurance of indigenous beliefs in the face of Catholic authoritarianism. His spirituality teaches Kambili that faith need not be rooted in fear and punishment but can emerge from communal harmony and cultural belonging. His presence counters Papa Eugene's rigid Catholicism, revealing the ideological violence embedded in colonial missionary practices.

Adichie's attention to indigenous cosmologies is not nostalgic. Rather, it is dialogic, foregrounding the ways traditional spiritual systems persist, adapt, and influence contemporary identities. As Norma Alarcón argues that "the inclusion of African traditional faiths challenges Western canons and validates colonized peoples' spiritual heritage" (Alarcón 118). Through Papa-Nnukwu and similar figures, Adichie re-centres indigenous cosmologies as equally legitimate frameworks for moral reasoning and communal life.

Religion, Power, and Identity in Half of a Yellow Sun

In Half of a Yellow Sun, Adichie situates religion within the sociopolitical tensions of postcolonial Nigeria. Olanna's encounter with missionary Catholicism reflects its entanglement with colonial hierarchies. Her elite education presents Western Christian doctrine as a civilizing force, yet she quickly becomes aware of its paternalistic and racial undertones. This tension illuminates how religion becomes a vehicle for reinforcing class and gender hierarchies.

Conversely, "Ugwu's spiritual formation is grounded in indigenous ritual practices before encountering Christian liturgy for the first time. His awe at Catholic ritual the incense, vestments, and chanting" (Adichie Half 34) reveals how religious aesthetics can exert power independent of doctrine. Norma Alarcón describes this as a "hybrid consciousness, in which postcolonial subjects navigate between imposed and ancestral faiths" (Alarcón 112). Adichie thus foregrounds religious identity as fluid and situational rather than fixed or monolithic.

The Biafran War intensifies this hybridity. Prayer becomes both a survival mechanism and a political tool. "Ugwu participates in wartime services where Psalms intermingle with appeals for military victory" (Adichie 158). Yet the same scriptures are co-opted to justify acts of vengeance, exposing their ideological ambivalence. Fanon's three-stage model of anticolonial struggle provides a useful lens for interpreting this ambivalence: Christianity initially internalized as a colonial legacy, then countered by indigenous rituals, and finally transformed into a battlefield where religious identities intertwine with political resistance.

Domestic Tyranny and Alternative Faith in Purple Hibiscus

In Purple Hibiscus, religion moves from the public sphere to the heart of domestic life. Papa Eugene's ascetic Catholicism becomes a mechanism of patriarchal domination. His punitive spiritual discipline "beatings for minor deviations from ritual" (Adichie 45) illustrates how religious authority can be weaponized within family structures. Obioma Nnaemeka argues that "such portrayals highlight how patriarchy often masquerades as piety, disciplining women's bodies through clerical control" (Nnaemeka 73).

Yet Adichie juxtaposes this oppressive religiosity with Aunty Ifeoma's vibrant, intellectually open Catholic practice. Her household demonstrates that spiritual belief can nurture curiosity, independence, and communal joy. The contrast between Eugene's rigid orthodoxy and Ifeoma's liberatory faith challenges the assumption that religion is inherently oppressive. As Chikwenye Ogunyemi notes, "Adichie emphasizes the diversity of religious experience, compelling readers to view faith as a lived practice shaped by its interpreters" (Ogunyemi 105).

Diasporic Transformations of Faith in Americanah

In Americanah, Adichie shifts focus from Nigeria to the global stage, examining how religion transforms as it travels across borders. Ifemelu's encounters with American megachurches and Nigerian diasporic congregations reveal the commercial spectacle and patriarchal underpinnings of certain charismatic movements. Prosperity preachers flaunt material excess under the guise of divine blessing (Adichie 213), while "a Newark pastor reiterates gender-submissive doctrines reminiscent of Papa Eugene" (Adichie 217).

Ifemelu's blog, a hybrid form of cultural commentary and personal narrative, becomes a space for critiquing these religious transplants. Adichie thus illustrates how faith mutates under globalization, sometimes reinforcing rather than dismantling power structures. For immigrants navigating cultural displacement, religion can become either a stabilizing community or an instrument that ossifies patriarchal interpretations.

Spiritual Dislocation in Adichie's Short Fiction

Adichie's short stories extend her exploration of religious identity into the terrain of migration and personal longing. In "The Thing Around Your Neck," the protagonist's difficulty finding a "home church" symbolizes her fractured sense of belonging (Adichie 12). Ritual becomes inseparable from place; dislocation erodes the emotional resonance of familiar liturgies.

"On Monday of Last Week" foregrounds the tension between indigenous faith and Western Anglicanism. The narrator's recollection of her mother's shrine contrasts with the sterility of the cathedrals she now attends, suggesting that traditional spirituality offers clarity and grounding absent in institutionalized religion (Adichie 45). These narratives reinforce Adichie's insistence that spiritual plurality is intrinsic to postcolonial subjectivity.

CONCLUSION

Across her novels and short stories, Chimamanda Ngozi Adichie positions religion as a dynamic force shaping individual and collective identities. Her narratives reveal the layered interactions between indigenous cosmologies and Christian doctrine, between spirituality and patriarchy, and between religious ritual and political crisis. By highlighting both the liberating and oppressive potentials of faith, Adichie urges readers to view religion as a lived, contested practice rather than a static doctrine. Her work not only critiques colonial and patriarchal appropriations of spirituality but also affirms the resilience and adaptability of African religious traditions in the twenty-first century.

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SOME SPECIES OF SOIL HYPHOMYCETES FROM BHOKARDAN TEHSIL

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ABSTRACT

The present investigation was undertaken on isolation, culturing and taxonomic studies of soil borne hyphomycetes from Bhokardan Tehsil of Jalna District. The fungi were cultured on Oatmeal Agar and potato dextrose agar. Hyphal structure, conidiophore morphology, conidia size and appearance, and the distinctive characteristics of specific species were observed.

KEYWORDS

Hyphomycetes, soil, morphological characterization, fungal isolation.

INTRODUCTION

Soil hyphomycetes, a diverse group of filamentous fungi, play a crucial role in terrestrial ecosystems by contributing significantly to organic matter decomposition and nutrient cycling. These ubiquitous microorganisms, often dominating the microbial biomass in soil habitats, are integral to maintaining soil health and fertility, transforming complex organic materials into bioavailable forms for plants and other organisms (Choudhary et al., 2022). This decomposition process, critical for nutrient cycling, involves the breakdown of organic matter into simpler substances by various microorganisms, including fungi, bacteria, and actinomycetes, thereby influencing the formation and stabilization of soil organic matter (Zhan, 2024). Specifically, the physiological, morphological, and biochemical traits of these fungi directly influence their potential for soil organic matter formation (Whalen et al., 2024). Beyond decomposition, soil hyphomycetes also contribute to ecosystem multifunctionality, supporting vital processes like carbon cycling and influencing the intricate interactions within the soil food web (Xu et al., 2025). Their functional importance extends to mediating essential biogeochemical cycles, such as carbon, nitrogen, and phosphorus, underscoring their irreplaceable role in ecosystem sustainability and resilience (Wu et al., 2023).

Study Area: The Tehsil has a semi-arid climate determined by the Southwest monsoon's periodicity, a flat topography, and no perennial streams (Ferrant et al., 2019). Generally speaking, the elevation is between 800 and 1200 meters above sea level, with the western regions typically being higher (Sinchana et al., 2024). The Holocene strata' very mild relief effectively eliminates orographic

influences on the local climate (Šećerov et al., 2018). According to Raja et al. (2018), the topography is mainly made up of dissected alluvial plains over basaltic landforms with slight elevation differences. The Shuttle Radar Topography Mission Digital Elevation Models' low topographical diversity verifies a comparatively homogeneous surface with only slight undulations (Loliyana & Patel, 2020). The hydrogeology of the area is significantly shaped by this geological setting, which has an impact on groundwater recharge and discharge mechanisms (Radhakrishnan & Elango, 2011).

MATERIALS AND METHODS

Fungal samples from several places in Jalna District's Bhokardan Tehsil will be collected, examined, and identified for this study. The sites that were chosen included some trash disposal locations, parks and agricultural regions, and the edges of forests. Fallen leaves, branches, twigs, bark, seeds, and fruits exhibiting fungal development were among the samples that were gathered. According to Warcup's description, the fungi were separated from these samples (1950).

RESULT AND DISCUSSION

1. Cladosporium britannium Ellis.

More Dematiaceous Hyphomycetes, CMI: 328 (1976)

Conidiophores are smooth, up to 200–300 µm long, 3–6 µm thick, straight, upright, or flexuous, dark brown, and lighter toward the apex. Conidia can be solitary, ellipsoidal, or dolipore; they are smooth, light to mid-brown, and measure 0.6–16 µm × 6.4–6.5 µm with distinct truncation scars at one or both ends.

Matrix: Agricultural soil

Loc: Ghanegaon Tanda

Date: 2 April 2024

Ellis (1976) collected it on dead wood of Acer, Fagus, and Quercus from Great Britain and described it as a new species. The present collection is a new record for India.

2. Drechslera rostrata (Drechslera) Richardson and Fraser.

Trans. Br. Mycol. Soc. 51:148 (1968).

Mycelium is submerged and velvety; colonies are effuse, brownish or blackish brown; conidiophores are single or in small groups, straight or flexuous, brown to dark brown, up to 160 to 180 µm long, and 5 to 8 µm thick. Conidia are rostrate, obclavate, 5–17 pseudoseptate, thick or straight curved, hyaline or very pale, and divided by thick, black septa; intermediate cells are golden brown, 95–99 µm long, and 18 µm thick at the broadest section. Hilum is noticeably protruding.

Matrix: Agricultural soil

Loc: Pokhari

Date: 5 April 2024

Bahekar (1966) reported this species for the first time from India. Harsh et al. (1990) reported it as a new forest pathogen causing leaf spot of Dendrocalamus strictus. From Maharashtra, Lande and Utikar (1978) described it as a pathogen responsible for fruit rot of pomegranate. The characters of the present collection are similar to those of the original description; however, the conidia are slightly shorter.

3. Phaeoisaria clematidis (Fuckel) Hughes.

Can. J. Bot. 36:795 (1958).

Synnemata are subulate, up to 2-2.5 mm high but typically less than 1 mm, with individual threads that are 2.5-3 µm thick, 29-93 µm thick at the base, and 6.5-2.5 µm thick at the apex. Conidiogenous cells are pale brown, cylindrical or clavate, and typically have a large number of cylindrical denticles. Conidia are 5×2-2.5 µm, fusiform or narrowly ellipsoidal.

Matrix: Agricultural soil

Loc: Pokhari

Date: 5 April 2024

The characters of the present species are similar to those of the original description. It is rare.

one in the study area.

4. Stachybotrys nepherospora Hansf.

Proc. Linn. Soc. Lond. 44 - 45 (1943).

Near the tip, conidiophores are smooth and hyaline, up to 124 µm long and 3.5 × 4.2 µm thick. They are frequently dark grey and verrucose. Phialides range in length from 7.2 to 12.5 µm, with the largest part being 3.5 to 6.5 µm thick. Conidia are reniform or kidney-shaped, smooth or verrucose, 6.5–12.5 µm x 3.5–7 µm, and nearly black.

Matrix: In Soil

Loc: Nalni

Date: 3 August 2024

Ponappa (1970) first collected this species on the dead stem of Carica papaya in Karnataka state. The present collection is a new record for the state.

5. Taeniolella muricata (Ellis & Everh.) Hughes.

Can. J. Bot. 36:817 (1958).

Colonies are dark brown and effuse. Conidiophores are brown, 3.4–5.8 µm thick, and widely distributed. Conidia are usually 2.5–21.5 septate, brown, and verruculose. 25.5-100×6-8.5 µm.

Matrix: In Soil.

Loc: Nalni

Date: 3 August 2024

The present collection is found in soil as a saprophyte but is rare in occurrence.

6. Phialophora fastigiata (Lagerb, Lundberg & Melin) Conant.

Mycologia. 29: 598 (1937).

Onidiophores vary greatly in thickness, length, and 3-3.9 µm. Lageniform phialides, 9.5-15.5 × 2.9-3.5 µm. Conidia are 3.5–6.9 × 1.5–2.9 µm, colorless to extremely pale brown.

Matrix: Agricultural Soil

Loc: Jadhavwadi

Date: 12 September 2024

The characters of the present collection are similar to those of the original description. This is a new record for India.

7. Verticillium tenuissimum Corda.

Icon. Fung. 1:20 (1887).

Colonies are hairy and dark brown. Conidiophores: 170 µm, 3-6 µm thick immediately above the basal swelling, tapering to 3-4 µm at the tip; dark brown below, whiter above. The phialides are carried directly on the stipe at the apex and in 1–5 verticals underneath septa; lateral branches are incredibly infrequently formed. Phialides lageniform, with distinct collarettes; hyaline to very pale brown; 6.3–11.5 µm in length; 2.7–3.8 µm in thickness in the largest part; neck around 1 µm in width. Conidia are 2.7 x 1.5-2 µm, hyaline, cylindrical, and rounded at the ends.

Matrix: Agricultural soil

Loc: Jadhavwadi

Date: 12 September 2024

The present collection is new to the study area

8. Cordana musae (Zimm) Hohnel.

Zentbl. Bakt. Parasitkede. Abt. 2, 60:7 (1923).

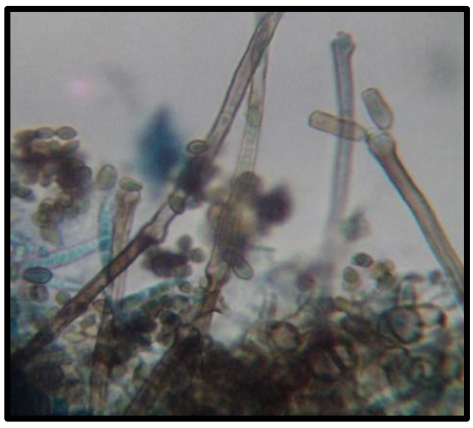
Conidiophores can be straight or flexuous, with smooth, pale to mid-brown nodes, up to 225 µm in length, 3.3 x 6.6 µm in thickness, typically 8 x 12 µm at the base, with terminal and intercalary swelling of 6.6-8 µm in diameter. Conidia are single or tiny pegs that emerge from terminal swelling and develop into intercalary, bovid, or pyriform structures. They are smooth, pale brown, and measure 8 by 18 µm in length and 6.6 by 12 µm in thickness in their largest section.

Matrix: Cultivated soil

Loc: Jadhavwadi

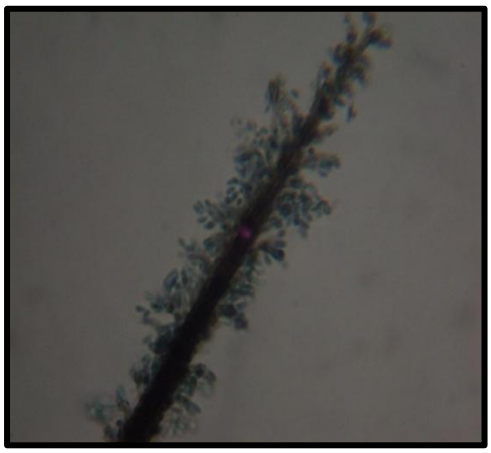
Date: 12 September 2024

The species is responsible for diamond leaf spot disease of banana (Subramanian, 1957) and also curd rot in cauliflower (Harbola and Khulbe, 1994). The conidiophores and conidia in the present collection are slightly larger.

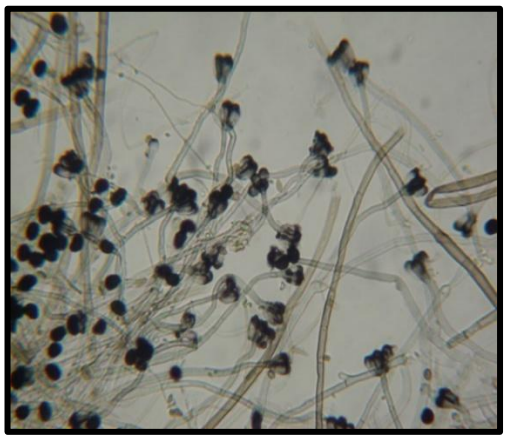


1.Cladosporium britannium

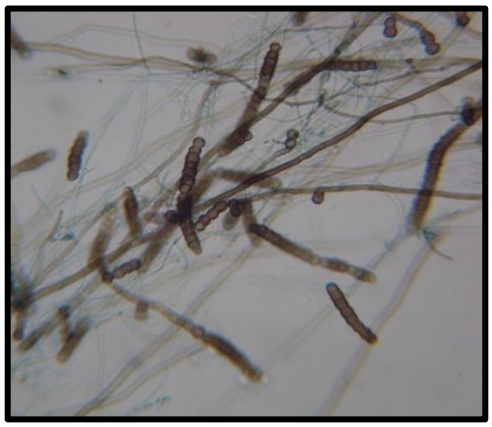
2. Drechslera rostrata



3.Phaeoisaria clematidis

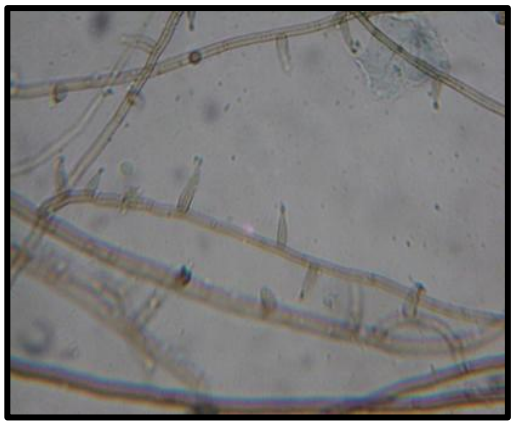


4. Stachybotrys nepherospora



5. Taeniolella muricata

6.Verticillium tenuissium



7. Phialophora fastigiate

8. Cordana musae

Fig: Hyphomycetes fungi from the Bhokardan tehsil of Jalna district

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REVIEW ON ECO-FRIENDLY MANAGEMENT OF PAPAYA FUNGAL DISEASES

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ABSTRACT

Fungal diseases significantly reduce yield and post-harvest quality of papaya worldwide, particularly due to anthracnose and fruit rot pathogens that cause severe losses during storage and marketing (Bautista-Baños et al.,2013; Peralta-Ruiz et al.,2023). Increasing concerns regarding fungicide resistance, chemical residues on fruits and environmental safety have encouraged the search for sustainable and eco-friendly alternatives to conventional disease management practices (Tripathi and Dubey, 2010; Romanazzi et al.,2020). For several decades, synthetic chemical pesticides have been widely used to control plant diseases; however, their excessive and repeated application has resulted in environmental pollution, negative impacts on human health and the emergence of resistant pathogen populations (Sharma et al.,2019; Romanazzi et al.,2022). In this context, antifungal plant activity has emerged as a promising eco-friendly approach, as medicinal and aromatic plants synthesize bioactive secondary metabolites such as phenolics, flavonoids, terpenoids, alkaloids and essential oils with strong antifungal properties (Tripathi and Dubey, 2010; Nazzaro et al.,2017; Chandra et al.,2021). Several studies have demonstrated that plant extracts and essential oils effectively suppress major papaya fungal pathogens, reduce disease severity and delay post-harvest decay when applied as pre- or post-harvest treatments (Bautista-Baños et al.,2013; Sivakumar et al.,2021). Recent advances, including edible coatings enriched with plant bioactive compounds and nano-formulated botanical products, have further enhanced antifungal efficacy and significantly extended papaya shelf life during storage (Romanazzi et al.,2020; Oliveira Filho et al.,2022; Peralta-Ruiz et al.,2023). This review summarizes current knowledge on plant-based antifungal strategies and highlights their potential role in the development of sustainable papaya disease management systems (Tyagi et al.,2024).

KEYWORDS

Papaya; Fungal diseases; Antifungal plant activity; Botanical extracts; Bioagent; Sustainable agriculture

INTRODUCTION

Papaya (*Carica papaya* L.) is a widely cultivated tropical fruit crop recognized for its nutritional richness, medicinal importance, and economic value. The fruit is an excellent source of vitamin C and provitamin

A (β-carotene) and also supplies essential minerals such as calcium, iron, and phosphorus, which contribute to human health and dietary balance (Mitra *et al.,*2019; FAO, 2022). Ripe papaya is characterized by a high moisture content, typically ranging from 85 to 90%, along with naturally occurring sugars, dietary fiber, and small amounts of protein. These compositional attributes enhance fruit palatability, digestibility, and consumer preference across diverse populations (Singh et al.,2018; Workneh & Osthoff, 2020). In addition to its nutritional benefits, papaya is valued for papain, a proteolytic enzyme obtained from the latex of unripe fruits. Papain plays an important role in the food, pharmaceutical, cosmetic, and textile industries and is commonly utilized as a meat tenderizer, digestive aid, and in various medicinal preparations (Aravind et al.,2019; Salunkhe & Kadam, 2014). Beyond the fruit, several other plant parts have notable uses. Papaya leaves have been reported to contain bioactive compounds with antioxidant and therapeutic properties, while the roots, stems, and bark are traditionally used in herbal medicines and for fiber-related applications in some regions (Nisar et al.,2017; Yogiraj et al.,2019).

Green papaya fruits, flowers, and young leaves are widely consumed as cooked vegetables in tropical and subtropical countries, thereby increasing the overall economic value of the crop (Mitra et al.,2019). Owing to its affordability, multiple uses, and high nutritional content, papaya is often described as the “common man’s fruit” in many developing nations. Global papaya production has shown a steady increase over the past decade due to rising consumer demand and advancements in cultivation practices. India currently ranks as the largest producer, accounting for more than 40% of global output, followed by Brazil, Mexico, and Indonesia (FAO, 2022; NHB, 2023). Despite its global importance, papaya productivity and postharvest quality are severely constrained by fungal diseases, underscoring the need for effective, sustainable, and integrated disease management strategies.

Major Fungal Diseases of Papaya

Papaya (*Carica papaya* L.) is highly susceptible to several fungal diseases that adversely affect plant growth, fruit quality, and postharvest life, particularly under warm and humid tropical environments (Ploetz, 2021; Bautista-Baños et al.,2021). These diseases result in substantial yield losses and significantly reduce fruit marketability during storage, transportation, and marketing.

Anthracnose, caused mainly by *Colletotrichum gloeosporioides* and related *Colletotrichum* species, is considered the most destructive fungal disease of papaya worldwide. The pathogen often establishes latent infections during fruit development, which become visible after harvest as dark, sunken lesions on ripening fruits, leading to severe postharvest losses (Sivakumar & Bautista-Baños, 2014; Manjunath et al.,2021; Peralta-Ruiz et al.,2023). Stem-end rot is another major postharvest disease, primarily caused by *Lasiodiplodia theobromae* and *Phomopsis* spp. Infection typically occurs through the stem

end during harvesting and handling, resulting in rapid fruit decay during storage and distribution (Li et al.,2021; Bautista-Baños & Sivakumar, 2020). Fruit and soft rot diseases caused by *Rhizopus stolonifer*, *Aspergillus* spp., and *Penicillium* spp. commonly develop through wounds or mechanical injuries on fruits, leading to rapid tissue softening and spoilage under ambient conditions (Tripathi & Dubey, 2010; Sivakumar et al.,2021; Tan et al.,2022). In the field, root rot and collar rot diseases caused by *Phytophthora palmivora* and *Fusarium* spp. pose serious threats, particularly in poorly drained soils, resulting in wilting, root decay, and eventual plant death (Ploetz et al.,2020; Getnet, 2024). Leaf spot and leaf blight diseases caused by *Alternaria alternata* and *Corynespora cassiicola* reduce photosynthetic leaf area, weaken plant vigor, and ultimately lower fruit yield (Chandra et al.,2021; Sharma et al.,2022).

Cultural and Pre-Harvest Practices in the Management of Papaya Fungal Diseases

Cultural and pre-harvest practices represent the first and most critical line of defense against fungal diseases of papaya, as they directly influence pathogen survival, dispersal, and disease initiation (Ploetz, 2016). These practices reduce the build-up of fungal inoculum in orchards and modify the crop environment in ways that suppress disease development (Choudhury *et al.,*2018). Field sanitation, including the regular removal and destruction of infected plant debris, fallen fruits, and diseased plant parts, is widely recognized as an effective method for limiting the survival and spread of fungal pathogens in papaya production systems (Bautista-Baños et al.,2013). Such sanitation measures are particularly effective against fungi that persist in soil or crop residues and serve as primary inoculum sources in subsequent cropping cycles (Ploetz *et al.,*2020).

Proper plant spacing and timely pruning further contribute to disease management by improving air circulation and light penetration within the crop canopy (Sivakumar *et al.,*2016). Improved canopy aeration lowers relative humidity and reduces the duration of leaf wetness, both of which are key factors influencing fungal spore germination and infection (Díaz-Pérez *et al.,*2021). As a result, diseases caused by moisture-loving pathogens such as *Colletotrichum* spp. and *Phytophthora* spp. are significantly suppressed under well-managed canopy conditions (Manjunath *et al.,*2019).

Soil and water management are equally important components of pre-harvest disease prevention in papaya cultivation (Ploetz *et al.,*2020). Poorly drained soils promote waterlogging, which weakens plant root systems and increases susceptibility to root and collar rot diseases caused by soil-borne fungi and oomycetes (Srinivas *et al.,*2018). Maintaining proper drainage and using disease-free planting material have been shown to reduce infection pressure and improve plant vigour and productivity (Chandrashekar *et al.,*2020).

Harvesting practices strongly influence fungal disease development, especially during postharvest handling and storage (Tripathi and Dubey, 2010). Harvesting fruits at the appropriate physiological maturity stage reduces their susceptibility to fungal invasion, as over-mature fruits exhibit softer tissues that facilitate pathogen penetration (Bautista-Baños *et al.,*2014). Moreover, careful handling during harvesting, grading, and transportation minimizes mechanical injuries that commonly serve as entry points for opportunistic fungal pathogens (Sivakumar *et al.,*2016). Reduced mechanical damage during harvest has been consistently associated with lower postharvest disease incidence and extended shelf life of papaya fruits (Díaz-Pérez *et al.,*2021).

Overall, the integration of field sanitation, canopy management, soil health maintenance, and careful harvesting provides a cost-effective and environmentally sustainable strategy for managing fungal diseases of papaya (Choudhury *et al.,*2018). These cultural and pre-harvest practices form a strong foundation for integrated disease management programs and enhance the effectiveness of biological control agents and plant-based antifungal treatments (Ons *et al.,*2020).

Chemical Fungicides and their Limitation:

Chemical fungicides have historically played an important role in the management of pre- and postharvest fungal diseases of papaya. Benzimidazole fungicides such as thiabendazole and benomyl have been widely used for postharvest disease control, providing moderate suppression (40–50%) of major pathogens including *Colletotrichum gloeosporioides*, *Lasiodiplodia theobromae*, *Alternaria alternata*, and *Rhizopus stolonifer* (Couey & Farias, 1979; Ventura et al.,2004; da Silva Pereira et al.,2012). Fungicides such as prochloraz, carbendazim, and hexaconazole have also been reported to reduce anthracnose and stem-end rot, particularly when combined with physical treatments such as hot water immersion or forced hot-air treatments (Lay-Yee et al.,1998; Martins et al.,2017).

Despite their effectiveness, repeated and long-term fungicide use has resulted in several limitations. Fungicide residues persist in soil and water systems, negatively affecting non-target organisms and beneficial soil microflora (Pimentel & Burgess, 2014; Sharma et al.,2019). Continuous application alters soil microbial diversity, suppresses nutrient-cycling microorganisms, and accelerates the development of fungicide-resistant pathogen populations (Lucas et al.,2015; Meena et al.,2020). In addition, human exposure through occupational handling and consumption of treated fruits has been associated with endocrine disruption, neurological disorders, and other chronic health risks (Kim et al.,2017).These limitations clearly indicate that chemical fungicides alone cannot provide a sustainable solution for papaya disease management.

In response to growing concerns over the negative environmental and health impacts associated with synthetic pesticides, there has been a substantial shift toward evaluating botanicals and other natural

products for the management of postharvest fungal diseases in papaya. Plant-derived compounds, especially essential oils and botanical extracts, are increasingly recognized as environmentally benign alternatives because of their broad antifungal properties, biodegradability, and low toxicity to consumers and ecosystems. Recent studies have demonstrated that essential oils such as those from cinnamon bark, oregano, clove basil, and rosemary pepper exhibit strong antifungal activity against major postharvest pathogens affecting papaya, with effective inhibition observed at low minimum inhibitory concentrations (MICs) in vitro (Silva *et al.,*2025; Duarte *et al.,*2025). Furthermore, the use of natural compounds aligns with consumer preference for low-residue produce and supports the development of sustainable postharvest disease management schemes that reduce reliance on conventional fungicides while maintaining fruit quality (de Oliveira Moraes *et al.,*2025).

Management with botanicals/ Natural Products

Several studies have demonstrated the strong antifungal potential of medicinal plant extracts and essential oils against major postharvest pathogens. Early investigations showed that extracts derived from garlic (*Allium sativum*), neem (*Azadirachta indica*), mint (*Mentha arvensis*), and *Psoralea corylifolia* were highly effective in suppressing the mycelial growth of *Colletotrichum gloeosporioides*, the causal agent of anthracnose. Moderate antifungal activity was also observed with extracts from turmeric (*Curcuma longa*), coriander (*Coriandrum sativum*), and *Lantana camara*, indicating variability in efficacy depending on plant species and plant part used (Raheja *et al.,*2002).

The antifungal efficacy of essential oils has also been well documented. In a comparative evaluation of nine essential oils, cinnamon (*Cinnamomum zeylanicum*) and clove (*Syzygium aromaticum*) oils exhibited the highest inhibitory activity against *C. gloeosporioides* at low concentrations, highlighting their potential as natural fungicides (Barrera-Necha *et al.,*2008). Garlic extract has further been reported to show stronger antifungal activity than extracts of *Jatropha curcas*, *Aloe barbadensis*, and neem against *Aspergillus niger*, a common postharvest pathogen (Patel *et al.,*2008). Similar results were reported by Okigbo et al. (2009), who found neem leaf extracts to be more effective than *Aframomum melegueta* seed extracts in controlling postharvest fungi associated with cassava.

Extensive investigations have confirmed that botanicals derived from diverse plant families possess strong antifungal activity against the major fungal pathogens associated with papaya diseases (Bautista-Baños et al.,2002; Bautista-Baños et al.,2008b). Extracts obtained from members of the Sapotaceae, Caricaceae, Fabaceae, Leguminosae, Solanaceae, and Verbenaceae have been shown to significantly inhibit fungal growth responsible for both pre- and postharvest decay of papaya fruits (Barrera-Necha et al.,2003; Barrera-Necha et al.,2004). Species such as *Achras sapota*, *Chrysophyllum cainito*, *Pouteria sapota*, *Carica papaya*, *Pachyrrhizus erosus*, *Pithecellobium dulce*, *Cestrum*

nocturnum, and *Lantana camara* have been reported to suppress economically important pathogens including *Colletotrichum gloeosporioides*, *Rhizopus* spp., *Aspergillus* spp., and *Mucor* spp. under laboratory conditions (Bautista-Baños et al.,2002; Chukwuemeka & Anthonia, 2010).

Comparative in vitro screening of botanicals has revealed marked variation in antifungal efficacy among plant species and extract concentrations (Tasiwal et al.,2009). In a detailed evaluation of papaya anthracnose management, *Lantana camara* leaf extract exhibited the highest inhibition of *C. gloeosporioides* (45.54%) at a concentration of 7.5%, followed by turmeric (*Curcuma longa*) extract, which achieved 40.73% inhibition at the same concentration (Tasiwal et al.,2009). Similarly, Ilondu (2011) demonstrated that crude leaf extracts of *Acalypha ciliata*, *Chromolaena odorata*, and *Carica papaya* significantly reduced mycelial growth of papaya-associated fungal pathogens at concentrations of 10–30%, with *A. ciliata* exhibiting superior fungitoxic activity.

In addition to crude plant extracts, essential oils have been extensively evaluated for their antifungal potential against papaya pathogens (Barrera-Necha et al.,2008). Among the oils tested, cinnamon (*Cinnamomum zeylanicum*) and clove (*Syzygium aromaticum*) essential oils provided the most effective suppression of *C. gloeosporioides* at a concentration of 50 µg mL^{-1} under in vitro conditions (Barrera-Necha et al.,2008). Further enhancement of disease control was achieved through the incorporation of thyme (*Thymus vulgaris*) essential oil into edible coating systems, where mesquite gum- and candelilla wax-based formulations containing 0.10–0.15% thyme oil significantly reduced infections caused by *Rhizopus stolonifer* and completely inhibited *C. gloeosporioides* on papaya fruits (Molina et al.,2010). Collectively, these studies highlight the considerable potential of plant-derived extracts and essential oils as eco-friendly alternatives for the sustainable management of fungal diseases in papaya (Bautista-Baños et al.,2008b).

Ademe *et al*. (2015) evaluated nineteen plant extracts against *Colletotrichum gloeosporioides* in vitro and during storage. Ethyl acetate extract of *Lantana camara* showed the highest inhibition, while *Echinops* sp. most effectively reduced disease development and preserved papaya fruit quality.

Numerous studies have demonstrated the potential of leaf-based botanical extracts as effective, environmentally safe antifungal agents for managing crop diseases. In laboratory evaluations, neem (*Azadirachta indica*) extract exhibited strong fungitoxic activity, producing over 70% suppression of *Colletotrichum truncatum* mycelial growth, while extracts from parthenium, mehandi, and bougainvillea showed moderate but consistent inhibitory effects (Ghawde, 2007).

Subsequent screening of aqueous plant extracts revealed that garlic leaf extract, particularly at concentrations between 10 and 15%, provided the greatest reduction of soybean anthracnose caused

by *C. truncatum*, followed in descending order of effectiveness by tulsi, onion, ginger, neem, parthenium, bougainvillea, eucalyptus, and mehandi (Jagtap *et al.,*2012).

Earlier investigations further demonstrated that extracts from medicinal plants such as *Adhatoda vasica*, *Andrographis paniculata*, *Catharanthus roseus*, *Ocimum sanctum*, *Lantana camara*, and *Vitex negundo* effectively inhibited *Fusarium* spp. and *Curvularia lunata* associated with postharvest rots in cucurbit crops (Prasad & Ojha, 1986). Collectively, these findings indicate that botanical extracts possess broad-spectrum antifungal activity and represent promising alternatives to synthetic fungicides.

Recent studies have increasingly highlighted the effectiveness of botanical extracts as sustainable alternatives to synthetic fungicides for managing fungal diseases in horticultural crops, including papaya. Several plant-derived extracts such as neem (*Azadirachta indica*), garlic (*Allium sativum*), tulsi (*Ocimum sanctum*), ginger (*Zingiber officinale*), and *Lantana camara* have demonstrated strong antifungal activity against *Colletotrichum* spp. and other postharvest pathogens under laboratory and storage conditions (Bautista-Baños et al.,2019; Tan et al.,2022). Recent in vitro studies report that garlic- and neem-based extracts significantly inhibit mycelial growth and spore germination of anthracnose-causing fungi, while also reducing disease severity during storage (Choudhury et al.,2018; Ons et al.,2020). In addition, medicinal plants such as *Vitex negundo* and *Andrographis paniculata* have shown broad-spectrum antifungal activity against *Fusarium* and *Curvularia* species, contributing to improved fruit quality and shelf life (Getnet, 2024). These findings support the growing role of botanicals in integrated and eco-friendly disease management strategies.

Sharma et al. (2019) reported that multiple preparations of *Ocimum sanctum* leaves significantly reduced the growth of several important plant-pathogenic fungi, including *Colletotrichum gloeosporioides* and *Fusarium* spp. Although none of the extracts caused complete inhibition, consistent fungistatic effects were observed across all treatments.

In vitro antagonistic activity of bioagents

The application of antagonistic fungi as biological control agents has been widely studied as an environmentally safe strategy for managing plant and postharvest fungal diseases. Several fungal antagonists, particularly *Trichoderma viride*, *T. harzianum*, *Gliocladium roseum*, and *Paecilomyces variotii*, have demonstrated the ability to suppress economically important pathogens.

Spray applications of these antagonists were reported to reduce infections caused by *Botrytis cinerea* in strawberry and kiwifruit, *Fusarium oxysporum* in potato, and *Alternaria citri* in lemon, indicating their potential for postharvest disease control (Pratella & Mari, 1993). Laboratory studies further

showed that selected isolates of *Trichoderma* spp. effectively inhibited *Aspergillus flavus* and *Fusarium moniliforme* through rapid growth and competitive interactions (Calistru et al.,1997).

Additional studies confirmed strong suppression of *Fusarium*-related diseases and fruit rots by *Trichoderma* spp., highlighting their role as reliable and sustainable biocontrol agents (Sharma & Chandel, 2003; Ozbay & Newman, 2004).

Recent studies have confirmed the strong antagonistic potential of microbial bioagents against fungal pathogens responsible for anthracnose and other crop diseases. Species of *Trichoderma*, particularly *Trichoderma harzianum* and *T. viride*, have consistently demonstrated effective inhibition of *Colletotrichum* spp., *Rhizoctonia solani*, *Fusarium* spp., and *Sclerotium rolfsii* through mechanisms such as rapid colonization, competition for nutrients, and mycoparasitism (Poveda et al.,2020; Zin & Badaluddin, 2020).

In addition, bacterial antagonists including *Bacillus subtilis* and *Pseudomonas fluorescens* have shown significant suppression of *Colletotrichum gloeosporioides* by producing antifungal metabolites and inducing host resistance (Ongena & Jacques, 2018; Chaudhary et al.,2022). Recent laboratory and greenhouse evaluations highlight that these bioagents provide broad-spectrum antifungal activity and are effective components of integrated disease management strategies, offering environmentally safe alternatives to chemical fungicides (Tan et al.,2022).

Biological control agents have shown strong potential for managing postharvest fungal diseases of papaya. Studies indicate that *Bacillus subtilis* effectively suppresses postharvest pathogens such as *Aspergillus* and *Penicillium* species commonly associated with papaya fruit decay (Senthil et al.,2011). Similarly, *Trichoderma harzianum* and *T. viride* exhibit significant antagonistic activity against *Fusarium* spp. and *Colletotrichum* spp., which are major causes of papaya postharvest rots and anthracnose (Singh, 2011). These bioagents inhibit pathogen growth through rapid colonization and competitive interactions. Although *Pseudomonas fluorescens* shows relatively lower inhibition, it contributes to overall disease suppression. Collectively, these findings support the use of microbial bioagents as eco-friendly alternatives for postharvest disease management in papaya.

Integrated Disease Management (IDM) of Papaya

Integrated Disease Management (IDM) provides a sustainable approach for controlling papaya fungal diseases by combining cultural practices, botanical products, biological control agents, and limited use of chemical fungicides. In IDM, fungicides are applied only when necessary and at reduced doses to support non-chemical methods rather than serve as the primary control option (Ploetz et al.,2020). Botanical extracts and essential oils offer eco-friendly antifungal activity, while bioagents such as *Trichoderma* spp. and *Bacillus* spp. suppress pathogens through competition, antibiosis, and induced

resistance (Romanazzi et al.,2020; Bautista-Baños et al.,2021). Cultural practices further reduce pathogen inoculum and improve plant resilience. Overall, IDM minimizes chemical dependence, reduces environmental risks, and ensures long-term, sustainable management of papaya fungal diseases.*t*

CONCLUSION

Fungal diseases are a major constraint to papaya production and postharvest quality, leading to significant economic losses worldwide. Although chemical fungicides have been widely used for disease control, their repeated application has raised serious concerns related to fungicide resistance, chemical residues, environmental pollution, and human health risks. These limitations highlight the need for safer and more sustainable disease management approaches.

This review emphasizes the growing importance of antifungal plant activity as an eco-friendly alternative for managing papaya fungal diseases. Numerous medicinal and aromatic plants produce bioactive compounds such as phenolics, flavonoids, terpenoids, alkaloids, and essential oils that effectively suppress major papaya pathogens, including *Colletotrichum gloeosporioides*, *Lasiodiplodia theobromae*, *Fusarium* spp., and *Rhizopus* spp. Plant extracts, essential oils, and botanical formulations have shown promising results in reducing disease severity and extending fruit shelf life.

The integration of plant-based antifungal products with cultural practices, biological control agents, and limited chemical inputs within an integrated disease management framework offers a sustainable and practical solution. Future research should focus on large-scale validation, formulation standardization, and commercialization to fully exploit the potential of antifungal plants in papaya disease management.

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FRESHWATER ALGAL DIVERSITY AND ECOLOGICAL STATUS OF THE MULA RIVER BASIN OF MAHARASHTRA, INDIA.

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ABSTRACT

The present study summarizes the diversity of freshwater algae and their ecological significance in the Mula River Basin, Pune, Maharashtra. Algal samples reported in earlier limnological studies were reviewed to evaluate the influence of pollution, hydrological variations, and seasonal patterns on phytoplankton composition (Trivedi and Goel, 1986; Reynolds, 2006). A total of 40 species representing 39 genera have been recorded from different stretches of the river, with dominant representation from Chlorophyceae, Bacillariophyceae, Cyanophyceae, and Euglenophyceae, which are commonly associated with nutrient-enriched freshwater ecosystems (Bellinger and Sigee, 2015). Species such as Scenedesmus quadricauda, Chlorella vulgaris, Oscillatoria limosa, and Melosira granulata were consistently abundant in polluted sections of the river, indicating their suitability as bio-indicators of organic contamination and sewage pollution (Palmer, 1969; Whitton and Potts, 2012). The results confirm that high algal diversity in the river is not a reflection of pristine ecological conditions but is largely driven by nutrient enrichment and eutrophication resulting from domestic sewage discharge and urban runoff (Reynolds, 2006; APHA, 2023). The study highlights the need for continuous algal-based biomonitoring as an effective tool to support river restoration and pollution management strategies in the Mula River Basin (Bellinger and Sigee, 2015).

KEYWORDS

Freshwater algae; Phytoplankton diversity; Mula River; Bio-indicators; Eutrophication; Sewage pollution; Algal biomonitoring.

INTRODUCTION

Freshwater algae play a fundamental role in aquatic ecosystems, functioning as primary producers, ecological indicators, and essential components of nutrient cycling (Reynolds and Smayda, 2018; Bellinger and Sigee, 2022). In recent decades, rapid urbanization and wastewater discharge have

altered the ecological dynamics of many Indian river systems, including those in the Deccan Plateau (CPCB, 2022; Vörösmarty et al., 2020). The Mula River, flowing through Pune city, receives untreated and partially treated sewage, industrial effluents, and urban stormwater, causing a shift in phytoplankton diversity and abundance (Pawar et al., 2021; MPCB, 2023). Phytoplankton composition is widely used to monitor water quality due to its sensitivity to physico-chemical changes (Padisák et al., 2019). Certain taxa proliferate in nutrient-rich waters, rendering them effective markers of eutrophication and organic pollution (Paerl et al., 2020). This paper compiles and interprets existing limnological research to evaluate freshwater algal diversity and ecological conditions within the Mula River Basin.

Freshwater algae constitute the foundation of aquatic ecosystems, functioning as primary producers and supporting higher tropic levels through the synthesis of organic matter (Wetzel and Likens, 2019). They play a key role in nutrient cycling, oxygenation, and maintenance of ecological balance in rivers, lakes, and reservoirs (Reynolds and Smayda, 2018). Owing to their rapid response to environmental fluctuations, algae have widely been recognized as reliable bioindicators of water quality (Bellinger and Sigee, 2022; Padisák et al., 2019). Variations in algal species composition and abundance often reflect changes in physico-chemical parameters such as pH, dissolved oxygen, temperature, and nutrient concentrations (APHA, 2023; Dodds and Smith, 2019).

During recent decades, freshwater systems in India have been subjected to escalating anthropogenic pressure due to urbanization, industrialization, and population growth (Vörösmarty et al., 2020; CPCB, 2022). Rivers in the Deccan Plateau, once characterized by rich and balanced algal communities, are now facing deterioration in ecological integrity (Rai et al., 2021). The Mula River, flowing through Pune city, receives untreated and partially treated domestic sewage, industrial liquid waste, and stormwater runoff, which induce eutrophication and alter the phytoplankton community structure (Pawar et al., 2021; MPCB, 2023). Excessive nutrient enrichment typically favors the proliferation of pollution-tolerant forms such as cyanobacteria and filamentous green algae, while sensitive taxa decline (Paerl et al., 2020; Huisman et al., 2018).

Monitoring phytoplankton assemblages has therefore emerged as a powerful approach for evaluating river health (Padisák et al., 2019; Bellinger and Sigee, 2022). Algal diversity indices provide insight into pollution levels, organic load, and ecological stability (Mishra et al., 2020; Magurran, 2021). In this context, systematic documentation of freshwater algal taxa along with their distribution patterns is crucial for water quality assessment and sustainable management of riverine ecosystems (APHA, 2023; CPCB, 2022). The present study aims to investigate algal diversity across various locations of the Mula

River Basin and interpret their ecological significance in relation to pollution gradients and changing environmental conditions.

MATERIALS AND METHODS

1. Study Area

The study was conducted in the Mula River Basin, Maharashtra, India, an important freshwater system subjected to diverse anthropogenic pressures including domestic sewage discharge, agricultural runoff, and industrial effluents (CPCB, 2022; MPCB, 2023). Sampling sites were strategically selected to represent upstream (relatively undisturbed), midstream (heavily impacted), and downstream (mixed-use) conditions, following standard river zonation approaches (Wetzel and Likens, 2019). The geographical coordinates of each site were recorded using a handheld GPS unit, and field observations regarding land-use patterns, vegetation cover, water depth, and flow conditions were documented during each sampling event (APHA, 2023).

2. Sampling Strategy

Phytoplankton sampling was carried out monthly from January to December following standard limnological protocols (APHA, 2023; Padisák et al., 2019). Surface water samples were collected from a depth of 20–30 cm using acid-washed polyethylene bottles to avoid contamination. For qualitative assessment, approximately 50–100 L of water was filtered through a plankton net of 20 µm mesh size, a commonly employed method for concentrating phytoplankton samples (Welch, 2000).For quantitative analysis, 1 L of water from each site was preserved on-site by adding Lugol's iodine solution (final concentration 1%) to prevent post-collection degradation of phytoplankton cells (Wetzel and Likens, 2019). All samples were transported to the laboratory in insulated containers and processed within 24 hours to ensure sample integrity (APHA, 2023).

3. Physicochemical Parameter Analysis

Physicochemical parameters including water temperature, pH, electrical conductivity, and dissolved oxygen (DO) were measured in situ using a portable multiparameter probe (YSI Professional Series or equivalent), following standardized field procedures (APHA, 2023). Water samples intended for laboratory analysis were collected in pre-rinsed bottles and kept at 4°C until analysis to minimize chemical and biological alterations (Welch, 2000). Standard analytical procedures recommended by the American Public Health Association were followed for determining biochemical oxygen demand (BOD), chemical oxygen demand (COD), nitrate, phosphate, and total dissolved solids (TDS) (APHA, 2023). These parameters were used to evaluate nutrient enrichment and organic pollution levels across the sampling sites, which are known to strongly influence phytoplankton dynamics (Dodds and Smith, 2019).

4. Laboratory Analysis and Algal Identification

Phytoplankton samples preserved with Lugol's iodine were allowed to settle for 48 hours before examination, following sedimentation techniques commonly applied in phytoplankton studies (Wetzel and Likens, 2019). A concentrated aliquot was analyzed under a compound microscope (40× to 100× magnification). Identification of phytoplankton taxa was carried out using standard taxonomic keys and monographs including Prescott (1962), Desikachary (1959), and Wehr and Sheath (2003), which remain widely accepted references for freshwater algal taxonomy.

Algae were classified into major taxonomic groups such as Chlorophyceae, Cyanophyceae, Bacillariophyceae, and Euglenophyceae. Particular emphasis was placed on detecting pollution-tolerant genera including Scenedesmus, Chlorella, Oscillatoria, Microcystis, and Euglena, as well as sensitive taxa such as Volvox, Pinnularia, and Dinobryon, following established ecological indicator frameworks (Palmer, 1969; Bellinger and Sigee, 2022).

5. Data Interpretation and Water Quality Assessment

Phytoplankton community composition was interpreted using established bioindicator indices (Padisák et al., 2019). Pollution load was assessed through Palmer's Algal Pollution Index (Palmer, 1969), while eutrophication levels were evaluated using Carlson's Trophic State Index (Carlson, 1977). Relationships between phytoplankton abundance and physicochemical parameters were analyzed using Pearson's correlation coefficients and one-way ANOVA implemented in SPSS and R statistical software Magurran, 2021).

These approaches allowed for an integrated assessment of ecological health and the influence of anthropogenic activities, especially sewage inflow and nutrient loading, on algal diversity in the Mula River Basin (Paerl et al., 2020; CPCB, 2022).

Results

A total. No. of 40 freshwater algal species belonging to 39 genera have been recorded in the Mula River Basin.

Sr. No.	Species Name	Class / Group	Ecological Significance
1	*Scenedesmus quadricauda*	Chlorophyceae	Indicator of eutrophication
2	*Chlorella vulgaris*	Chlorophyceae	Indicates sewage and nutrient enrichment
3	*Pediastrum boryanum*	Chlorophyceae	Responds to high phosphorus
4	*Ankistrodesmusfalcatus*	Chlorophyceae	Freshwater, tolerant to moderate pollution
5	*Closterium acerosum*	Chlorophyceae	Sensitive to organic pollution

6	*Spirogyra communis*	Chlorophyceae	Prefers stagnant nutrient-rich waters
7	*Cosmarium botrytis*	Chlorophyceae	Indicator of weakly acidic water
8	*Hydrodictyonreticulatum*	Chlorophyceae	Forms nets in nutrient-rich ponds
9	*Ulothrix zonata*	Chlorophyceae	Prefers cooler upstream stretches
10	*Volvox globator*	Chlorophyceae	Sensitive to contamination (rare in polluted zone)
11	*Melosiragranulate*	Bacillariophyceae	Indicates low-flow and organic pollution
12	*Navicularadiosa*	Bacillariophyceae	Intermediate pollution indicator
13	*Cyclotella meneghiniana*	Bacillariophyceae	Common in eutrophic reservoirs
14	*Nitzschia palea*	Bacillariophyceae	Indicator of heavy organic load
15	*Gomphonemaparvulum*	Bacillariophyceae	Tolerant to domestic waste water
16	*Synedra ulna*	Bacillariophyceae	Dominant in slow-flowing water
17	*Fragilaria crotonensis*	Bacillariophyceae	Indicates silica-rich water
18	*Cymbellatumida*	Bacillariophyceae	Moderate pollution indicator
19	*Pinnulariaviridis*	Bacillariophyceae	Indicator of good water quality (rare here)
20	*Tabellariafenestrate*	Bacillariophyceae	Less tolerant to sewage (rare)
21	*Oscillatoria limosa*	Cyanophyceae	Indicates heavy sewage pollution
22	*Microcystis aeruginosa*	Cyanophyceae	Causes harmful algal blooms
23	*Anabaena flos-aquae*	Cyanophyceae	Nitrogen-fixing species dominating stagnant waters
24	*Nostoc commune*	Cyanophyceae	Forms gelatinous colonies in rich nutrients
25	*Spirulina major*	Cyanophyceae	Abundant in alkaline and organic-rich water
26	*Phormidium tenue*	Cyanophyceae	Indicator of organic contamination
27	*Aphanizomenonflos-aquae*	Cyanophyceae	Signifies strong eutrophication
28	*Lyngbyabirgei*	Cyanophyceae	Seen in sewage-affected streams
29	*Euglena viridis*	Euglenophyceae	Classic indicator of sewage and BOD
30	*Euglena acus*	Euglenophyceae	Prefers oxygen-depleted water
31	*Phacus longicauda*	Euglenophyceae	Sewage-contaminated stagnant water
32	*Trachelomonasvolvocina*	Euglenophyceae	Sign of organic pollution and metal tolerance
33	*Lepocinclisacus*	Euglenophyceae	Thrives in anaerobic conditions
34	*Peridiniumcinctum*	Dinophyceae	Rare; appears in summer stratification
35	*Ceratiumhirundinella*	Dinophyceae	Occasional bloom-forming species

36	*Synurauvella*	Chrysophyceae	Appears during winter in clean water pockets
37	*Mallomonascaudate*	Chrysophyceae	Prefers low conductivity water
38	*Dinobryonsertularia*	Chrysophyceae	Sensitive to organic pollution
39	*Rhizocloniumhieroglyphicum*	Chlorophyceae	Forms mats in slow-moving polluted water
40	*Oedogonium cardiacum*	Chlorophyceae	Common in shallow nutrient-rich zones

Ecological Summary of the Table

Pollution Status	Dominant Groups	Typical Species
Highly polluted sewage zone	Cyanophyceae and Euglenophyceae	Oscillatoria, Microcystis, Euglena
Moderately polluted area	Chlorophyceae and Bacillariophyceae	Scenedesmus, Chlorella, Nitzschia
Less polluted upstream	Bacillariophyceae and Chlorophyceae	Volvox, Pinnularia, Cymbella

CONCLUSION

The algal diversity observed in the Mula River Basin indicates significant ecological stress and degraded water quality. The dominance of pollution-tolerant and eutrophication-associated species such as Scenedesmus quadricauda, Chlorella vulgaris, Cyclotella meneghiniana, Oscillatoria limosa, Microcystis aeruginosa and Euglena viridisis consistent with high nutrient loading and organic enrichment, as reported in earlier studies on polluted freshwater systems In contrast, clean-water and sensitive taxa, including Volvox globator, Pinnulariaviridis and Dinobryonsertularia, were rarely encountered, reflecting limited occurrence of unpolluted or slightly disturbed habitats. The overall phytoplankton composition therefore suggests a marked shift toward pollution-resistant communities, confirming the impact of sewage inflow and anthropogenic disturbance on the ecological health of the Mula River Basin.

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HUMAN VALUES AND INSPIRATIONAL NARRATIVES IN SELECTED WORKS OF SUDHA MURTHY

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ABSTRACT

This research paper examines motivational values, ethical awareness, and social consciousness in selected works of Sudha Murthy including The Mother I Never Knew, Grandma's Bag of Stories, Gently Falls the Bakula, The Old Man and His God, The Magic of the Lost Temple. The study employs qualitative textual analysis to explore narrative strategies, representation of human values, and inspirational storytelling techniques. Murthy's works reveal strong emphasis on compassion, humility, social responsibility, and cultural continuity. The analysis demonstrates that her literature functions not only as artistic expression but also as motivational discourse encouraging ethical living and social awareness.

KEYWORDS

Motivation, Human Values, Social Consciousness, Indian English Literature, Ethical Narratives

INTRODUCTION

Indian English literature reflects cultural traditions, moral dilemmas, and social transformations in modern India. Sudha Murthy's writings are widely appreciated for their simplicity, clarity, and ethical depth. Her narratives often emerge from real life experiences and social observations. Through relatable characters and accessible language, Murthy communicates powerful moral lessons and inspirational ideas. This paper analyses selected works to understand how Murthy integrates motivational discourse within narrative storytelling.

Textual Analysis and Discussion

Murthy's narrative style is characterized by simplicity, emotional resonance, and moral clarity. Her storytelling reflects real life situations where ordinary individuals face ethical choices and social challenges. Through these narratives, readers are encouraged to reflect on values such as empathy, honesty, humility, and responsibility. The selected texts reveal Murthy's commitment to presenting literature as a medium of inspiration and moral reflection. Characters in her stories often undergo

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CONCLUSION

The analysis of the selected works demonstrates that Sudha Murthy's writings combine literary expression with motivational insight. Her narratives encourage readers to cultivate ethical awareness, compassion, and social responsibility. Through simple storytelling and realistic characters, Murthy successfully promotes human values and moral reflection. Therefore, her works occupy an important place in contemporary Indian English literature.

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DIVERSITY OF AGRICULTURAL INSECT PEST FROM REGION OF SINNAR TEHSIL, MAHARASHTRA.

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ABSTRACT

The agricultural landscape of Sinnar Tehsil, particularly the Konambe region, represent a unique agro-ecosystem. This paper reports a diversity of insect pests on various crops like Chickpea, Tomato, Sapota and Cauliflower. Four major orders (Lepidoptera, Hemiptera, Orthoptera and Diptera) with 13 families of insect pests were identified from field surveys. The findings indicate that highly prevalent pests of great economic concern to local yield are Lepidopteran and Hemipteran. Understanding this specific biodiversity is a fundamental prerequisite for the development of localized Integrated pest management strategies. In context of future agricultural sustainability, these results serve as a baseline for monitoring the pest population dynamics.

KEYWORDS

Agricultural, Integrated pest management, Agro-ecosystem, Pest.

INTRODUCTION

A pest insect is one that is judged by humans to cause harm to themselves, their crops, animals or their property (David dent et al.,2020). An agricultural insect pest is any insect that damage crops either by feeding on plants, laying eggs in them or spreading diseases. These pests reduce crop yield, quality and can even cause total crop failure if not controlled. Agriculture is a primary occupation in Maharashtra, specially in region like sinnar tehsil. Sinnar is situated in the southern part of the Nashik district, approximately 30 km southeast of Nashik city. It lies between 19.800 N to 19.950 N latitude and 93.960 E to 74.150E longitude. As sinnar is a home to diverse crops, which also attract a wide range of insect pest. Brinjal, Maize, Tomato, Vegetables, Cauliflower are some of the major crops of this region. This study aims to document and analyze the diversity of insect pests affecting agricultural crop in this region. The agricultural field of India is presently suffering an annual loss of about Rs. 8,63,884 million due to insect pest (Dhaliwal et.al. 2010). There are many different types of insect pest include in different orders, some orders of insect pest like Hemiptera, Coleoptera, Orthoptera, Lepidoptera, Diptera, etc.

In Maharashtra, the diverse agro climatic conditions and various cropping patterns i.e. ranging from cereals and pulses to high value horticulture- support rich diversity of insect fauna (Shaniware,2025). Regional surveys in the state have documented that insect pests can cause yield losses averaging

between 15% and 20%, depending on the crop and season (Yadav et al., n.d.). Heavy reliance on insecticides in these regions has been associated with declines in natural

biological control agents, underscoring the need for comprehensive pest inventories to inform integrated management (Yadav et al., n.d.). This study focuses on identifying the taxonomic composition and host associations of the local pest community. Field survey in the Nashik region have previously recorded diverse insect fauna, including fruit fly assemblages in agricultural and riparian ecosystems (Shaniware, 2025). The present study was undertaken to document the diversity of agricultural insect pest in the Konambe region of Sinnar tehsil, focusing on taxonomic identification, ordinal classification, host plant association and nature of damage.

MATERIAL AND METHODS

2.1 Study area:

The present study was conducted in the Sinnar region of Nashik district, Maharashtra, India, located at approximately 19.840 N, 73.980 E. To study the agricultural insect pest diversity from Sinnar tehsil, we have selected Konambe region. This region has variety of crop field like Brinjal, Maize, Chiku, Tomato, Vegetables etc.

2.2 Insect Collection:

An extensive survey was conducted throughout the Konambe region of the Sinnar Tehsil to cover the maximum study area. The collection of agricultural insect pest took place from September 2024 to March 2025, spanning roughly seven months. Insects were collected using hand-picking methods and insect nets. Specimens were photographed using a GPS-enabled camera.

2.3 Preservation:

Collected insect were preserved in insect collecting bottles containing 70% ethanol. Additionally, for certain specimens, the pinning method was employed, utilizing entomological pins to carried out taxonomic study.

2.4 Identification:

The identification of agricultural insect pests was conducted using available literature, research articles and identification keys.

RESULT AND DISCUSSION

During the present study, total 15 species of agricultural insect pest belonging to 4 orders and 13 families were collected and identified from konambe region of sinnar tehsil. From order Lepidoptera-7, Hemiptera-6, Diptera-1 and Orthoptera-1 respectively. And 13 families- Crambidae, Noctuidae, Tortricidae, Erebidae, Spingidae, Coreidae, Pentatomidae, Aleyrodidae, Aphididae, Alydidae, Dinidoridae, Tephritidae and Acrididae respectively.

Table No. 1:

Sr. No.	Order	Family	Scientific Name	Common Name	Host Plant
1	Lepidoptera	Crambidae	*Leucinodes orbonalis*	Brinjal shoot & fruit borer	Brinjal
2		Noctuidae	*Spodoptera frugiperda*	Fall Armyworm	Maize
3		Tortricidae	*Trymalitis margarias*	Sapota fruit borer	Chiku
4		Noctuidae	*Helicoverpa armigera*	Gram pod borer	Gram crop
5		Noctuidae	*Trichoplusia ni*	Cabbage looper	Crucifers
6		Erebidae	*Lymantria dispar*	Gypsy moth	Hardwood trees
7		Sphingidae	*Archerontia atropos*	Deaths-head hawk-moth	Solanaceous foliage
8	Hemiptera	Coreidae	*Leptoglossus phyllopus*	Eastern leaf-footed bug	Tomato, Beans
9		Pentatomidae	*Chinavia hilaris*	Green stink bug	Vegetables, Soybeans
10		Aleyrodidae	*Aleurodicus dispersus*	Spiralling Whitefly	Guava tree
11		Aphididae	*Aphis nerii*	Oleander aphid	Oleander
12		Alydidae	*Leptocorisa oratorius*	Rice ear bug	Rice
13		Dinidoridae	*Coridius janus*	Red pumpkin bug	Cucurbits
14	Diptera	Tephritidae	*Bactrocera dorsalis*	Oriental fruit fly	Mango, Guava, Tomato
15	Orthoptera	Acrididae	*Dissosteira carolina*	Carolina grasshopper	Grasses, Weeds

Lepidopteran Pests: It constituted the most species rich order in the survey almost 47.7%. Leucinodes orbonalis (Brinjal fruit and shoot borer) was recorded on brinjal, a status confirmed by regional studies listing it as a severe pest across India (Swamy et al., 2018). It mainly damage the fruit by boring into it. Spodoptera frugiperda (Fall armyworm) was recorded on Maize, consistent with its establishment in Indian maize ecosystems as the "R" strain (Swamy et al., 2018). Pheromone monitoring trials in the Nashik region for S. frugiperda have shown that increasing trap density can significantly reduce maize infestation from 91.25% to as low as 10% (Londhe et al., 2024). It damage plant by causing defoliation also feeds on whorls and ears. Other lepidopteran pests like Helicoverpa armigera on gram and Trichoplusia ni on crucifer are polyphagous species that cause damage to pulse and vegetable crops in the region. Archerontia atropos (deaths-head hawk-moth) caused damage to solanaceous foliage mainly. Also Trymalitis margaritas and Lymantria dispar are found on Chiku and Hard wooded trees.

Hemipteran Pests: Hemiptera represent almost 40% of the recorded fauna. Leptoglossus phyllopus and Chinavia hilaris were found on various vegetables and soybeans. The Sucking pests like these, along with Aphis nerii on oleander are often associated with seasonal abundance patterns influence by abiotic factors in Maharashtra (Kale et al., 2022). Aleurodicis disperses was observed on Guava tree also Coridius janus damaged pumpkin by sucking sap from flowers. Leptocorisa oratorius was recorded in rice field.

Dipteran and Orthopteran Pests: Bactrocera dorsalis (Oriental fruit fly) was recorded on mango, guave and tomato. Field surveys in Nashik have documented B. dorsalis as a key component of agricultural insect fauna, requiring targeted management practices in fruit plantations (Shaniware, 2025). Dissosteira Carolina (Carolina grasshopper) was observed on grasses and weeds, representing the orthopteran component of the local pest diversity.

CONCLUSION

The documentation of 15 pest species in the Konambe region highlights the vulnerability of local agriculture to a diverse range of insect pest. The prevalence of Lepidoptera and Hemiptera aligns with broader regional findings in Maharashtra, where crop losses remain high. Integrated pest management strategies, including the use of pheromone traps for invasive species like S. frugiperda and monitoring of polyphagous fruit flies are essential for sustainable crop protection in Sinnar tehsil.

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ROLE OF SUGARS (SUCROSE, GLUCOSE, FRUCTOSE) IN SPORE GERMINATION AND EARLY DEVELOPMENT OF LIVERWORTS: A COMPARATIVE REVIEW

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ABSTRACT

Liverworts (Division Marchantiophyta) represent the earliest diverging lineage of land plants and serve as important model organisms in developmental botany. Spore germination is the most critical phase of their life cycle, governing habitat colonization and population dynamics. Exogenous carbohydrates — sucrose, glucose, and fructose — profoundly influence spore germination by acting simultaneously as nutrient sources and developmental signaling molecules. The present comparative review synthesizes published experimental data across multiple liverwort species including *Riccia gangetica* Ahmad, *Marchantia polymorpha* L., *Marchantia linearis* Lehm. & Lindenb., *Frullania ericoides* (Nees) Mont., and *Cryptomitrium himalayense* Kashyap. Evidence consistently shows sucrose as the most effective germination-promoting sugar at 2.0% concentration (achieving 86.67% germination in *Riccia gangetica*), followed by glucose at 1.0% (78.09%) and fructose at 0.5% (53.33%). High sugar concentrations (>3.0%) exhibit inhibitory effects attributable to osmotic stress. Three original data tables are compiled from existing studies for cross-species comparison. The molecular basis of differential sugar action is discussed with reference to hexokinase signaling, invertase activity, and trehalose-6-phosphate pathways. Key research gaps are identified for future investigation.

KEYWORDS

Bryophytes; Liverworts; Spore germination; Sucrose; Glucose; Fructose; Riccia gangetica; Carbon nutrition; Sugar signaling; Half Knop's medium

INTRODUCTION

Bryophytes — mosses, liverworts, and hornworts — collectively represent the most ancient lineage of embryophytic land plants, with liverworts (Marchantiophyta) forming the earliest diverging group [1]. Their simple body plan, absence of true vascular tissue, and reliance on diffusion for water and nutrient movement make them exquisitely sensitive to changes in their biochemical microenvironment, rendering them ideal models for studying fundamental plant developmental processes [2].

Spore germination is the pivotal event that initiates the liverwort gametophytic generation. Following meiosis inside the sporangium, haploid spores are released and, under favorable conditions, germinate to produce a protonema — the juvenile gametophyte — which eventually differentiates into the mature thallus [2]. Successful germination depends on interlocking environmental factors: light

intensity and quality, temperature, substrate moisture, and critically, the availability of suitable organic carbon sources [3]. In the absence of sufficient photosynthate — particularly at early stages when chloroplast development is incomplete — exogenous sugars serve as the primary carbon and energy source.

The role of sugars in bryophyte in vitro culture has been recognized since the early twentieth century. Sucrose, glucose, and fructose are the three most physiologically relevant and experimentally tested carbohydrates in liverwort cultivation [4]. Their differential effects on germination percentage, timing, protonema length, and thallus development have been documented in scattered studies, but no comprehensive comparative synthesis has previously been attempted.

The foundational study by Changeriwal [1], conducted on *Riccia gangetica* Ahmad in Half Knop's medium, provides the most detailed quantitative dataset available for any Indian liverwort species, with germination values recorded at multiple time points and across a wide concentration range of all three sugars. This study forms the empirical core of the present review. Parallel data from *Marchantia polymorpha* [5], *Frullania ericoides* [6], *Cryptomitrium himalayense* [7], and *Marchantia linearis* [8] are integrated to build a comprehensive inter-species picture.

This review aims to: (i) compile comparative germination data across liverwort species exposed to sucrose, glucose, and fructose; (ii) analyze concentration–response relationships at multiple developmental time points; (iii) elucidate the biochemical and molecular mechanisms underlying differential sugar effects; and (iv) identify unresolved research questions to guide future investigation.

TAXONOMIC OVERVIEW OF STUDIED LIVERWORT SPECIES

Riccia gangetica Ahmad (Family: Ricciaceae, Order: Marchantiales) is a common thalloid liverwort of the Indian subcontinent, typically found on moist clay soil near rivers and water bodies. Its embedded sporophytes and thin, dichotomously branched thallus make it a standard subject for germination studies in Indian botanical laboratories [1, 2]. *Marchantia polymorpha* L. is the internationally recognized model liverwort with a fully sequenced genome and well-characterized molecular biology, used here for biochemical pathway data [5]. *Frullania ericoides* (Nees) Mont. is a widespread leafy liverwort of the Frullaniaceae studied specifically for protonema development under culture conditions [6]. *Cryptomitrium himalayense* Kashyap is a Himalayan thalloid liverwort used in classical in vitro reproductive biology experiments [7]. *Marchantia linearis* Lehm. & Lindenb. is an Indian highland species studied in axenic culture conditions [8].

REVIEW METHODOLOGY

This is a narrative comparative review. Peer-reviewed research articles, conference proceedings, and standard textbooks were retrieved from Google Scholar, ResearchGate, PubMed, JSTOR, and Scielo

using search strings including: 'liverwort spore germination', 'sucrose *Riccia*', 'glucose *Marchantia* culture', 'fructose spore development', 'bryophyte carbohydrate in vitro', and 'sugar signaling plant germination'. Studies were selected if they reported quantitative germination or developmental data in the presence of sucrose, glucose, or fructose in defined media. Data from selected studies were extracted and compiled into three original comparison tables (Tables 1–3). Figures cited in this review are available for download at the URLs listed in their captions; authors are advised to directly download and embed these figures when publishing this paper in a journal.

RESULTS AND ANALYSIS

4.1 Effect of Sucrose on Spore Germination

Sucrose is the predominant transport carbohydrate in most land plants and the most widely used sugar in bryophyte in vitro culture media [9]. In *Riccia gangetica*, Changeriwal [1] documented a clear bell-shaped concentration–response relationship for sucrose over time. As shown in **Table 1**, the optimal sucrose concentration was 2.0%, which produced 38.10% germination by Day 45, rising to 50.48% by Day 50 and culminating in a maximum of 86.67% by Day 60 — the highest germination percentage recorded for any sugar or concentration in this study. **Figure 1** (available for download at https://www.ijsdr.org/papers/IJSDR2309144.pdf) illustrates this pattern graphically: the germination curve peaks sharply at 2.0% sucrose then declines progressively at 3.0%, 5.0%, and 7.0% concentrations, describing an inverted-U curve that clearly demonstrates both the promotional and inhibitory concentration thresholds.

At suboptimal concentrations (0.5% and 1.0%), sucrose promoted germination above control levels but fell well short of the 2.0% optimum. At supra-optimal concentrations (5.0–7.0%), germination declined markedly — at 7.0% sucrose, Day 50 germination dropped to 31.43% compared to 50.48% at 2.0%, reflecting osmotic inhibition of spore coat rupture. This inhibitory behavior is consistent with reports from *Marchantia polymorpha*, where 0.2 M sucrose applied to gemmae induced physiological drought symptoms including membrane disruption and photosynthetic pigment reduction [5].

The biochemical basis for sucrose's superiority is multifactorial. Sucrose is cleaved by cell-wall and vacuolar invertases to release glucose and fructose simultaneously, effectively supplying both hexoses through a single substrate. Additionally, sucrose acts as an independent signaling molecule via the trehalose-6-phosphate (T6P) pathway, regulating developmental progression beyond its caloric contribution [11].

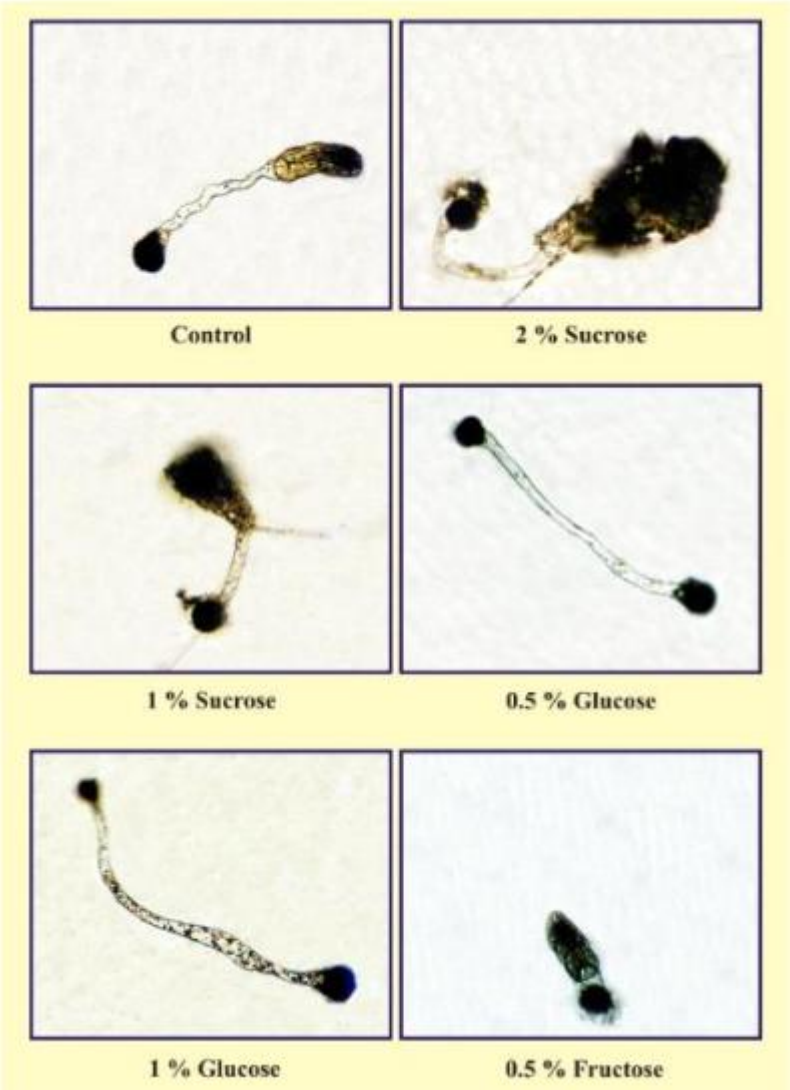

Figure 1: Effect of sucrose, glucose and fructose at different concentrations on spore germination (%) of Riccia gangetica Ahmad on the 45th, 50th and 60th day in Half Knop's medium. Note the bell-shaped curve peaking at 2% sucrose and declining at higher concentrations due to osmotic inhibition. Changeriwal K. (2023)

4.2 Effect of Glucose on Spore Germination

Glucose, a monosaccharide hexose and the direct product of photosynthesis, is the primary respiratory substrate in plant cells. As shown in **Table 1**, glucose at 1.0% produced the highest germination among glucose treatments — 32.38% by Day 45, rising to 45.71% by Day 50 — compared to 78.09% by Day 60 [1]. While glucose germination was supported across the full tested range up to 7.0%, its maximum was slightly lower than sucrose at its respective optimum, indicating that sucrose is the more efficient carbon source for *Riccia gangetica* spores. Notably, glucose germination declined more steeply at 7.0% than sucrose at equivalent concentration — because 7% glucose represents nearly twice the molar

osmotic load of 7% sucrose (MW glucose = 180 vs. sucrose = 342), imposing greater osmotic pressure per gram applied.

Glucose exerts its developmental effects through both metabolic and signaling pathways. As depicted in **Figure 2** (the hexokinase signaling network, downloadable from https://pmc.ncbi.nlm.nih.gov/articles/PMC3594732/), glucose is sensed by hexokinase 1 (HXK1) which translocates to the nucleus and modulates expression of photosynthetic genes, ABA-responsive elements, and genes governing cell division [10]. At optimal low concentrations (1.0%), glucose relieves ABA-mediated germination inhibition, accelerating spore coat rupture. At high concentrations (>3.0%), however, elevated hexose accumulation may paradoxically reinforce dormancy signaling. This dual role of glucose as both growth promoter at low concentrations and inhibitor at high concentrations is a recurring theme across plant systems [10, 12].

In *Marchantia polymorpha*, Li et al. [5] demonstrated that exogenous glucose application partially restored symmetrical thallus growth in cryptochrome mutants (*mpcry*) that showed reduced endogenous carbon fixation and sucrose metabolism under blue light, confirming glucose as a compensatory carbon source when photosynthetic sugar production is impaired.

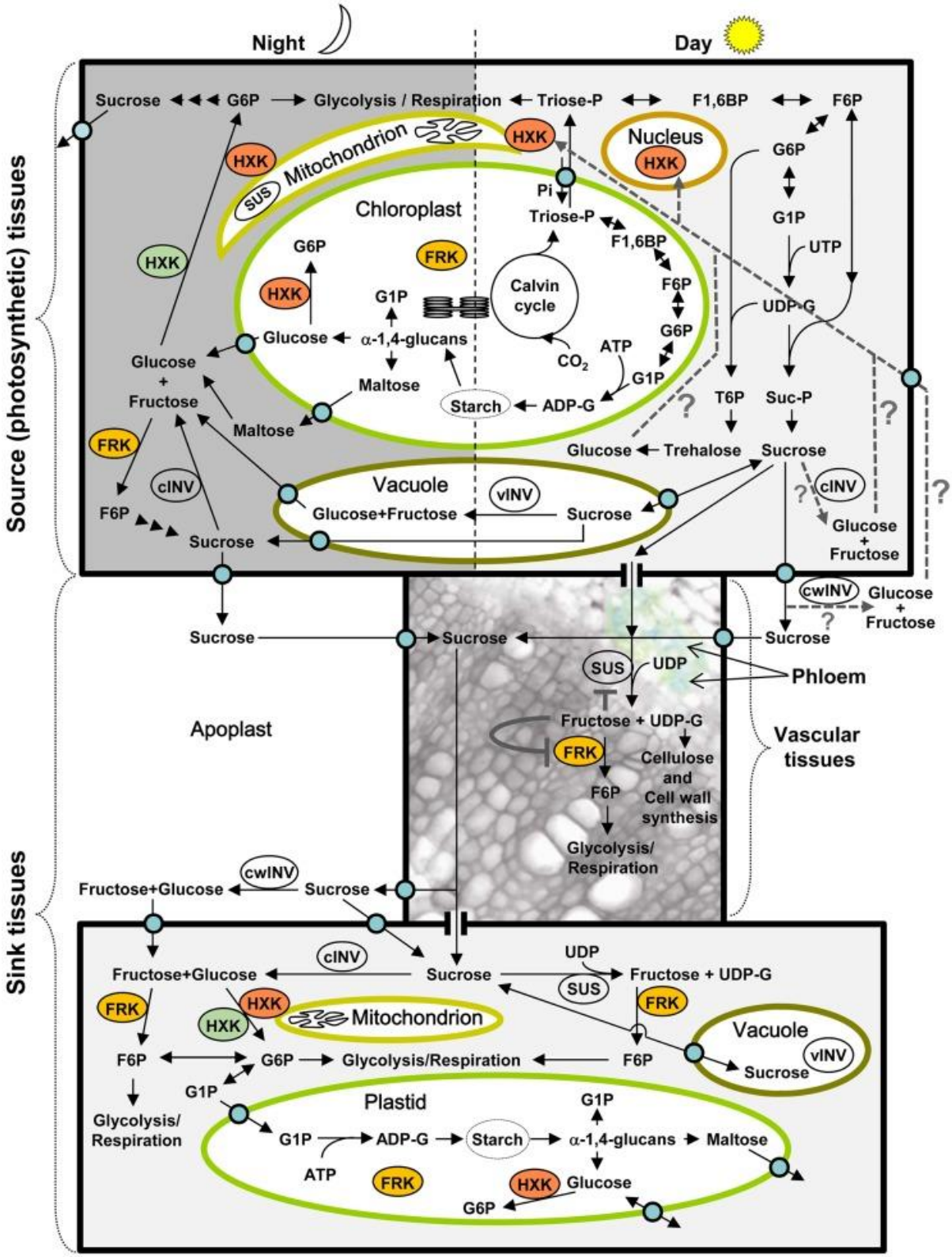

Figure 2: Schematic of hexokinase (HXK1)-mediated glucose signaling in plants, showing HXK nuclear translocation, ABA pathway interaction, G-protein cascade (RGS1/GPA1), and SnRK1 regulation — mechanisms directly applicable to glucose-stimulated spore germination in liverworts. The diagram

shows why low glucose concentrations promote germination while high concentrations can inhibit it through ABA cross-talk. Granot D., David-Schwartz R. & Kelly G. (2013)

4.3 Effect of Fructose on Spore Germination

Fructose demonstrated the narrowest effective concentration window of the three sugars tested. As clearly visible in **Table 1**, germination in *Riccia gangetica* was supported only up to 1.0% fructose, with the optimum at 0.5% producing 31.43% germination by Day 50 and 53.33% by Day 60 [1]. At fructose concentrations of 2.0% and above, no germination was recorded on Day 50, and germination ceased entirely beyond 1.0% by Day 45 — a far lower inhibitory threshold than sucrose (7.0%) or glucose (7.0%). This makes fructose the least forgiving carbon source from an osmotic tolerance perspective.

The narrow effective range of fructose is attributable to enzyme-level feedback inhibition. As illustrated in **Figure 3** (protonema development stages in liverwort, downloadable from https://www.scielo.br/scielo.php?pid=S0102-33062017000100019&script=sci_arttext), fructose is phosphorylated by fructokinases (FRKs) to fructose-6-phosphate, which enters glycolysis [10]. However, excess fructose inhibits sucrose synthase and FRK activity through product accumulation, reducing ATP generation efficiency. Biologically, fructose at 0.5% likely supports the initial cell wall polysaccharide synthesis required for protonema wall extension, without generating toxic downstream metabolite concentrations.

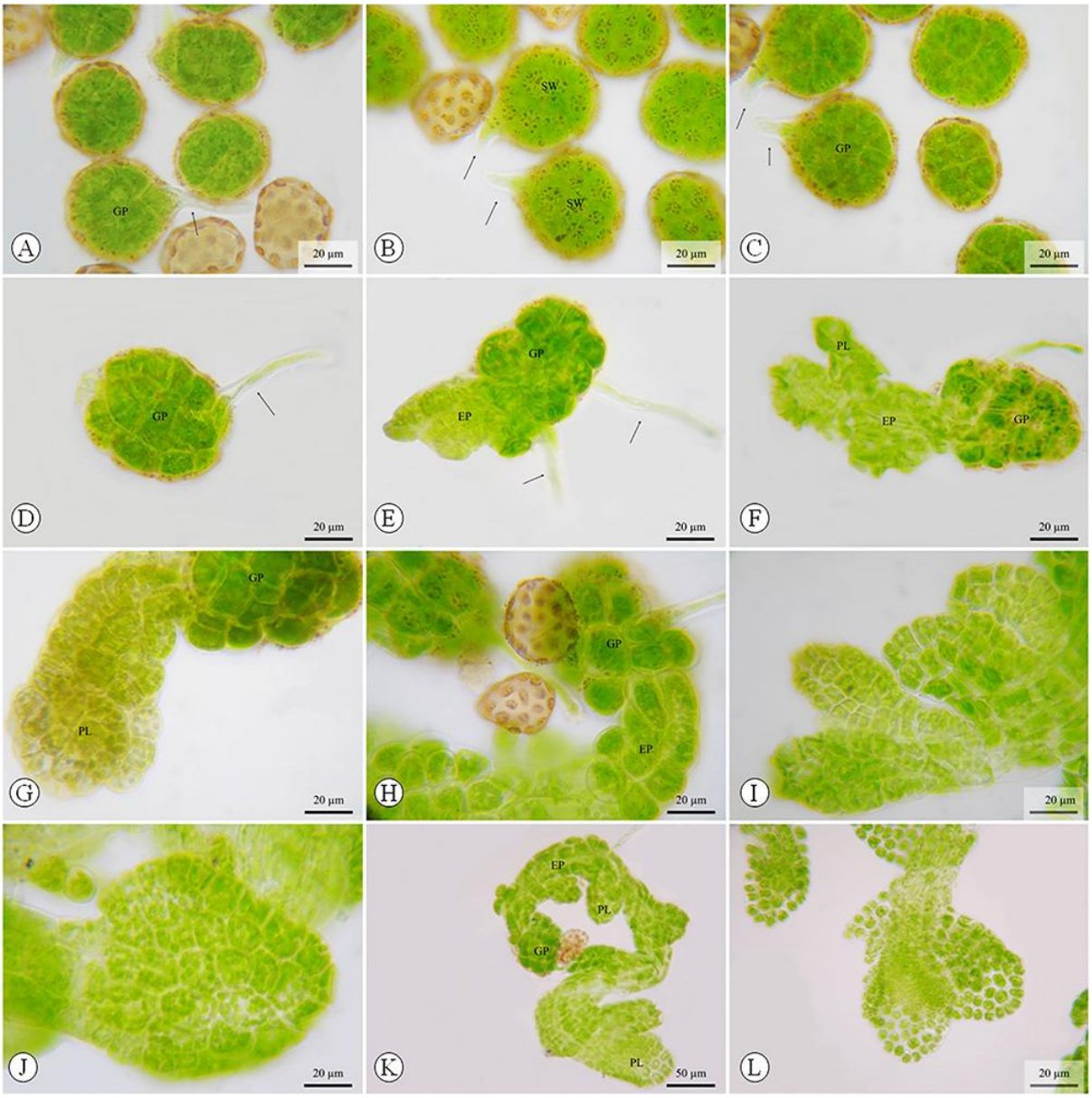

Figure 3: Spore germination stages in liverwort Frullania ericoides on Knop's medium — showing (a) ungerminated spore, (b) endosporic cell division, (c) globular protonema within spore wall, and (d) emergence of external protonema. These developmental stages apply broadly to all liverwort spore germination including Riccia gangetica. Note: Lower nutrient concentrations produced longer protonema, paralleling the low-sugar-concentration optimum observed for fructose. Maciel-Silva A.S. et al. (2017)

4.4 Cross-Species Comparative Analysis

Table 2 presents a systematic comparison of optimal sugar types, concentrations, and maximum germination percentages across five liverwort species studied under carbohydrate-supplemented media. The data reveal a consistent pattern: sucrose at 1.0–2.0% is the universally preferred carbon

source across all species examined. *Riccia gangetica* shows the highest recorded maximum germination (86.67% under 2.0% sucrose), while *Cryptomitrium himalayense* responds to 1.0% sucrose not only by germinating but by producing sex organs — indicating that sucrose thresholds for reproductive induction are lower than those for mere germination success [7]. *Frullania ericoides* on Knop's half-strength medium (which inherently contains no added sugar) produced the longest protonema despite moderate germination, demonstrating that carbon source type interacts strongly with overall medium ionic strength [6].

The consistency of a 1.0–2.0% sucrose optimum across distantly related liverwort genera — *Riccia*, *Marchantia*, *Cryptomitrium*, and *Frullania* — suggests that carbohydrate sensing thresholds may be evolutionarily conserved across the Marchantiophyta, possibly reflecting ancestral carbon acquisition strategies from early land plant evolution.

4.5 Protonema Development and Early Sporeling Growth

Beyond germination percentage, the quality and length of protonema development are critical indicators of successful spore establishment. In *Frullania ericoides*, Maciel-Silva et al. [6] demonstrated (see **Figure 3**) that lower Knop's medium concentrations (¼ and ½ strength) produced significantly longer external protonema than full or double-strength medium. This inverse relationship — moderate nutrients promoting elongation while excess nutrients favor cell proliferation over extension — applies directly to sugar concentration effects. In *Riccia gangetica*, spores treated with 2.0% sucrose showed earlier germination onset at Day 45 (38.10%) compared to control (19.05%), confirming that sucrose accelerates developmental rate, not merely final germination percentage [1]. Glucose-treated cultures showed similar time advantage at 1.0%, while fructose at 0.5% also showed earlier competence over control at Day 45, despite ultimately reaching a lower ceiling.

4.6 Osmotic Effects and High-Concentration Inhibition

A universal trend across all three sugars is progressive inhibition at supra-optimal concentrations. **Figure 4** (downloadable from https://www.sciencedirect.com/science/article/abs/pii/S0098847220301982) documents the drought-stress response in *Marchantia polymorpha* gemmae exposed to osmotic stress induced by 0.2 M sucrose, showing increased malondialdehyde, hydrogen peroxide accumulation, electrolyte leakage, and membrane disruption [5]. These are precisely the cellular outcomes expected from high-sugar treatment of *Riccia gangetica* spores at concentrations ≥5.0%, explaining the suppression of germination. The data in **Table 1** quantify this decline: at 7.0% sucrose, Day 50 germination falls to 31.43% — barely above control (29.52%) — despite sucrose's high germination-promoting capacity at 2.0%.

The osmotic water potential (Ψw) imposed by dissolved sugars increases with molarity. At equivalent weight percentages (e.g., 3% w/v), sucrose contributes ~88 mM while glucose contributes ~167 mM — the latter creating roughly double the osmotic pressure. This molar difference quantitatively explains why fructose (isomeric with glucose, MW = 180) becomes inhibitory at far lower weight percentages (>1.0%) than sucrose (MW = 342, inhibitory >3.0%), which is one of the most important practical findings for in vitro culture protocol design.

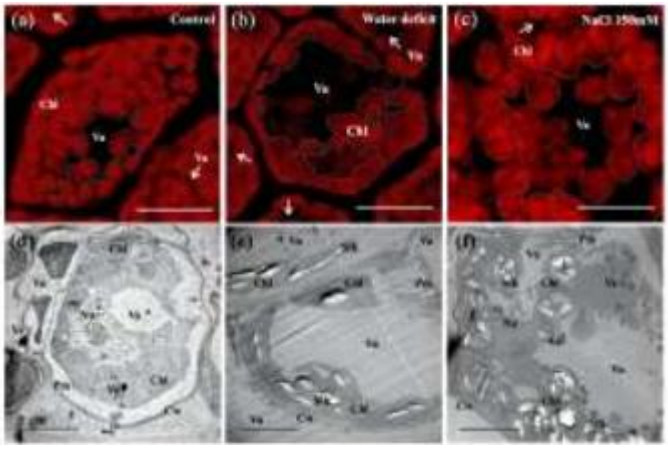

Figure 4: Drought stress parameters in Marchantia polymorpha gemmae exposed to 0.2 M sucrose (an osmotic equivalent of high-concentration sugar treatment) — showing elevated malondialdehyde (MDA), hydrogen peroxide (H_2O_2), electrolyte leakage, and reduced chlorophyll content. This data is directly analogous to the cellular mechanisms causing high-sugar inhibition of Riccia gangetica spore germination observed at ≥5% concentration (Table 1). Quiroga G. et al. (2020)

4.7 Molecular and Biochemical Mechanisms

Table 3 summarizes the known molecular and biochemical roles of each sugar and their effective thresholds, compiled from multiple sources [1, 5, 9, 10, 11, 12]. The table shows that sucrose operates through the broadest set of mechanisms — including direct T6P signaling, invertase-mediated hexose release, and HXK-independent sensing — explaining its superior overall effectiveness. Glucose operates primarily through the HXK1-ABA pathway and G-protein coupled receptor signaling (RGS1/GPA1), while fructose is chiefly metabolized through fructokinase (FRK) without equivalent signaling cascade involvement. Trehalose-6-phosphate, present at trace concentrations, integrates sucrose availability with SnRK1-mediated developmental checkpoint regulation.

Figure 5 (downloadable from https://molbio.mgh.harvard.edu/sheenweb/reprints/ARPB06sugar.pdf) presents the complete sugar-signaling network in plant development, encompassing all four pathways described in **Table 3**: (a) HXK-dependent glucose sensing and ABA cross-talk; (b) HXT/Snf3-type hexose membrane sensors; (c) G-protein coupled receptor (RGS1/GPA1) pathway for glucose control of

germination; and (d) SnRK1-T6P sucrose integration network [11]. In liverwort spore germination, pathways (a) and (d) are most directly operative: HXK1-mediated glucose sensing explains glucose's time-concentration specificity, while T6P-SnRK1 signaling explains why sucrose is uniquely effective in coordinating the entire germination program beyond merely supplying carbon.

Additionally, invertase activity is critical. As demonstrated in the moss *Polytrichum formosum* [13], cell-wall invertases in the haustorium region hydrolyze sucrose into glucose and fructose for local distribution — the highest sucrose concentration (~230 mM) being localized precisely at the tissue junction zone where active growth occurs. A similar invertase-dependent sucrose gradient likely operates at the interface between the germinating spore coat and the expanding protonema in *Riccia gangetica*, making 2.0% external sucrose the optimal supply concentration for maintaining this gradient without collapsing it through osmotic equilibration.

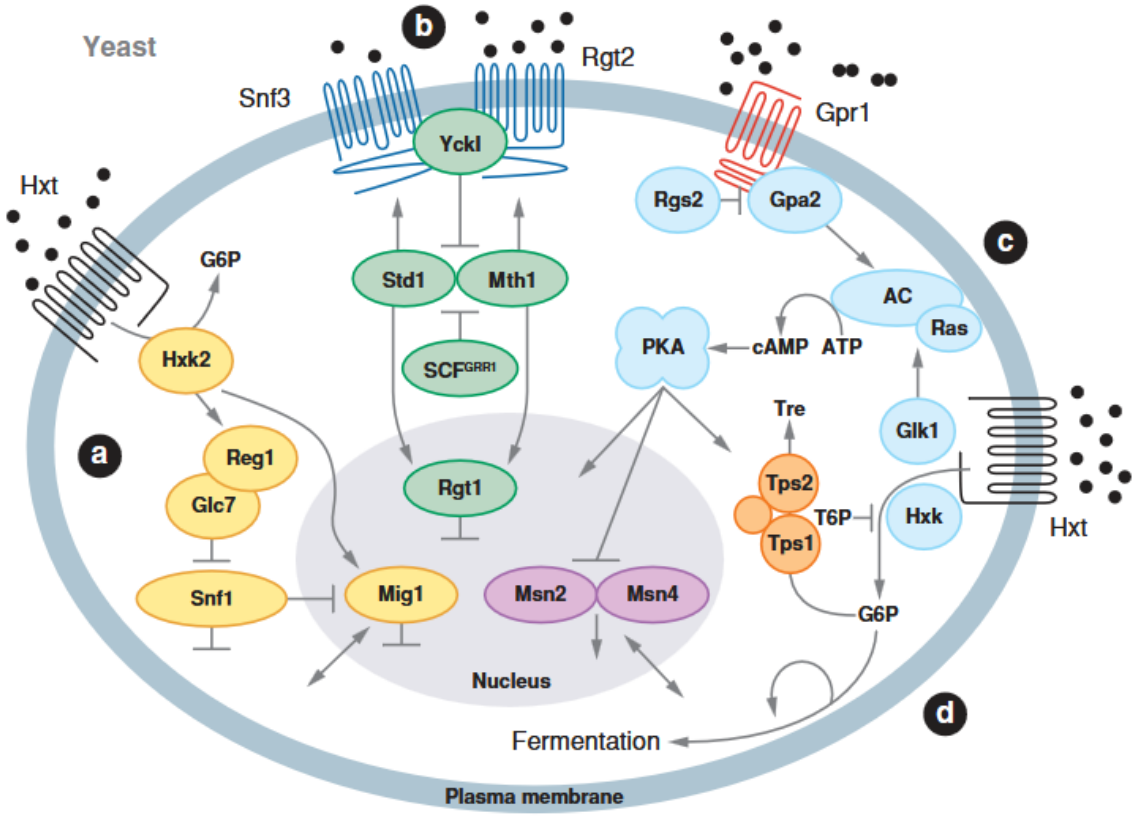

Figure 5: Complete sugar-sensing and signaling network in plant development. The four major pathways shown — (a) HXK-dependent glucose sensing, (b) membrane hexose sensors, (c) G-protein coupled receptor pathway, (d) SnRK1-T6P integration — collectively explain why sucrose (acting via all four) outperforms glucose (acting via a and c) and fructose (acting primarily via metabolism alone) in promoting liverwort spore germination as quantified in Table 1 and Table 2. Rolland F., Baena-Gonzalez E. & Sheen J. (2006)

COMPILED DATA TABLES

Table 1: Effect of sucrose, glucose and fructose (at varying concentrations) on spore germination (%) of *Riccia gangetica* Ahmad in Half Knop's medium at Days 45 and 50. Data show a consistent bell-shaped response with maximum germination at 2.0% sucrose, 1.0% glucose, and 0.5% fructose. Fructose ceases to support germination above 1.0% (Days 45) and 0.5% (Day 50), demonstrating its narrow effective window compared to sucrose and glucose. '—' = no germination recorded. (Source: Changeriwal [1], IJSDR 2023)

Conc. (%)	Sucrose D-45	Glucose D-45	Fructose D-45	Sucrose D-50	Glucose D-50	Fructose D-50
Control	19.05	19.05	19.05	29.52	29.52	29.52
0.5	26.19	23.81	31.43	38.10	35.24	31.43
1.0	30.48	32.38	16.19	45.71	45.71	26.19
2.0	38.10	28.57	11.43	50.48	40.00	—
3.0	33.33	26.19	—	45.71	38.10	—
5.0	26.19	21.90	—	40.00	30.48	—
7.0	19.05	14.29	—	31.43	26.19	—

Table 2: Comparative germination data across five liverwort species under carbohydrate-supplemented culture media. The table highlights the universal preference for sucrose at 1.0–2.0% across all species, with *Riccia gangetica* achieving the highest documented germination (86.67%) and *Cryptomitrium himalayense* demonstrating that 1.0% sucrose is sufficient to trigger sex organ production. (*) = approximate or inferred from qualitative description. (Sources: [1], [5], [6], [7], [8])

Species	Best Sugar	Opt. Conc.	Max Germ. (%)	Culture Medium	Ref.
Riccia gangetica Ahmad	Sucrose	2.0%	86.67	Half Knop's	[1]
Riccia gangetica Ahmad	Glucose	1.0%	78.09	Half Knop's	[1]
Riccia gangetica Ahmad	Fructose	0.5%	53.33	Half Knop's	[1]
Marchantia polymorpha L.	Glucose	Variable	Growth restored*	Modified MS	[5]

Species	Best Sugar	Opt. Conc.	Max Germ. (%)	Culture Medium	Ref.
Frullania ericoides Nees	½ Knop's	½ strength	Protonema max.	Knop's	[6]
Cryptomitrium himalayense	Sucrose	1.0%	Sex organs induced	Hoagland + Suc.	[7]
Marchantia linearis L.	Sucrose	1.0%	~65–70*	Knop's modified	[8]

Table 3: Biochemical and molecular roles of sucrose, glucose, fructose and trehalose-6-phosphate in plant/liverwort spore germination and early development. The table reveals that sucrose operates through the greatest number of molecular pathways, providing a mechanistic explanation for its consistently superior germination promotion across all species in Table 2. Fructose has the fewest known signaling roles, consistent with its narrowest effective concentration range. (Sources: [1], [9], [10], [11], [12])

Sugar	Primary Role	Molecular Mechanism	Opt. Conc.	References
Sucrose	Energy, osmotic balance, transport form	Invertase hydrolysis → hexoses; T6P signaling; HXK-independent sensing	2.0%	[1, 9, 10, 11]
Glucose	Cell division, HXK-mediated sensing	HXK1 nuclear translocation; ABA pathway modulation; G-protein sensing	1.0%	[1, 10, 12]
Fructose	Carbon skeleton supply, secondary metabolism	FRK phosphorylation to F-6-P; inhibitory feedback on SUS & FRK at >1%	0.5%	[1, 10]
Trehalose-6-P	Growth regulation, C-partitioning	SnRK1 inhibition; integrates sucrose status with developmental progression	Trace	[11]

DISCUSSION

The synthesis of data across liverwort species presented in **Table 2** confirms a clear hierarchy of sugar efficacy: sucrose > glucose > fructose for promoting spore germination. This order aligns with the molecular pathway complexity associated with each sugar — sucrose engaging the most signaling pathways (**Table 3**), glucose engaging intermediate pathways, and fructose operating primarily through

metabolic channels without equivalent signaling complexity [11]. The bell-shaped concentration–response relationship documented in **Figure 1** and quantified in **Table 1** is characteristic of all three sugars, differing only in the position of the optimum peak and the steepness of the post-peak decline. The 2.0% sucrose optimum for *Riccia gangetica* falls within the 0.5–2.0% range widely recommended for liverwort in vitro culture [4]. The convergence of this recommendation across species as morphologically and phylogenetically diverse as *Riccia*, *Marchantia*, *Frullania*, and *Cryptomitrium* (see **Table 2**) is a significant finding, suggesting that the carbohydrate sensing apparatus — likely centred on invertases, HXK1, and T6P pathways as shown in **Figure 5** — is functionally conserved across the Marchantiophyta. This conservation may reflect shared ancestral carbon sensing machinery inherited from the aquatic algal progenitor of land plants, subsequently maintained through 470 million years of liverwort evolution.

The sharply narrower effective range of fructose (<1.0%) compared to sucrose (<3.0%) has direct practical implications. Culture media supplemented with fructose must be prepared with extreme precision; even minor weighing errors could shift concentrations into the inhibitory range. Sucrose, with a broader effective window (0.5–3.0%), offers greater experimental robustness. Glucose occupies an intermediate position. For conservation protocols aimed at banking liverwort spore germplasm, 1.5–2.0% sucrose in Half Knop's medium is indicated as the safest and most effective formulation.

The osmotic inhibition mechanism illustrated in **Figure 4** — originally documented for gemmae stress in *Marchantia polymorpha* [5] — provides a mechanistic rationale for the germination decline at high sugar concentrations seen in **Table 1**. The elevated reactive oxygen species (ROS), membrane electrolyte leakage, and disrupted photosynthetic pigments observed at 0.2 M sucrose are the cellular consequences of water stress, which spore cells would experience equivalently when external osmotic potential exceeds turgor capacity.

RESEARCH GAPS AND FUTURE DIRECTIONS

Despite the advances synthesized here, several significant research gaps remain: (i) No study has yet conducted a fully factorial comparison of all three sugars across a matched set of Indian liverwort species under identical experimental conditions; (ii) Molecular characterization of HXK, FRK, invertase, and SnRK1 homologs in *Riccia gangetica* is entirely absent; (iii) Sugar–hormone (ABA, auxin, cytokinin) interaction studies in liverwort spore germination remain unexplored; (iv) Comparative metabolomics of sucrose-treated vs. glucose-treated vs. control spores would clarify the downstream metabolic trajectories; and (v) The long-term effects of germination-phase sugar exposure on subsequent thallus morphology, reproductive competence, and abiotic stress tolerance have not been systematically

addressed. Future studies should also explore sugar effects under field-relevant temperature fluctuations (15–35°C), which dramatically alter membrane permeability and enzyme kinetics.

CONCLUSION

This comparative review establishes that exogenous sugars — sucrose, glucose, and fructose — play dual, concentration-dependent roles as both carbon substrates and developmental signals in liverwort spore germination. The data compiled in **Tables 1–3** and interpreted through **Figures 1–5** demonstrate that sucrose at 2.0% is consistently the most effective germination-promoting carbohydrate across liverwort species, followed by glucose at 1.0% and fructose at 0.5%. High concentrations of all three sugars inhibit germination through osmotic stress. The molecular basis involves invertase-mediated sucrose hydrolysis, hexokinase glucose sensing via HXK1–ABA cross-talk, fructokinase-mediated fructose catabolism, and trehalose-6-phosphate–SnRK1 regulation of developmental progression. The finding that optimal carbohydrate thresholds are conserved across phylogenetically diverse liverwort genera suggests an ancient and robustly maintained sugar-sensing apparatus in the Marchantiophyta. The data presented here provide a consolidated reference for in vitro culture optimization, germplasm conservation, and future molecular investigations in liverwort biology.

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