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Editorial

Dear Readers

Season's Greetings

Please find the April issue of 2025 of "**Subharti Journal of Interdisciplinary Research**" an online publication of our prestigious Swami Vivekanand Subharti University.

It is with deep sense of appreciation that I thankall the Deans/Heads of Institutes and Research contributors, who have unconditionally extended support towards the online publication of our journal since the December 2018 issue. The journal was established with a sole objective to support the students, academicians, clinicians, researchers across various streams, who are in quest of publishing their novel work. The journal has already started receiving citations across various platforms from researchers across the globe. The authors have been steadfast in providing their valuable work for publication and it has been an abiding and enriching experience to go through their work.

We are working hard to get submissions from outside the University too and sincerely seek everyone's support for that. All efforts are being made in the right direction so as to improve the quality of the journal and increase the visibility and indexing of the journal in the near future.

I hope that this journal is living up to the expectations of our readers and patrons and our team is looking forward to any and every beneficial contribution on streamlining our publication process. I once again seek your support and look forward to welcoming your submissions for next issue and your valuable suggestions are eagerly awaited.

Happy Reading

Dr Vijay Wadhwan

Editor-in-Chief

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Review Article

A Comprehensive Review on Phytochemical Analysis of *Eclipta alba*

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Abstract

Eclipta alba (L.) Hassk., commonly known as False Daisy, is a traditionally valued medicinal herb widely recognized in Ayurvedic, Unani, and Chinese systems of medicine. It is extensively used for its hepatoprotective, antimicrobial, antioxidant, anti-inflammatory, and anti-aging properties. This comprehensive review provides a detailed analysis of the phytochemical constituents present in various extracts of *Eclipta alba*, including alkaloids, flavonoids, coumarins, terpenoids, polyacetylenes, saponins, and tannins. Advanced analytical techniques such as Thin Layer Chromatography (TLC), High-Performance Liquid Chromatography (HPLC), Gas Chromatography-Mass Spectrometry (GC-MS), and Fourier Transform Infrared Spectroscopy (FTIR) have been utilized in various studies to identify and quantify these bioactive compounds. The review highlights the correlation between specific phytoconstituents and their pharmacological activities, emphasizing the potential of *Eclipta alba* as a source for drug development and nutraceutical formulations. Furthermore, the review identifies research gaps and suggests future directions for in-depth metabolomic and bioavailability studies to validate traditional claims with modern scientific evidence.

Keywords: *Eclipta alba, phytochemical analysis, bioactive compounds, flavonoids, HPLC, GC-MS, medicinal plant, pharmacognosy*

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Introduction

Eclipta alba, commonly known as false daisy, holds a prominent position in traditional medicine systems, particularly in Ayurveda, where it is revered for its diverse therapeutic properties. This plant, belonging to the Asteraceae family, thrives in tropical and subtropical regions, including India, Nepal, and Bangladesh, where it has been traditionally employed to address a wide array of ailments [26 & 31]. Its traditional applications span across various health conditions, including gastrointestinal disorders, respiratory ailments, fever, hair loss and premature graying, liver disorders, skin diseases, spleen enlargement, and wound healing, underscoring its versatile therapeutic potential [20]. Phytochemicals, the bioactive compounds produced by plants as secondary metabolites, play a crucial role in mediating these therapeutic effects, acting as a defense mechanism against predators and environmental stressors [23]. These compounds are responsible for the plant's diverse pharmacological activities [4]. A comprehensive understanding of the phytochemical composition of *Eclipta alba* is crucial for unlocking its full therapeutic potential and for developing standardized herbal formulations with consistent efficacy and safety profiles.

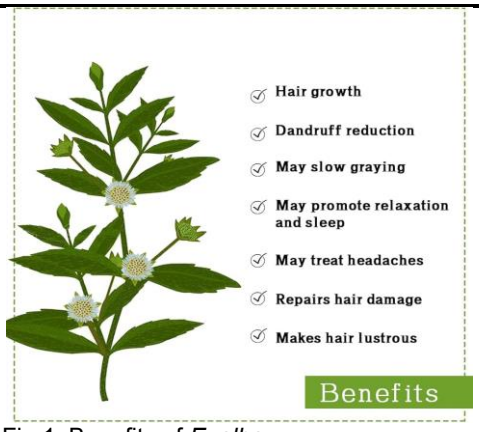

Fig 1. Benefits of *E. alba*

Phytochemical Profile of *Eclipta alba*

The phytochemical analysis of *Eclipta alba* reveals a rich reservoir of bioactive compounds, encompassing a diverse array of chemical classes, each contributing to the plant's multifaceted pharmacological activities. Among the key phytochemical constituents identified in *Eclipta alba* are flavonoids, known for their antioxidant, anti-inflammatory, and cardioprotective properties, which are frequently found in medicinal plants [28].

Coumarins, another class of compounds present in *Eclipta alba*, exhibit anticoagulant, anti-inflammatory, and anticancer activities, contributing to the plant's therapeutic potential [2]. Terpenoids, including triterpenoids and steroids, constitute a significant portion of the phytochemical profile of *Eclipta alba*, imparting diverse pharmacological effects, such as anti-inflammatory, antimicrobial, and anticancer activities (Qualitative and Quantitative Analysis of the Biochemical Components in Plant Samples Gathered from Muzaffarnagar, n.d.). Saponins, glycosidic compounds found in *Eclipta alba*, possess expectorant, anti-inflammatory, and immunostimulatory properties, further enhancing the plant's therapeutic value. Phenolic acids, such as gallic acid and caffeic acid, are also present in *Eclipta alba*, contributing to its antioxidant, anti-inflammatory, and hepatoprotective effects.

Fig 2. Different parts of E. *alba* plant

Literature Review

The presence of these diverse phytochemicals in *Eclipta alba* underscores its potential as a valuable source of natural remedies for various health conditions. The plant also contains wedelolactone, a coumestan with hepatoprotective and anti-inflammatory properties, and ecliptalbine, an alkaloid with potential anticancer activity. Other notable constituents include stigmasterol, a plant sterol with anti-inflammatory and cholesterol-lowering effects, and luteolin, a flavonoid with antioxidant, anti-inflammatory, and anticancer properties. Polyacetylenes, polypeptides, and thiophene derivatives have also been isolated from E. prostrata [3]. The presence of tannins, alkaloids, flavonoids, and saponins in the plant extracts may contribute to its medicinal properties. The synergistic interactions between these diverse phytochemicals are believed to contribute to the overall therapeutic efficacy of *E. alba*. *Eclipta alba* is known to contain secondary compounds like alkaloids, flavonoids, terpenoids, and phenolic compounds, all of which contribute to the plant's various therapeutic effects [22]. These compounds play a crucial role in the plant's medicinal properties, offering a wide range of pharmacological activities.

The extraction and analysis of phytochemicals from *Eclipta alba* involve a range of sophisticated techniques aimed at isolating, identifying, and quantifying the bioactive compounds present in the plant material. Solvent extraction, maceration, and Soxhlet extraction are commonly employed methods for extracting phytochemicals from *Eclipta alba*, utilizing solvents such as methanol, ethanol, and water to selectively dissolve the desired compounds [6]. These extraction methods are optimized based on the solubility characteristics of the target phytochemicals and the desired yield and purity of the extract. Following extraction, various analytical techniques are employed to identify and quantify the phytochemical constituents in the extract. High-performance liquid chromatography, coupled with diode-array detection or mass spectrometry, is a widely used technique for separating, identifying, and quantifying phytochemicals in *Eclipta alba* extracts due to its high resolution and sensitivity [1].

Eclipta alba, commonly known as false daisy, holds a significant position in traditional medicine systems, particularly in Ayurveda, where it is revered for its diverse therapeutic properties. This plant, belonging to the Asteraceae family, has been extensively utilized for treating a wide array of ailments, ranging from skin disorders and liver conditions to gastrointestinal and respiratory issues [20, 26 & 31]. Understanding the intricate phytochemistry of *E. alba* is crucial to elucidating its pharmacological mechanisms and validating its traditional uses. Plants produce phytochemicals as secondary metabolites to defend themselves from predators [23]. The medicinal properties of plants are correlated to the bioactive phytocompounds they possess [4]. Natural products from plants continue to be a major source of pharmaceuticals [28]. Comprehensive investigations into the phytochemical composition of *E. alba* have revealed the presence of a diverse array of bioactive compounds, including coumestans, flavonoids, terpenoids, steroids, and alkaloids. These compounds contribute significantly to the plant's therapeutic potential, exhibiting antioxidant, anti-inflammatory, antimicrobial, and hepatoprotective activities [5]. The chemical and biological sciences emphasize that biological or medical phenomena have a chemical foundation [14]. Squalene and other triterpenes have been isolated and identified from *E. alba* (Qualitative and Quantitative Analysis of the Biochemical Components in Plant Samples Gathered from Muzaffarnagar).

The exploration of *E. alba*'s phytochemistry reveals a complex profile of bioactive molecules, each contributing uniquely to its therapeutic efficacy. Flavonoids, a ubiquitous group of polyphenolic compounds, are abundant in *E. alba* and are known for their potent antioxidant and anti-inflammatory properties [24]. These compounds scavenge free radicals, inhibit lipid peroxidation, and modulate inflammatory signaling pathways, thereby protecting cells from oxidative stress and inflammation [27]. Terpenoids, another major class of phytochemicals found in *E. alba*, exhibit a wide range of biological activities, including antimicrobial, anticancer, and immunomodulatory effects. Coumestans, such as wedelolactone, are particularly noteworthy components of *E. alba*, demonstrating significant hepatoprotective and anti-inflammatory actions. Steroids present in *E. alba* have also been reported to possess anti-inflammatory and analgesic properties, contributing to the plant's traditional use in pain management.

The study of phytochemicals involves extraction, screening, identification, and characterization from

various biological materials [22]. Different solvent extraction techniques exist for optimum recovery of phytochemicals, like maceration, decoction, soxhlet extraction, hydro distillation, and microwave-assisted extraction. Phytochemical analysis techniques such as thin-layer chromatography, gas chromatography-mass spectrometry, and high-performance liquid chromatography play pivotal roles in identifying and quantifying the various bioactive compounds present in plant extracts. Spectroscopic techniques, including nuclear magnetic resonance spectroscopy and mass spectrometry, are indispensable for elucidating the chemical structures of novel phytochemicals.

The essential oils derived from plants contain complex mixtures of numerous chemicals, sometimes exceeding 400 different compounds, depending on the plant species, extraction method, and plant parts used [29]. The growing trend of comparing phytochemical constituents isolated from plants with their pharmacological actions underscores the importance of understanding the relationship between a plant's chemical composition and its therapeutic effects [17]. Herbal extracts contain essential nutrients and diverse bioactive compounds with antioxidant properties, such as flavonoids, phenolics, sterols, alkaloids, carotenoids, and glucosinolates [17]. These compounds act as substrates, cofactors, or inhibitors in biochemical and enzymatic reactions, influencing physiological functions [32]. Plants exhibiting differences in physical properties, such as color variations, may indicate the presence of diverse medicinal compounds, with flavor and special compounds being important features of medicinal plants [30].

The use of medicinal plants in healthcare is increasing, emphasizing the importance of discovering new medicinal plants to meet people's needs [21]. The study of pharmacophylogeny, which examines the relationships between plant kinship, chemical composition, and medicinal effects, guides the research and improvement of medicines [19]. In addition, environmental factors, including cultivation area, climate, planting and harvesting times, and post-harvest storage, can affect the consistency of plant extracts. Furthermore, processing and extraction methods, processing time, particle size, and the ratio of sample to solvent can influence the compositional diversity of phytochemicals present in natural extracts [33].

Conclusion

This study reveals that both *Eclipta alba* is rich in bioactive phytochemicals, especially phenolics and flavonoids. These findings provide scientific validation for their ethnomedicinal usage and indicate their potential as sources for natural therapeutic agents.

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Conflicts of Interest: The authors declare no conflict of interest.

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Review Article

Decoding Disease Mechanisms via Metabolic Modeling: Computational Approaches for Precision Medicine

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Abstract

Metabolism, essential for cellular function and homeostasis, is increasingly recognized in the etiology of various diseases. Biological system modeling has emerged as a promising approach to study complex metabolic regulatory networks involved in disease. By integrating biological knowledge with mathematical methods, these models simulate metabolic processes to reveal insights into disease development and progression. Recent studies highlight the potential of computational models to deepen understanding of metabolic reprogramming and aid targeted therapy design. Incorporating metabolic transport and mechanical elements can further enhance these models' effectiveness in identifying therapeutic targets. This article explores how computational metabolism models uncover disease mechanisms and their growing role in advancing precision medicine and treatments.

Keywords: Metabolism, Computational modeling, Disease pathology, Precision therapies, Metabolic networks, Therapeutic targets

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Introduction

Metabolism refers to the totality of chemical reactions occurring within a living organism, enabling the conversion of food into usable energy for cellular processes. It comprises two interdependent pathways: catabolism, the breakdown of complex molecules to release energy, and anabolism, the synthesis of complex compounds from simpler ones, requiring energy input [1]. The equilibrium between these processes ensures the body maintains homeostasis, supporting energy production, growth, and repair [2]. Efficient metabolism depends on optimal internal conditions, particularly temperature, as enzymatic reactions are highly sensitive to thermal fluctuations. Notably, energy needed for anabolic reactions often arises from coupling with energy-releasing catabolic reactions, resulting in high-energy molecules like ATP [3]. Metabolic activity extends beyond individual cells, influencing and being influenced by broader physiological systems. For example, in cancer biology, the tumor microenvironment can reprogram cellular metabolism to resist therapy [4]. As such, a deep understanding of metabolic mechanisms—from basic energy exchange to disease-related adaptations—offers valuable insights for advancing medical treatments and promoting health.

Computational Modeling in Biological Systems: Unlocking Life's Complexities Computational modeling has become a pivotal tool in biological research, enabling molecular-level insights and supporting the transition from descriptive to predictive science [5]. These models elucidate complex biological mechanisms, guide experimental strategies, and are instrumental in studying disease progression and evaluating therapies, including agent-based models for simulating infection dynamics and vaccine planning [6]. A key application is metabolic modeling, which deciphers cellular biochemical processes using mathematical constructs such as stoichiometric equations, matrices, and kinetic models [7, 8]. Techniques like flux balance analysis apply conservation principles to simulate realistic cellular behavior, while dynamic flux models capture temporal metabolic shifts. The integration of these models with high-throughput data and machine learning enhances the analysis of complex biological systems, offering deeper insights into immune responses, metabolic regulation, and therapeutic development.

Metabolic Dysregulation and Multi-Omics Integration in Disease Mechanisms

Metabolism, the cornerstone of cellular energy conversion and biosynthesis, plays a pivotal role in maintaining physiological balance. Disruptions in metabolic homeostasis are closely associated with diseases such as diabetes, obesity, and cancer [9, 10]. Lipid metabolism, in particular, is a critical contributor; its dysregulation not only supports tumor proliferation through enhanced lipid synthesis but also underlies

many metabolic disorders. Factors such as sedentary lifestyles and poor nutrition have further exacerbated these imbalances globally [11]. Advancements in lipidomics offer novel insights into lipid dysfunction in type 2 diabetes, aiding in early diagnosis and the development of targeted therapies. Additionally, metabolism interacts intricately with genetic regulation, inflammatory signaling, and cellular stress responses—including ER stress and immune pathways—making it a central node in chronic disease development [12, 13]. To elucidate these complexities, the integration of multi-omics data—including genomic, transcriptomic, proteomic, and metabolomic layers—into metabolic models has emerged as a transformative approach. This strategy enables a systems-level understanding of disease pathogenesis and phenotype variability, especially in rare diseases where data limitations pose challenges. Leveraging machine learning for pattern recognition in such high-dimensional datasets, integromics facilitates the identification of novel biomarkers, disease pathways, and therapeutic targets. Dynamic simulations using omics-enriched metabolic models link molecular alterations to metabolic outcomes, making them indispensable tools in precision medicine and targeted intervention strategies

Tools and Software for Building Metabolic Models

Metabolic modeling relies on computational tools that analyze biochemical pathways using databases such as KEGG, MetaCyc, and BIGG. These tools utilize various network representations—substrate graphs, bipartite graphs, hypergraphs, and stoichiometric (S) matrices—to map metabolic reactions. To optimize pathway identification, techniques like atom mapping, structure similarity scoring, and cofactor removal are employed to prune non-essential connections, improving computational efficiency [18]. Search algorithms such as depth-first search (DFS), breadth-first search (BFS), Monte Carlo simulations, branch-and-bound, and Mixed-Integer Linear Programming (MILP) guide pathway discovery based on criteria like atom conservation, thermodynamics, and metabolite connectivity. For example, **ReTrace** uses bipartite graphs and ranks pathways by atom conservation and length, while PathComp applies DFS on substrate graphs [19].

utilizes KEGG data and Eppstein's k-shortest path algorithm for atom-level pathway analysis [14]. Other tools like RouteSearch and NeAT combine weighted graph representations with branch-and-bound and Takahashi-Matsuyama algorithms to rank paths by metabolite frequency and connectivity. DESHARKY, using Monte Carlo methods, incorporates phylogenetic data to evaluate metabolic burden [15]. Stoichiometry-based tools such as **optStoic,** PathTracer**,** and CFP rely on S-matrix and MILP formulations to optimize metabolic flux or yield. Retrosynthesis tools like Simpheny**,** GEM-Path, and BNICE focus on synthesis feasibility using thermodynamics, enzyme availability, and product yield. Metabolic search tools help identify desirable biochemical transformations for pathway design by mining metabolites and reactions [16]. These tools draw from diverse biochemical databases—BIGG, KEGG, MetaCyc, and BR—each differing in reaction coverage, resolution, and accuracy. However, such databases may contain inconsistencies like stoichiometric errors, missing chemical structures, and redundant entries, often requiring manual curation. Reconciliation tools such as MNXref**,** BKM-react**,** and RxnFinder improve database integrity using compound identifiers and InChI strings. Services like **UniChem** and the Chemical Translation Service enable ID conversion across databases. Organism-specific databases (e.g., EcoCyc**,** AraCyc**,** HumanCyc**)** provide curated metabolic data for native pathway modeling, while broader tools like **optStoic** and XTMS integrate KEGG or MetaCyc data for heterologous pathway design [17].

Conclusion and Future Scope

Metabolic modeling has become a vital tool for understanding disease mechanisms by simulating cellular metabolic changes. In cancer, models reveal metabolic reprogramming like the Warburg effect, where cells favor glycolysis despite oxygen presence to support rapid growth. Similarly, in metabolic disorders such as non-alcoholic fatty liver disease and metabolic syndrome, disrupted glucose and lipid metabolism drive chronic inflammation and systemic dysfunction [20]. These models help identify metabolic vulnerabilities, suggest therapies, and discover early diagnostic biomarkers, advancing personalized medicine. However, challenges persist due to the complexity of metabolic networks, their interactions with regulatory pathways, genetic variability, and environmental influences like diet and stress. Simplifying assumptions in models may overlook critical biological details, affecting prediction accuracy.

Future improvements will come from integrating multi-omics data, advanced algorithms, and real-time biological information. Overcoming issues related to genetic and environmental diversity will enhance model utility. With progress in data science, machine learning, and systems biology, metabolic modeling is set to play a central role in precision medicine by enabling predictive insights, novel target identification, and tailored treatments across diseases

Name of Database	Function	Error Handling	Organism-Specific	Coverage	Login Required
BIGG	Biochemical reactions and molecules	Not specified	No	Extensive	No
KEGG	Biochemical reactions and interactions	Requires manual curation	No	Comprehensive	No
MetaCyc	Metabolic pathways and enzymes	Requires manual curation	No	Broad	No
MNXref (MetaNetX)	Reconciliation of metabolite information	Compound synonyms, InChI structures	No	High	No
EcoCyc	E. coli-specific pathway data	Not specified	Yes	Limited	No
AraCyc	*Arabidopsis thaliana* pathway data	Not specified	Yes	Limited	No
HumanCyc	Human metabolic pathways	Not specified	Yes	Limited	No
Chemical Translation Service	Metabolite ID conversion across databases	Not specified	No	Wide	No
UniChem	Standardizes metabolite IDs across databases	Not specified	No	Extensive	No

Table 1: Comprehensive Metabolic and Biochemical Databases

Table 2: List of Metabolic Pathway Analysis Tools

Name of Tool	Datasets	Network Representation	Search Algorithms	Ranking Criteria	Multi-Path Analysis	Optimal Path Selection	Login Required
ReTrace	KEGG	Bipartite graph	Heuristic search	Atom conservation, pathway length	No	Yes	No
PathComp	Substrate graph	DFS	Pathway length	No	Yes	No	
Pathway Hunter Tool	Substrate graph	BFS and higher-order logic	Structure similarity, pathway length	No	Yes	No	
MetaRoute	KEGG	Weighted reaction graph	Eppstein's k-shortest paths	Atom conservation, connectivity	Yes	Yes	No
RouteSearch	Weighted graphs	Branch-and-bound, Takahashi-Matsuyama k-shortest paths	Connectivity, frequency	No	Yes	No	
NeAT	Weighted graphs	Branch-and-bound	Pathway connectivity	Yes	No	No	
DESHARKY	Phylogenetic data	Monte Carlo approach	Metabolic burden	Yes	No	No	
optStoic	Stoichiometry matrix (S matrix)	MILP	Flux, metabolic yield	Yes	Yes	No	
PathTracer	S matrix	MILP	Metabolic yield	No	Yes	No	
CFP	S matrix	MILP	Metabolic yield	No	Yes	No	
Simpheny	Retro synthon enumeration	Molecular signature mapping	Thermodynamics, product yield, enzyme presence	Yes	No	No	
GEM-Path	Retrosynthesis	Molecular signature mapping	Pathway feasibility	No	Yes	No	
BNICE	Retrosynthesis	Molecular signature mapping	Thermodynamics, enzyme presence	Yes	Yes	No	

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Review Article

Untouchability And Social Justice In India

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Abstract

The caste system, with all of its peculiarities, is a distinctive feature of Indian society, where untouchability was the practice of avoiding physical contact with people due to erroneous notions about ritual purity and defilement. Caste Hindus believed that the touch, shadow, or voice of an untouchable was a Defilement of the upper caste, which also legitimized certain practices that were humiliating, exclusionary, and exploitative.Dr. B.R. Ambedkar launched a relentless struggle and demand for self-government to uplift the conditions of the depressed classes along with sharing of power among the untouchable community, without which fundamental human rights enforcement was impossible. He believed that the 'Just Society' must be based on the ideals of liberty, equality, and fraternity with equal distribution of state resources. Being chairman of the constitution drafting coming and as a visionary behind constitutional framing, he advocated the Hindu Code Bill, where he explained secularism. According to him, a secular state parliament should not be competent to impose any particular religion upon the rest of the country's people. According to Dr. B.R. Ambedkar, 'graded inequality' was inherent in the caste system of Hindu society. His main sociological findings were this 'graded inequality.' This principle of graded inequality also overshadows the economic spheres of society. In Dr. B.R. Ambedkar's dream, India would be a country where there would be no discrimination between men and women, no exploitation, no untouchability, and no degradation for the attainment of the rule of law.The present paper is an effort to highlight Dr. B.R. Ambedkar's contribution to framing the basic Structure of the Indian constitution along with the reasons for the non-attainment of desired objectives for a balanced, casteless-secular, and Just Society even after seven decades.

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Untouchability, Dr. B.R. Ambedkar, and the Constitution of India[1]

The word *'untouchability'* signifies or denotes a culture or system or tradition to not to touch human beings because of prevalent class classification in that society, particularly in Indian society. The origin of untouchability and its historicity are still debated. B. R. Ambedkar believed that untouchability has existed at least as far back as 400 AD.[2] Along with Mahatma Gandhi, Dr B. R. Amebedkar is known not only a social reformer but also a legal expert whose efforts played pivotal role in making the contribution of Mahatma Gandhi in reality. Dr. Ambedkar employed two methods for reforming Hinduism and removing untouchability with the cooperation of the Brahmins and with the cooperation of non-Brahmins. First, he tried to seek the help of the Brahmins, because commoners never differentiate between the pure scriptures and interpolated ones. "They (commoners) are too illiterate to know the contents of the Shastras. They have believed what they had been told and what they have been told is that Shastras do enjoin as religious duty the observance of caste and untouchability."[3] The Brahmins interpret the Shastras and people believe in them. Hence, Ambedkar believed that if the Brahmins tried to remove untouchability naturally commoners would follow them. Ambedkar through all communication devices propagated that for saving and safeguarding Hindu culture and Hindu religion, Hindu unity was essential. Up to 1932, Ambedkar's stance about Hindu unity can be consistently observed though it became inconsistent later on. For Hindu (unity), Ambedkar started joint Ganeshotsava of the Sawarna Hindus and the Untouchables. He arranged 'Satyanarayana Pooja'

[2] Ambedkar, Bhimrao Ramji; Moon, Vasant (1990). Dr. Babasaheb Ambedkar, Writings and Speeches, Volume 7

[3] Triloknath: Politics of the Depressed Classes (Delhi. Deputy Publications 1987) p. 232

which was administered by the Untouchables. He conducted interlining programmes. On the Congress party initiative to made it compulsory for its members the use of Khadi and spindling, Ambedkar thought that if non-observance of untouchability was also made compulsory for the Congress members, the mission of removal of untouchability would have gathered momentum and he suggested the same to the Congress.

The second way Ambedkar adopted in removing untouchability was to seek the help of the non-Brahmins. There was a close association between him and Rajarshi Shahu. This approach challenged the supremacy of the Brahmins. The Marathas possessed the potential to check the Brahmanic dominance. However, in social field Ambedkar realised that the Marathas were not honest. He also accepted that the Brahmins had more ability for social reforms. He had already made the leaders of the Satya shodhak movement aware of this fact. The experience of the Untouchable students in the Maratha boardings was not encouraging. Secondly the movement launched by Rajarshi Shahu was also Hindutvawadi. In his movement the Brahmin dominance was replaced by the Kshatriya dominance.

Ambedkar ridiculed at Gandhi's movement of removing untouchability. He insisted that Gandhi should give more emphasis on the removal of untouchability than the freedom movement. Ambedkar advised his followers to keep away from the freedom movement. To some extent he succeeded in realising his objective. This weakened Gandhi's movement. If Ambedkar would have brought his followers, independently in freedom movement, the experience achieved there, would have been utilised in other movements. It would have, even silenced his critics who used to finger at Ambedkar's neutrality about the freedom movement. And participation in freedom movement would have boosted the morale of the Untouchables.

At the time of launching movement for removing untouchability, Ambedkar wanted to consolidate 'all Shudras' (non-Brahmins). If he had succeeded in this task, he would have been able to capture political power. However, he side-tracked it so much that he refused seats to the Adiwasis, because the Adiwasis were not politically conscious. It did not suit the democratic values, Ambedkar held. Ambedkar proposed that the seats to the Muslims should be reduced and given to the Scheduled Tribes. Ambedkar suggested that a separate fund for the Scheduled Tribes should be raised; and used for their education to make them politically conscious. But this was suggested to bypass the legitimate rights of the Adiwasis. Ambedkar seemed to have determined not to give seats to the Adiwasis from the share of the Untouchables. It is quite clear that when the Adiwasis claimed share from the quota of Untouchables, Ambedkar laid condition that first they should become politically conscious but if the Adiwasis claimed share from the Muslim quota, he waived the condition. In the power sharing process in India it is observed that the culturally better people received more share. The Brahmins claimed more share by virtue of their education, then the Marathas raised eye-brows against them. The Brahmins pleaded their case saying they were better educated and hence must have more share.. Afterwards, Maratha did the same when other backward communities demanded their share and surprisingly Ambedkar continued to harp on the same stringe when the Adiwasis claimed their share.

It is also interesting to record that during the Round Table Conference, Ambedkar, who was strongly making a case for the separate interests of the Untouchables, is said to have written a confidential letter pleading the case of Hindus to the then prime minister of England that the Muslim representatives were taking disadvantage of his arguments against the Sawarna Hindus. The Hindu representatives could not plead the case of the Sawama Hindus. Ambedkar in that confidential letter pleaded the case of the Sawama Hindus also.[4]

In the Second Round Table Conferance Ambedkar was also confronted with the problem as to who should he support to-Gandhi or the British Government. Several scholars have rightly suggested that the problem which rose up in the Second Round Table Conference could have been easily solved by granting reserved seats and joint electorates. Keer said that the followers of Gandhi misguided him about the popularity of Ambedkar otherwise he would not have opposed Ambedkar.

Ambedkar based the dhamma on science but made it difficult to understand. He presented its theoretical aspect for the rational people, yet leaving certain weak links. When Ambedkar, with the help of 'karm-phal' theory analysed the linkages between karma and phal, many questions arise, which do not find satisfactory replies in Ambedkar's further analysis. Ambedkar differentiated between the 'rule' and 'principle'. No doubt, the Bouddha religion envisages more freedom to its followers, but not to that extent as presupposed by Ambedkar. Otherwise there is no propriety to distinguish between 'what belongs to the Buddha and what not'. The freedom inBuddhism should allow the variations in interpreting Buddha. The difference between 'rule' and 'principle' in the background, it is difficult to recognise rules for defining 'Bhikku' and 'Upasak'. It cannot be said that Buddha's utterances are flexible. Ambedkar's argument that the war can be waged if needed and not willed was not even acceptable to Buddha himself who in any event, wanted to avoid war. This has been clearly, indicated in 'The Buddha and his Dhamma'. Buddha's 'Karuna' was so extensive that before reaching 'buddhatva', instead of waging a war he left his country. After reaching 'buddhatva' his 'karuna' must have extended further and it is difficult to believe that even if there was need for war, he would recommend war.

In Buddhism irrational matter is not entertained. Still, in his 'The Buddha and his Dhamma' Ambedkar included many myths. It can be acceptable that he did it for the sake of common people but on the basis of the criterion he established his 'dhamma' turns into 'dharma'. I n Buddhism, though the women were given diksha they

[4] Keer, Dhananjay - Dr. Babasaheb Ambedkar (Bombay, Popular Prakashan 1984) P. 198

were not elevated to the position of men. Dange has amply explained this. Dange points out that Buddha had remarked that the pure nature of his religion was to last for a thousand years but because of admitting women in the Sangha it would remain in pure form for five hundred years only. Though Ambedkar refuted these things, one may accept that the Buddhism might have lost its pure form in the course of long period. Every religion has enjoyed a period when it was practised in a pure form and therefore their propagandists desire to go back.

The Bouddhas revolted against the varna system not to blow it up. P. Laxmi Narsu who inspired Ambedkar, by offering evidence from Ambbat Sutta stated that the Buddha established the superiority of the Kshatriya. The Boudha religion stood distinct from other religions on theoretical and practical levels for some time but on practical level it was impossible for it to be so for a very long time. Ambedkar did not consider the 'Charwaks' when he left Hinduism. They had also denied the Vedas, Unpanishadas 'shabd-pramanya' and accepted rationalism and materialism. Ambedkar could have changed it to suit him and accepted it. When Ambedkar gave thought to conversion and came to a conclusion to embrace Buddhism, he considered Buddhism on theoretical level and other religions on practical level. During the lifetime of the Buddha his philosophy could not change the basic social structure.

Even when the process of taking decision to embrace Buddhism was going on, Ambedkar continued to bluntly criticize not only his political opponents but other religions also. On the contrary in spite of his political activities, political maneuvering unsuitable to Mahatma Gandhi even as an orthodox Hindu, it seems was tilting towards Buddhism.

At the time of conversion he was tearful, may be, due to solemnity of the ceremony or due to being overcome by parting from his beloved religion. He asked his followers to take anti Hinduist oath. Also this might be from desperateness. Before this, in 1947 when Delhi was rocked by the communal riots, the Muslims there, were frightened. The majority of the Muslim tongawalas shaved their heads and grew shendi (small bunch of hair, which Hindus retain after shaving head). They also sported 'tilak (a mark the foreheads of the Hindus). They were trying to save their life by posing themselves as Hindus. Ambedkar asked one of his close associates, Shastri to bring some Arya Samaji leaders to convert them to Hinduism so that their problem would be solved and the number of Hindus would also be increased.[12] Ambedkar introduced thfHindu Code Bill with a solitary intention of reforming Hinduism.

An attempt is made to show similarity between Hinduism and Buddhism. It is said that the grandfather of Addya shankaracharya was Bouddha and Shandaracharya himself was a prachchanna Bouddha (real Bouddha i,e. overtly Hindu). He elevated the Buddha as the eleventh incarnation. The Buddhism is separate from Hinduism so far as varna system caste system inequality between men and women, concept of soul, God, incarnation, rebirth, hell and the heaven are concerned. However, culturally as Ambedkar thought the Buddhism was not different from Hinduism. Therefore the Indian culture absorbed other religions having their origin in India. The Indian culture removed the separate entities of the Buddhism and Jainism. Ambedkar must be in the know of this therefore in the Indian Constitution Buddhist, Jain and Sikh people are treated as Hindus.

The politics in the last phase of freedom movement was better apprehended by Nehru, Patel and Azad than Gandhi and Ambedkar. It is remarked that Ambedkar did not appease the Muslims like Nehru."[5] But Nehru and Patel threw Jinnah in desperate condition. Nehru was confident that without bowing before the demand of Pakistan the leaders of the League could be put in a tight corner. Right from the period of the Nehru report, the Congress continued the same policy. Wavell appealed to the Congress that it should not stress on the strength of number but on statesmanship. However, the Congress did not respond to this request and instead of statesmanship preferred show of strength."[6]

Ambedkar endeavoured to model the Indian Constitution on Buddhism. He studied the constitutions of various countries. He also requested the Hindu Mahasabha to send the Indian Constitution if drafted independently. It is claimed by the Hindu Mahasabha that Ambedkar borrowed some clauses from it. Under the Chairmanship of Damodar Vishwanath, alias Baburz Gokhale a committee on drafting constitution was appointed, it prepared a draft, which was accepted by the Lokshahi Swarajya Paksha. Date says that Ambedkar called for a few copies of the constitution and extensively used it. In the drafts prepared by the Hindu Mahasabha and committee of the Indian Parliament many similarities can be found."[7]

Two clauses from the constitution prepared by the Hindu Mahasabha could be cited ... (11) In the words of President Roosevelt the human rights are enshrined in four freedoms. (i) freedom to lead a happy life, (II) freedom from fear (iii) freedom of speech and (iv) freedom to 'worship. The Constitution should assure these freedoms '(13) equality of men and women before law. Their rights should be identical. By no order or law they could be discriminated."[8] These two clauses and some others in both the constitutions are similar. In democracy such similarities are bound, to come. However, Ambedkar also promised to select the saffron flag as a national flag. On July 10 (1947) Ambedkar was going to Delhi. Some of the leaders of the Bombay

[5] Dadu Miya: Dalitanche Rajkaran (Bombay, Majestic Book Stall, 1974) p. 3

[6] Seervai op. Cit. p. 50 - History repeated itself, and Wavell's appeal for a statesmanlike approach found no response in the Congress because it preferred logic", "Philosophy" and "arithmetic to statesmanship".

[7] Dai Shankar Ramchandra - Maharashtra Hindu Sabhechya Karyacha Itihas (Pune, Date 1975) P. 192

[8] Dai Shankar Ramchandra - Maharashtra Hindu Sabhechya Karyacha Itihas (Pune, Date 1975) P. 227-228

Provincial Hindu Mahasabha and Maratha leaders met Ambedkar and handed him over a saffron flag. That time Ambedkar said that if an agitation was launched to accept saffron flag as national flag he would support it. He also told Babasaheb Bole and Anantrao Gadre that they were trying to furl the saffron flag on the constitional committee at the hands of a Mahar's son. Ambedkar's car also bore a saffron flag with the emblem of 'Om'. As Ambedkar was for some time in America for education, he could observe the functioning of federation. He was well- versed in constitutional law. Ambedkar also presented a scheme to avoid communal deadlock and creation of Pakistan."[9] Since there were no provinces of Untouchables majority, Ambedkar assigned them so much weight age that without their cooperation it was not possible for the Congress or League to run the government. In the editorial of 'The Times of India (May l7, 1945) Ambedkar's scheme was heavily criticised. To refute the criticism Ambedkar presented the principle of 'relative majority'. The scheme provided that the Untouchables would be constantly in power. This could have been changed and accepted. But Ambedkar could not retain the support of his community. It was evidenced in the election of 1946. Ambedkar could not foresee the consequences of the election system in the Pune Pact. The election tactics of the Congress party were also responsible for Ambedkar's declining influence.

There were certain reasons for Ambedkar's isolation. Some of them might be as under –

(1) The Congress underrated him and other parties. (2) No other party in India resisted the British rule as forcefully as the Congress. (3) Ambedkar like Jinnah and the Congress were always at the logger heads and hence they lost Congress sympathy. (4) Some of the Untouchables and their leaders joined the Congress. (S) The British knew that it was only the Congress that could challenge their power. (6) For delaying independence of India, the British Government used Jinnah and Ambedkar, but as it was determined to free India, there was no need to entertain either Jinnah or Ambedkar. At this time, Ambedkar could not prove that his castemen were solidly supporting him.

This was evidenced in the discussion in the Constituent Assembly and discussion on the Hindu Code Bill. When in Constituent Assembly and ministry, Ambedkar successfully won the concessions for the backward classes but he could not as per his expectation, raise the Untouchables as a social and political power. And in fact this mission was far more important than any other from his and his community's point of view. After drafting the Constitution if he had devoted his time to the task of building organisation, the rifts among the Untouchables would not have been created. When freedom became a near possibility, the Congress turned more and more complacent. Gandhi could not control over this situation His policies were opposed within the Congress from the Second World War. Gandhi felt that non-violence should be accepted on a world level. The Congress leaders were not in mood to accept Gandhi's proposal. Ambedkar also criticized it. It seems that Gandhi also changed his policy. Lord Wavell always used to say that on this occasion Gandhi thumped the table and said, 'If India wants blood-path she shall have it'. Because of the dogmatic stand of the Muslim Leaguers and their intimidations Gandhi might have said like that.

Ambedkar programme of the removal of untouchability was not free from limitations. His political and social activities were centred on the main objective of materialising welfare of the Untouchables. It is the distinguished feature of his politics; his strength lies in it and also limitations.

In introducing the Hindu Code Bill also, his love for Hinduism could be noted. In the British period, all religious groups had their independent personal laws and Hindus were recorded as non Muslims. Ambedkar teased that no Sawarna Hindu was ever ashamed of it. He had an ambition to produce a progressive law for the Hindus. A question arises that if Ambedkar had affection for Hinduism why he criticized Hinduism. An answer has already been given to it in the preceding chapters. In a nutshell, it can be aid that Ambedkar's criticism on Hinduism was in fact on brahmanya, egoism and selfishness. Ambedkar remarked that for greed the Brahmins sacrificed the hour an unity in Hinduism. For some time he held the opinion the lost solidarity in Hinduism could be revived by the Brahmins only. They had adequate potentials for affecting 'Sanshodhakata' in Hinduism. Even before Ambedkar many social reformers criticized Hinduism with a view to modifying it.

Gandhi, bringing in morality in politics attempted to spiritualise politics. His theories of truth, non-violence, trusteeship, satyagraha were projected on the moral principles. There were certain drawbacks in them. One can find a gap between his principles and practice. During the Second World War Gandhi was prescribing non-violence for the world. But at the time of the creation of Pakistan, as stated by Wavell, Gandhi declared that if India wantedblood-path she should have it. Gandhi's concept of democracy also changed and became retrograde. He refined his life through experiments with the truth. He related the experiment with the sex to the violent events happening speedily. The unity of India which he valued more than his life was at stake. As the freedom came on the threshold the Hindus and Muslims were butchering each other. With his life's work in ruins, Gandhi felt deeply sad and frustrated, could not sleep for days, almost lost his will to live and was heard murmuring to himself, 'what shall I do? There is darkness everywhere."[38] He had thought that he had a message for the world weary of violence, but evidently it had proved impotent even in his own country, under his own leadership...that there must be some serious flaw deep down in me which I am unable to discover."[39] He thought-If he was absolutely pure, with not a 'particle'. Jmpure desire or the slightest element of egoism and violence left in him,

[9] Ganjre, M.F. Babasaheb Ambedkaranchi Bhashane Vol 5 (Nagpur, Ashok Prakashan 1976) p. 106

he should be able to mobilise his spiritual shakti...."[10]
Ambedkar presented the state socialism also. In 1952, he partnered with the socialist party. He was in favour of extensive socialism. He suggested to nationalise agriculture. Here also his key principle was that of bringing welfare to the Untouchables."[11] His programme of nationalization did not displace freedom. Ambedkar was favorable to emancipative distributive and organizational development of the rural area.
Ambedkar intended to nationalize industries and land within the parliamentary democratic framework. One question remains that if obstacles cropped up, what plans he had to remove them? The Government which he assumed to remove them would exist in principle only. Because for carrying out massive nationalization totalitarian Communist Government was needed, which he rejected out rightly. The democratic framework falls short of carrying this task, and Ambedkar's expectations about Indian Government were very high.
Ambedkar has stated the concept of constitutional morality, which refers to the nature of enjoying rights with due respect for the constitution. India lacked this constitutional morality and hence the nature of administration should be decided in the constitution only. Ambedkar opined that due to the interference of the legislature the constitution loses its shape. Thus he travels from the concept of development through constitution.

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7. Seervai op. Cit. p. 50 - History repeated itself, and Wavell's appeal for a statesmanlike approach found no response in the Congress because it preferred logic", "Philosophy" and "arithmetic to statesmanship".
8. Quoted in Seerval op. cit. p. 53.
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10. Seervai : op. cit p. 43 "Representatives of Nationalist Muslims" were interviewed by Cripps and Alexander on 16 April, 1946. Maulana Madani said, inter alia, that "he was in favour of one centre and one Constituent Assembly. Hindus and Muslims should have parity both in the Government and in the Central Legislature. Elections should bemade on the basis of joint electorates coupled with reservation of seats."Mr. Ziharuddin agreed that there should be parity between Muslims and Hindus in the Central Government and Mr. Hussain said that this was aiso his view (Quoted from Transfer of Power Vol. VU page-286 at p. 287).
    Nemisharan Mittal (Dharmayug 6-12 August, 1989) however opined that the nationalist Muslims in competition with the League Muslims were defeated and hence alongwith Azad all nationalist Muslims held Nehru and Patel responsible for partition.
11. Dai Shankar Ramchandra - Maharashtra Hindu Sabhechya Karyacha Itihas (Pune, Date 1975) P. 239.
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OriginalArticle

In Vitro Seed Germination and Optimization for Dalbergia Sissoo Roxb

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ABSTRACT
Dalbergia sissoo, a commercially significant legume, faces challenges in propagation and cultivation due to factors such as salinity. This study aimed to optimize seed germination conditions for this species. Seeds were subjected to various sterilization methods and germinated on filter paper, semi-solid, and liquid MS media. Results indicated that liquid MS medium exhibited the highest germination rate (67.53%), followed by semi-solid MS medium (57.14%) and filter paper (47%). These findings suggest that liquid MS medium provides an optimal environment for Dalbergia sissoo seed germination. Further research is necessary to evaluate the impact of salt stress on germination and to explore in vitro propagation techniques for this valuable species.

Keywords: Propagation, Germination, MS medium, Dalbergia sissoo, Valuable

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Introduction

The genus *Dalbergia* is part of the legume family Fabaceae and the subfamily Papilionoideae. This tropical genus includes around 100 species of trees, shrubs, and lianas. One species, *Dalbergia sissoo*, is a medium to large tree that can reach approximately 25 meters in height, with a grey-yellow trunk measuring 2-3 meters in diameter. Its leaves are leathery and pinnately compound, with alternate, broad, ovate, acuminate, glabrescent leaflets that have a fine-pointed tip [(1)]. *Dalbergia sissoo* primarily reproduces by seed, allowing it to form dense thickets. The flowering season is from March to May. It is found in an exotic range including Bangladesh, Bhutan, India, Malaysia, and Pakistan, and a native range covering Cameroon, Ethiopia, Indonesia, Iraq, Israel, Kenya, Mauritius, Nigeria, Sudan, Tanzania, Thailand, Togo, the US, and Zimbabwe [(2)].

Dalbergia sissoo is renowned for its medicinal properties and has been traditionally used to treat various ailments including skin and blood diseases, syphilis, stomach issues, dysentery, nausea, and disorders of the eye and nose[(3)]. It also serves as an aphrodisiac and expectorant. Indian rosewood exhibits insecticidal and larvicidal properties and is resistant to some wood-boring insects[(4)].

Plant cell, tissue, and organ cultures leverage the "totipotency" of plant cells, which allows them to regenerate into a complete organism. This technique enables the growth of isolated cells, tissues, differentiated organs, or whole plants in a growth medium under sterile conditions, outside their natural environment [(5)].

The following study was carried out with the following objectives as to assess the seed viability of *Dalbergia sissoo* Roxb. seed germination percentages were determined using the filter paper method conducted in liquid and semi-solid basal MS media, with varying durations of sterilization and to evaluate seed germination percentage and viability under salt stress, seeds were subjected to different concentrations of Sodium chloride (NaCl) in basal MS medium.

Material And Methodology

Following methodology was conducted to check the seed germination percentage by cultivating seeds on filter paper and in liquid and semi-solid basal MS media.

Sample (seeds) Collection

Seeds of *Dalbergia sissoo* Roxb were obtained from Forest Research Institute and experiment was performed at Graphic Era University, Dehradun. These seeds were utilized as the sample material for the experiments.

Preparation of filter paper medium and basal liquid and semi-solid MS media

Sterile and autoclaved petri plates were supplied with Whatman filter paper serving as a platform for germination of seeds. Total 10 petri plates were prepared for the purpose. Total 7 test-tubes containing semi-solid basal MS medium were utilized for seed germination. Following this, 7 test tubes containing

liquid basal MS medium supplied with filter-paper bridge acting as platform for seeds germination.

Seeds surface sterilization treatment

Seeds of *Dalbergia sissoo* soaked in a solution of liquid detergent (Tween-20, 2-3 drops) for 10 minutes and 0.1%, w/v) for a time period of 10 minutes rinsed with autoclaved distilled water. To assess the viability and germination percentage rate of the *Dalbergia sissoo* seeds, ten petri plates each with ten seeds were cultivated on moist filter paper and seeds were also inoculated in test tubes containing semi-solid basal MS medium (two bunches of seven test tubes each).

Seed Viability Test and Germination percentage on basal liquid MS medium

Using liquid basal medium supplied with a filter paper bridge, to measure the germination percentage and viability of *Dalbergia sissoo* seeds

Surface Sterilization of Seeds of *Dalbergia sissoo*

Dalbergia sissoo seeds were treated with liquid detergent solution (Citrimide, 4-5 drops) for a time period of 10 minutes. Following this, seeds were treated with an aqueous solution of the fungicides Dithane M-45 (0.1%, w/v) and Bavistin (0.2%, w/v) for 15 minutes in order to decrease contamination. Seeds were surface sterilised for 7 minutes using Mercuric chloride (Hgcl2, 0.1%, w/v) before inoculation. Single seeds were inoculated in liquid basal MS media in a test tube total 11 sets (one set has 7 test tubes).

Results and Discussion

In vitro seed germination percentage of *Dalbergia sissoo* seeds on filter paper

Ten petri plates with moist filter paper were utilized to grow seeds of *Dalbergia sissoo.* Each petri plate consists of 10 seeds **(Figure 1)**. The observations and calculations were done after 30 days of induction of cultures **(Table 1)**, **(Figure 2)**. A graph was plotted between number of replicates and number of seeds was germinated on filter paper **(Graph 1)**.The seeds showed 47% of germination rate. It means that atleast 50 percent seeds are in viable condition and able to germinate on moist filter paper.

***In vitro* seed germination of *Dalbergia sissoo* seeds grown on semi-solid basal MS medium**

To check seed viability and germination percentage, 14 test tubes supplemented with semi-solid basal MS media were utilized for inoculation of sterilized seeds. Each test tube consists of only 1 seed **(Figure 3).** After rinsed with distilled water. Pre-disinfection treatments of thefungicide Bavistin (0.2%, w/v) and Dithane M-45 (0.1%, w/v) for duration of 15 minutes. Following these steps, seeds underwent surface sterilization using Mercuric chloride (HgCl2,

30 days of culture induction, number of seeds germinated and their germination percentage was calculated **(Table 2), (Figure 4).**Overall seed germination percentage was calculated as 57.14%.

***In Vitro* seed germination of *Dalbergia sissoo* seeds grown in liquid basal MS medium**

Total 11 sets of test tubes **(one set consists of 7 test tubes)** were prepared which consists of basal liquid MS medium and filter-paper bridge which provides a platform for germination **(Figure 5)**. Observations and calculations were recorded after 15 days of induction **(Figure 6, Table 3)**. Only 55 seeds out of 77 were shown good germination with better growth. A graph was plotted between number of test tube sets containing seeds in basal liquid MS medium and number of seeds germinated in each set (**Graph 2)**. Overall seed germination percentage of 77 seeds was calculated as 67.53 %.

Conclusion

Dalbergia sissoo, a commercially important legume, faces challenges due to salinity and propagation difficulties. This study aimed to optimize seed germination conditions for this species.Results indicated that **filter paper**and **semi-solid MS medium** supported seed germination, with **47% and 57.14% germination rates,** respectively. However, **liquid MS medium** demonstrated the highest germination rate of **67.53%.** These findings suggest that liquid MS medium provides a suitable environment for *Dalbergia sissoo* seed germination.

Further research is warranted to investigate the influence of different salt concentrations on seed germination and seedling growth, as well as to explore the potential of in vitro techniques for large-scale propagation and salinity tolerance improvement in Dalbergia sissoo.By optimizing germination protocols and understanding the effects of salinity, this study contributes to the development of sustainable cultivation practices for this valuable species.

Conflict of Interest- There is no conflict of interest among the authors.

1. **TABLES**

Table 1- Table shows number of petri plates utilized, number of seeds germinated in each petri plates out of 10 seeds and the overall germination percentage of all 100 seeds.

Number of Replicates of seeds grown on filter paper	Number of seeds germinate (Out of 10)	Overall Germination Percentage (Considered of all 10 replicates)
I	4	**47/100*100 = 47%**
II	5	
III	5	
IV	7	
V	0	
VI	5	
VII	6	
VIII	5	
IX	6	

X	4	

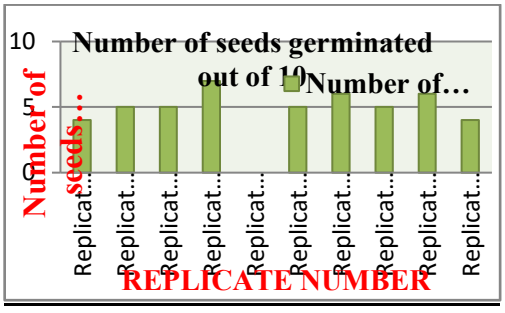
Table 2- Germination percentage of seeds grown on semi-solid MS medium after 30 days.

Number of test tubes containing	Observation of seed germination	Overall Germination Percentage
a.	No seed germinated	
b.	No seed germinated	
c.	Seed germinated	
d.	Seed germinated	
e.	Seed germinated (Plantlet with two leafs)	
f.	Seed germinated (Plantlet with five leafs)	**8/14*100 = 57.14%**
g.	Seed germinated	
h.	Seed germinated (Plantlet with 7 leafs)	
i.	No germination	
j.	No germination	
k.	Seed germinate (Plantlet with nine leafs)	
l.	No germination (Fungal contamination)	
m.	Seed germinate	
n.	No germination	

Table 3- Germination percentage of seeds grown on liquid MS medium after 15 days.

Number of test tube sets	Seed Germinate (out of 7)	Overall Percentage
I	5	
II	6	
III	7	
IV	4	
V	5	
VI	6	
VII	6	**52/77*100 = 67.53%**
VIII	4	
IX	7	
X	5	
XI	4	

FIGURES



Graph 1: Graphical representation between Replicate numbers and number of seeds (out of 10) germinated in each replicate.

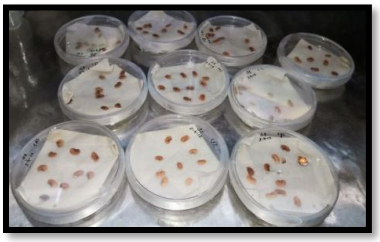
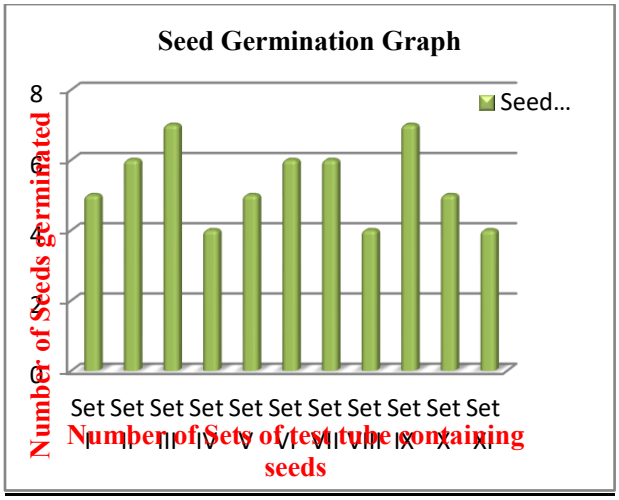


Figure 1: 10 petri plates containing *Dalbergia sissoo* seeds (each petri plate contains 10 seeds) growing on moist filter paper (at inoculation time).

Figure 2: Seeds germination on filter paper, observations after 30 days of induction.

Figure 3: Dalbergia sissoo seeds inoculated on semi-solid basal MS media.

Figure 4: Seeds germination on semi-solid basal MS media, observations after 30 days of induction.



Graph 2: Graphical representation between number of test tubes sets containing seeds and number of seeds germinated.

Figure 5: Dalbergia sissoo seeds inoculated on liquid basal MS media. Images were taken after 7 days of inoculation.

Figure 6: Dalbergia sissoo seeds germinated on liquid basal MS media after 15 days of inoculation.

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Original Article

Knowledge And Information Survey On Mahakumbh Among Nursing Students Of Selected Nursing Colleges, Meerut

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ABSTRACT

Background: Hosting nearly 400 million attendees is no small feat for Prayagraj, a city of just 5.5 million residents. This year, a sprawling temporary settlement spanning 4,000 hectares will feature a mega global event(1). One of the central rituals of the Mahakumbh is the holy dip in rivers like the Ganges, Yamuna, and the mythical Saraswati. Beyond the spiritual significance, scientific studies have revealed the self-purifying nature of the Ganges. Psychological studies suggest that shared experiences in large gatherings can foster a sense of collective consciousness and emotional well-being. **Objective:** To assess the knowledge/ general awareness among nursing students regarding Maha Kumbh.**Study design**: Descriptive design was used for the study.**Setting**: The survey was carried out in selected nursing colleges, Meerut**Material and Method:**Quantitative research approach was used in this study consisting of 400 samples, selected using non probability convenient sampling method. The data was collected using structured questionnaireto assess knowledge / general awareness among the participants.**Statistics:** The data collected was analyzed using both descriptive and inferential statistics. **Results:** The result showed that majority of 183 (45.75%) samples felt that the event was of utmost importance and 332 (83%)**samples** felt that this event will signify our country's perception among foreign nations. With regard to knowledge 241 (60.25%) had adequate knowledge, 131 (32.75%) had moderate knowledge and 38 (09.50%) had poor knowledge. **Conclusion:** The findings highlight that, the student nurses had a significant knowledge or they were aware of the global event widely and they were willing to contribute to the event through health camps and it was also found that a significant proportion of the samples need more knowledge or training in the field of disaster management with relation to any mega public event.

Keywords: Mahakumbh, Knowledge, Awareness, Nursing students, Disaster, Health

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Introduction

Hosting millions of pilgrims at a single site requires extraordinary planning and execution. From sanitation to healthcare and crowd control, the Mahakumbh showcases exceptional organizational skills. Scientists and urban planners often study the festival's logistics to develop models for managing large-scale events. Innovations in technology, such as real-time monitoring, AI-driven crowd management, and mobile healthcare units, are increasingly employed, blending ancient traditions with modern solutions(2).

Psychological studies suggest that shared experiences in large gatherings can foster a sense of collective consciousness and emotional well-being. The Mahakumbh exemplifies this, as millions come together to meditate, pray, and celebrate. Such collective positivity can have measurable benefits on mental health, resonating with modern concepts of mindfulness and community support.

The Mahakumbh is a testament to India's rich heritage, where spiritual practices were often intertwined with scientific wisdom. By revisiting these traditions through the lens of modern science, we can preserve their essence while adapting them to contemporary challenges. Whether it's leveraging technology for better event management or drawing inspiration from ancient environmental practices, the Mahakumbh bridges the gap between India's storied past and its aspirational future(3).

As we celebrate this remarkable festival, let us embrace its lessons—respect for nature, community spirit, and sustainable living(4). The Mahakumbh is more than a ritual; it is a reflection of how science and spirituality can coexist, guiding humanity toward a harmonious future.

Methods And Materials:

Quantitative research approach with descriptive research design was used for this study. The study samples comprised of nursing studentsof various nursing colleges. And non probability convenient sampling

technique is used for this study. All samples available during the period of data collection were included in the study and thus the data was collected from 400 samples.

Each individual subject was informed about the purpose of the study, their benefits and after which both oral and written consent was obtained. The individual had the freedom to withdraw from the study at any point of time.

The data collection tool was developed in English and consists of 2 sections i.e., Baseline Performa consisting of demographic variables, Structured questionnaire to assess the knowledge and general awareness of Mahakumbh.

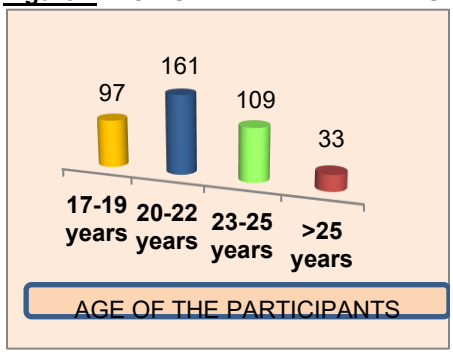
Inferences From Demographic Variables:

With regard to the demographic variables,with respect to age majority of 161 (40.25%) subjects were in the age group of 20-22 yrs, 309 (77.25%) subjects were females, whereas majority of subjects 261 (65.25%) wish to be part of the event by attending physically and 113 (28.25%) wish to get involved in health camps, In context to importance of the event, majority of 183 (45.75%) of the samples felt that the event was of utmost importance and with regard to the arrangements made by the concerned authorities 159 (39.75%) felt the arrangements made were good though not excellent. Most of the samples 332 (83%)felt that this event will signify our country's perception among foreign nations

Table 1: Demographic variables of the study sample (n=400)

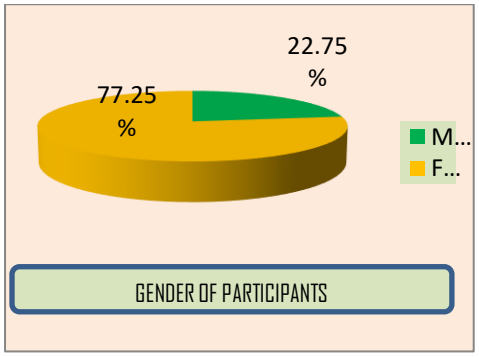
DEMOGRAPHIC VARIABLES	FREQUENCY (F)	PERCENTAGE (%)
AGE (IN YEARS)		
17-19 years	**97**	**24.25%**
20-22 years	**161**	**40.25%**
23-25 years	**109**	**27.25%**
>25 years	**33**	**08.25%**
SEX		
Male	**91**	**22.75%**
Female	**309**	**77.25%**
HOW DO YOU WISH TO BE PART OF THIS GRAND EVENT?		
By attending the event physically	**261**	**65.25%**
By getting involved in health camps	**113**	**28.25%**
Active part in social media campaigning	**26**	**06.50%**
IMPORTANCE OF EVENT IN A SCALE OF 1 – 5 (LESS IMPORTANT TO MOST IMPORTANT)		
1	**21**	**05.25%**
2	**28**	**07.00%**
3	**39**	**09.75%**
4	**129**	**32.25%**
5	**183**	**45.75%**
ARRANGEMENT DONE FOR THE GLOBAL EVENT IN A SCALE OF 1 – 5 (POOR TO EXCELLENT)		
1	**38**	**09.50%**
2	**25**	**06.25%**
3	**77**	**19.25%**
4	**159**	**39.75%**
5	**101**	**25.25%**
WILL THIS GLOBAL EVENT SIGNIFY OUR COUNTRY'S PERCEPTION AMONG FOREIGN NATIONS?		
Yes	**332**	**83%**
No	**12**	**03%**
Maybe	**56**	**14%**

Figure 1: AGE OF THE PARTICIPANTS.



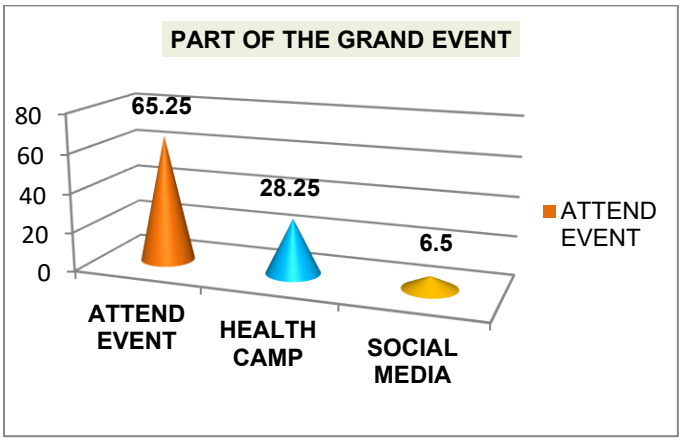
With regard to the age of the participant's majority of the participants 161 (40.25%) were in the age group of 20-22 years, followed by 109 (27.25%) participants in the age group of 23-25 years, 97 (24.25%) were in the age group of 17-19 years and the minimum of 33 (08.25%) were falling in the age group of more than 25 years.

Figure 2: GENDER OF THE PARTICIPANTS.



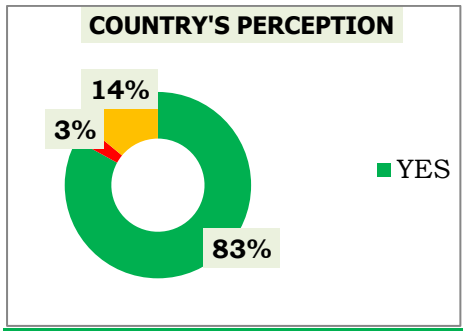
With regard to the gender of the participant's majority of the participants 309 (77.25%) were females and remaining 91 (22.75%) of participants were males

Figure 3: HOW DO YOU WISH TO BE PART OF THIS GRAND EVENT?



When asked to the participants how they wish to be part of this grand event, a majority of 261 (65.25%) participants have and wanted to attend the event physically.

Figure 4: WILL THIS EVENT SIGNIFY OUR COUNTRY'S PERCEPTION AMONG FOREIGN NATIONS?



The majority of the participants 332 (83%) felt that this event will signify our country's perception among foreign nations where as 56 (14%) of the participants felt it may signify and a minimum of 12 (3%) gave negative response.

TABLE 2: KNOWLEDGE QUESTIONNAIRE

KNOWLEDGE SURVEY QUESTIONNAIRE	FREQUENCY (F)	PERCENTAGE (%)
When is the Kumbh Mela 2025 scheduled to take place?		
1 January 2025 - 28 February 2025	**9**	**2.25%**
13 January 2025 – 26 February 2025	**287**	**71.75%**
14 January 2025 – 26 February 2025	**78**	**19.5%**

14 January 2025 – 28 February 2025	**26**	**6.5%**
How many days will the Kumbh Mela 2025 last		
30 days	**13**	**03.25%**
40 days	**102**	**25.5%**
45 days	**213**	**53.25%**
48 days	**72**	**18%**
Which rivers are associated with the Triveni Sangam?		
Ganga, Yamuna, Godavari	**45**	**11.25**
Ganga, Yamuna, Saraswati	**321**	**80.25%**
Godavari, Krishna, Kaveri	**34**	**08.5%**
Narmada, Tapti, Chambal	**0**	**0**
What is the ritual bath in Mahakumbh called?		
Ganga Snan	**101**	**25.25%**
Shahi Snan	**155**	**38.75%**
Pavitra Snan	**112**	**28%**
Moksha Snan	**32**	**08%**
In which year was the Mahakumbh Mela recognized as an Intangible Cultural Heritage by UNESCO?		
2003	**17**	**04.25%**
2013	**32**	**08%**
2017	**312**	**78%**
2023	**39**	**09.75%**
What is the name of the mobile app launched for Kumbh Mela 2025?		
Kumbh 2025 App	**121**	**30.25%**
Maha Kumbh Tracker	**97**	**24.25%**
Kumbh Info'2025 App	**11**	**2.75%**
Mahakumbh Mela 2025 App	**171**	**42.75%**
A special eye camp spanning 9 acres inaugurated in Mahakumbh is named as,		
Netra Sangh	**39**	**9.75%**
Netra Kumbh	**311**	**77.75%**
Nethralaya	**32**	**8%**
Surya Sangh	**18**	**4.5%**
What is the name of the mobile medical service given in mid of river Ganga?		
River Medical Camp	**11**	**02.75%**
Ganga River Medical Boat	**107**	**26.75%**
River Ambulances	**274**	**68.5%**
Ganga MediCare	**8**	**02%**
To ensure clean water in the Ganga and Yamuna rivers how many temporary sewage treatment plants are installed?		
2	**91**	**22.75%**
3	**121**	**30.25%**
4	**107**	**26.75%**
5	**71**	**17.75%**
Full form of IRS, the term used in disaster management is		
Incidence Report Service	**131**	**32.75%**
Incidence response system	**97**	**24.25%**
International Response system	**106**	**26.50%**
Indian Rescue service	**66**	**16.50%**
The Major health concern during Maha Kumbh Mela are because of		
Airborne diseases	**26**	**06.50%**
Waterborne diseases	**319**	**79.75%**
Pollution	**43**	**10.75%**
Food borne diseases	**12**	**03%**

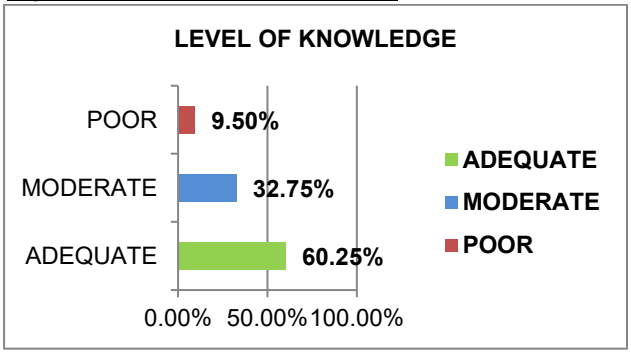
Common disaster event in Maha kumbh can be?		
Fire accidents	**41**	**10.25%**
Drowning	**186**	**46.50%**
Stampede	**157**	**39.25%**
Road Accidents	**16**	**04%**

TABLE 3: LEVEL OF KNOWLEDGE

LEVEL OF KNOWLEDGE	FREQUENCY (F)	PERCENTAGE (%)
ADEQUATE KNOWLEDGE	**241**	**60.25%**
MODERATE KNOWLEDGE	**131**	**32.75%**
POOR KNOWLEDGE	**38**	**09.50%**

The above table shows that in the knowledge questionnaire out of the 400 subjects, 241 (60.25%) had adequate knowledge, 131 (32.75%) had moderate knowledge and 38 (09.50%) had poor knowledge.

Figure 5: LEVEL OF KNOWLEDGE



The above figure shows that with regard to knowledge, out of the 400 subjects, 241 (60.25%) had adequate knowledge, 131 (32.75%) had moderate knowledge and 38 (09.50%) had poor knowledge.

The mean knowledge score of the subjects was 9 with S.D 0.91; the chi-square computed to assess the influence of demographic variables on knowledge showed a significant association with the age of the samples. Samples who were in the age group of 23 – 25 years had a better knowledge and practice of foot care.

Result:

The result showed that majority of 183 (45.75%) samples felt that the event was of utmost importance and 332 (83%)samplesfelt that this event will signify our country's perception among foreign nations. With regard to knowledge 241 (60.25%) had adequate knowledge, 131 (32.75%) had moderate knowledge and 38 (09.50%) had poor knowledge.

Discussion:

In the present study, 241 (60.25%) had adequate knowledge, 131 (32.75%) had moderate knowledge and 38 (09.50%) had poor knowledge.

The results or the data obtained from the knowledge questionnaire showed that most of the participants had moderate knowledge with regard to disaster management[5]. So with this we could develop a course and give more importance to disaster management.

Conclusion: The findings highlight that, the student nurses had a significant knowledge or they were aware of the global event widely and they were willing to contribute to the event through health camps and it was also found that a significant proportion of the samples need more knowledge or training in the field of disaster management with relation to any mega public event.

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Conflict of interest: Nil
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Review Article

Role of Radiology in Detecting the Microbial Diseases

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Abstract

Radiology is crucial in the diagnosis and treatment of microbial disorders, assisting doctors in recognizing and comprehending these infections. Radiology visualizes the structural changes generated by microbiological agents in the human body using various imaging modalities such as X-rays, computed tomography (CT), magnetic resonance imaging (MRI), and ultrasound. These infections can cause pneumonia, TB, abscesses, and septicemia, among other symptoms. Radiological data give critical information regarding the location, extent, and severity of the disease, allowing for an accurate and prompt diagnosis. Furthermore, radiology directs interventional procedures such as image-guided biopsies and drainage, resulting in more tailored treatment strategies. In a dynamic medical landscape with growing infectious risks, radiology's role in microbial diseases remains critical, improving patient treatment and outcomes.

Key words: Microbial disease, infections, pneumonia, abscesses, as X-rays, computed tomography (CT), magnetic resonance imaging (MRI).

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Introduction

Radiology has evolved as a critical tool in the diagnosis and therapy of microbial infections, with a critical role in comprehending the complicated interactions between pathogens and the human body. Emerging infectious conditions are presently recognized at an alarming rate of one evert time, ranging from the introduction of new contagious agents to the re-emergence of previously documented disorders [1]. Microbial infections can range from ordinary respiratory infections to life-threatening septicaemia, and early and precise detection is critical for effective treatment and containment.

X-rays, CT scans, MRI, and ultrasound are examples of radiological imaging modalities that can reveal structural alterations produced by microbial pathogens. On chest X-rays, for example, pneumonia shows typical infiltrates, whereas CT scans can reveal the distribution and extent of the illness within the lungs. Tuberculosis, another serious microbiological illness, frequently causes distinctive nodules and cavities in affected organs, which can be detected using several radiological techniques.

Emerging infectious diseases, defined by the Centres for Disease Control and Prevention (CDC) as those whose "incidence in humans has increased in the past two decades or threaten [(1)] to increase in the near future," have seen a record increase in prevalence over the past two decades related to increased international travel, developing antibiotic resistance, and increased industrialization and globalization of food production and distribution [(2)]

Ultrasound imaging can help in the detection of soft tissue infections, abscesses, and organ-specific infections, allowing for more targeted therapies. Furthermore, nuclear medicine techniques such as positron emission tomography (PET) scans aid in the detection of infectious foci in difficult patients. Radiology not only aids in early diagnosis but also in therapeutic decision-making. Radiologists work with other medical specialists to perform image-guided treatments like as biopsies and infected collection drainage. These treatments improve germ identification accuracy and provide critical information on antibiotic resistance, resulting in more effective and customized treatment methods. [(3)]

In an ever-changing medical landscape characterized by increasing infectious threats and global pandemics, radiology's role in microbial diseases remains dynamic and critical. Continuous advances in imaging technology and procedures improve diagnostic accuracy and treatment potential, ultimately improving patient outcomes and reinforcing global efforts to combat microbial illnesses.

Aetiology

The aetiology of radiography to provide essential diagnostic information regarding the structural alterations caused by diverse infections is the origin of its significance in microbial disorders. X-rays, CT scans,

MRI, and ultrasound are examples of radiological imaging modalities that aid in the early and accurate diagnosis of diseases such as pneumonia, tuberculosis, and septicaemia. Bioluminescence (BLI) and fluorescence imaging, positron emission tomography (PET), single photon emission computed tomography (SPECT), and magnetic resonance imaging (MRI) have all been developed and applied to both patients and animal models of infections [3]. These imaging techniques allow clinicians to see the location, extent, and severity of microbial infections, directing treatment decisions and allowing for image-guided therapies. As a result, radiography plays an important role in improving patient care and management of microbial diseases by providing critical information for diagnosis, treatment planning, and therapeutic outcome monitoring. (4)

Epidemiology

The epidemiology of radiology's function in microbial diseases emphasizes its importance in affecting disease management and healthcare outcomes. Radiological imaging is important in the epidemiological landscape because it allows for the early detection and exact diagnosis of numerous infectious diseases, which aids in the timely execution of public health measures. Radiology aids in the tracking and monitoring of microbial infections in communities by offering useful insights on disease distribution, severity, and progression. Furthermore, radiological data aid in research and monitoring activities, allowing for the creation of effective strategies for controlling and preventing the spread of infectious pathogens in communities. (5)

Pathophysiology

The ability of radiology to visualize and grasp the anatomical and pathological alterations generated by infectious agents is fundamental to the pathophysiology of microbial illnesses. Microbial diseases cause a chain reaction of events in the human body, culminating in specific tissue abnormalities. These changes are captured by radiological imaging techniques such as X-rays, CT scans, MRI, and ultrasound, indicating patterns of infection and tissue destruction. In the event of pneumonia, radiography can reveal lung infiltrates and consolidations. (6) Typical nodules and cavities are visible in TB. Radiology can help identify problems such as abscesses and septicaemia and guide suitable therapies. Furthermore, radiology can detect systemic infection locations using nuclear medicine techniques such as PET scans. Understanding the pathophysiology of microbial diseases through radiology allows for more accurate diagnoses, more timely treatment decisions, and better patient outcomes.

History and physical Examination

Radiology's history and physical characteristics for identifying microbial diseases have evolved dramatically over time, transforming medical diagnostics and patient care. The voyage began in 1895 with Wilhelm Conrad Roentgen's discovery of X-rays, which marked the beginning of radiology. Early applications concentrated on bone fractures, but radiologists quickly discovered its utility in identifying a wide range of disorders, including those caused by microbial pathogens. (6)

Imaging modalities such as CT scans and MRI were developed as radiology improved, providing more precise views of inside structures and aiding the diagnosis of infectious diseases. Ultrasound became a vital technique for identifying soft tissue infections and abscesses in the mid-twentieth century.

The physical examination is still important, as physicians use clinical signs and symptoms to guide the selection of radiological studies. Combining physical examination findings with radiological data allows for a fuller picture of the condition, resulting in more accurate diagnoses and individualized treatment regimens. (6)

Today, radiography plays an important role in the detection of microbial infections, with sophisticated technologies and imaging techniques giving rapid and precise insights into infectious processes. In the field of microbial diseases, integrating radiography with clinical evaluation ensures early discovery, proper care, and improved patient outcomes.

Evaluation:

Radiology has become an essential tool in the detection of microbial diseases, providing several benefits in the diagnostic process. In this context, radiological evaluation can be summarized as follows:

1. Diagnosis: Radiological imaging allows for the early diagnosis of microbial diseases, allowing for timely intervention and improving patient outcomes. It gives precise anatomical information to professionals, assisting them in identifying specific illnesses and their extent, and advising proper treatment options.
2. Non-invasive Imaging: Most radiological procedures are non-invasive, which reduces patient pain and the risk of consequences. As a result, it is appropriate for a wide spectrum of patients, including those who are too sick or delicate to undertake invasive operations.
3. Image-Guided Interventions: Radiology assists in the performance of image-guided procedures such as biopsies and the draining of contaminated collections. These interventions improve microbial identification accuracy and contribute to focused and effective treatment options.
4. Limitations: While radiology has many advantages, it also has certain limits. Some infections may not have distinct radiological signs, requiring a multimodal diagnosis strategy. Furthermore, picture misinterpretation and false negatives/positives might occur, highlighting the necessity of clinical correlation. (7)

Treatment of microbial disease:

The treatment of microbiological disorders is determined by the pathogen that caused the infection. The following are general treatment options for several types of microbial diseases:

1. **Infections caused by bacteria:** Antibiotics are the cornerstone of bacterial infection treatment. The antibiotic used is determined by the specific bacterium and its susceptibility to various medicines.
   In severe infections, broad-spectrum antibiotics may be taken initially while waiting for culture results, which can influence the selection of tailored medications.

2. **Infections caused by viruses:** Antiviral medications are used to treat viruses such as influenza, herpes, and HIV. These drugs can aid in the reduction of viral replication and the alleviation of symptoms.

Because viral infections generally recover on their own, supportive care, such as hydration and symptom control, is the predominant therapy in some situations.

3. **Infections caused by fungi:** Fungal infections are treated with antifungal medicines. The antifungal chosen is determined on the type of fungus and the site of illness.

Some fungal infections may necessitate long-term therapy, particularly in people with compromised immune systems. (2)

4. **Infections with Multidrug Resistance:** In cases of antibiotic resistance, alternative drugs or combination therapies may be required to treat the infection adequately.

Management of microbial disease:

Microbial illness management entails a comprehensive strategy to diagnosing, treating, and controlling the spread of infectious agents. The following are the essential components of microbial illness management:

1. **Diagnosis:** It is critical to begin proper treatment with an accurate and fast diagnosis. Laboratory tests, including as cultures, serology, and molecular assays, aid in the identification of the causing pathogen.(1)

2. **Antimicrobial Treatment:** To target and remove the pathogen, specific antimicrobial medicines such as antibiotics, antivirals, and antifungals are utilized. The drug of choice is determined by the detected bacteria and its susceptibility to treatments.

3. **Infection Prevention:** Strict infection control procedures are conducted in hospital settings to avoid the transmission of microbiological infections among patients, healthcare workers, and visitors. Hand hygiene, personal protective equipment, and isolation procedures for infected patients are all part of this.

4. **Vaccination:** Vaccination is critical in the prevention of some infectious illnesses. Immunization protects individuals and communities from diseases such as influenza, measles, hepatitis, and others.

5. **Prevention and education:** In order to reduce the spread of illnesses, public education about the transmission and prevention of microbial diseases is critical. Many infectious diseases can be prevented by promoting good hygiene and vaccination. Microbial illness management involves a coordinated effort involving healthcare practitioners, public health agencies, and the community. To control and prevent the transmission of infectious agents, prompt diagnosis, proper treatment, and adherence to infection control measures are required.

Prognosis

1. **Early Detection:** Radiological imaging, such as X-rays, CT scans, and MRI, allows for the early detection of infectious lesions and tissue changes induced by microbial agents. Early identification allows for faster treatment commencement, lowering the risk of complications and disease progression.
2. **Targeted Interventions:** Radiology provides critical information for image-guided treatments such as biopsies and drainage, resulting in focused and effective interventions. These treatments enable in the collection of precise diagnostic samples as well as the management of problems such as abscesses.
3. **Accurate Diagnosis:** Radiological results give critical information about the location, scope, and severity of microbial diseases. When imaging findings are combined with clinical data, accurate diagnoses are obtained, leading appropriate treatment strategies.(7)
4. **Monitoring Treatment Response:** Radiology can aid in the monitoring of antimicrobial therapy and interventions. Follow-up imaging can be used to evaluate treatment efficacy, identify treatment failures, and guide future management.(4)

Complications

Depending on the pathogen and the organs/systems involved, microbial illnesses can cause a variety of consequences. Bacterial infections can result in sepsis, abscesses, and organ failure. Viral infections can cause pneumonia, encephalitis, or long-term complications such as chronic hepatitis. Fungal infections can cause systemic problems, particularly in immunocompromised people. Parasitic infections can result in anemia, malnutrition, or organ damage. Microbial illnesses can also cause secondary infections and antibiotic resistance. To prevent or reduce these consequences and enhance patient outcomes, timely and proper management is critical.

Pearls and other issues

Radiology is critical in the diagnosis of microbial infections because it provides vital insights into the structural alterations caused by infectious agents. Here are some crucial points (PEARL) and other important topics concerning radiology's function in this context:

1. Early Detection: Radiological imaging provides for the early diagnosis of microbial illnesses, allowing for earlier management and improving patient outcomes.
2. Accurate Diagnosis: Radiology aids in the proper diagnosis of infections by supplementing clinical data and test results to achieve definitive conclusions.
3. Imaging Modalities: Imaging modalities such as X-rays, CT scans, MRI, and ultrasound provide complementary information that allows for a thorough evaluation of various infectious illnesses. Proton MRI of the lung is known to be especially challenging since air-tissue interfaces produce strong susceptibility artefact's leading to very fast T2* relaxation. In the work of Marzola et al. it was shown that oedema formation in lung infections resulted in significantly modified lung tissue, leading to a significant increase in T2* which allowed for the detection of hyper intense lesions in both T2* and T1 weighted gradient echo images[4].
4. Disease Localization: Radiology aids in the localization of infections by identifying specific organs or areas affected by microbial agents, allowing for more targeted care.

5. Radiological follow-up and monitoring can assess disease development and therapy response, guiding management adjustments as appropriate.
6. Image-guided Interventions: Radiology provides image-guided treatments such as biopsies and drainage, which aid in accurate diagnosis and treatment.

Result

The detection of microbial diseases in radiology is dependent on the imaging modalities utilized and the characteristics of the infection. Here are some examples of frequent radiological findings for several types of microbial diseases:

1. **Bacterial Infections:** As in bacterial pneumonia or tuberculosis, radiological abnormalities may include infiltrates, consolidations, or cavities in the affected organs.
2. **Viral infections:** It can have distinct imaging patterns, such as ground-glass opacities in viral pneumonia or particular brain abnormalities in viral encephalitis.
3. **Fungal Infections:** As in fungal pneumonia or widespread fungal infections, radiology may reveal nodular or cavitary lesions in the lungs or other afflicted organs.
4. **Parasitic Infections:** These are produced by parasites that can cause organ-specific alterations, such as hepatomegaly in malaria or cystic lesions in cysticercosis.
5. **Abscesses:** Radiology can help diagnose abscesses caused by various microorganisms and guide drainage operations for localized infections.
6. **Septicaemia and Systemic Infections:** Nuclear medicine techniques such as PET scans may aid in the identification of locations of systemic infection in difficult patients.

X-ray findings

1. **Bacterial Pneumonia:** X-rays may reveal localized or patchy infiltrates, which are frequently lobar or segmental in distribution. Consolidation of afflicted lung regions may indicate the existence of inflammatory exudates.
2. **Tuberculosis:** X-rays may show nodular or cavitary lesions in the upper lobes of the lungs. These lesions can cause unusual observations such as Ghon complexes or Ranke complexes.
3. **Viral Pneumonia:** X-rays of viral pneumonia may show widespread bilateral interstitial infiltrates, which are commonly referred to as "ground-glass opacities." These opacities are caused by fluid build-up in the lung tissues.
4. **Fungal Pneumonia:** Depending on the type of fungal infection, X-rays may reveal a variety of patterns, such as nodules, consolidations, or cavitary lesions.
5. **Lung Abscess:** A cavity or air-fluid level within the lungs caused by bacterial infection and frequently located near the bronchi.

Computed tomography findings

1. **Brain Abscess:** A ring-enhancing lesion on CT of the brain may indicate a focal area of inflammation and necrosis caused by microbial infection.
2. Inflammation, abscesses, or fluid collections in abdominal organs such as the liver, spleen, or kidneys might be seen on CT.
3. **Osteomyelitis:** CT scans of afflicted bones may reveal areas of bone deterioration, sequestrum, or periosteal response.
4. **Sinusitis:** Sinus CT scans can show opacification, fluid levels, or mucosal thickening caused by bacteria or fungal illness.

M.R.I findings

1. **Brain Abscess:** A brain abscess presents on MRI as a well-defined ring-enhancing lesion with a central necrosis and surrounding inflammatory edema. The ring augmentation is caused by the abscess capsule, while the centre necrosis is caused by pus build-up.
2. **Meningitis and Encephalitis:** MRI may indicate meningeal enhancement (leptomeningeal enhancement) and higher signal intensity in the brain parenchyma, indicating meningeal inflammation and infection.
3. **Infections of the Spine:** MRI can detect epidural or Para spinal abscesses, vertebral osteomyelitis, and inflammation of the spinal cord and surrounding tissues.
4. **Joint Infections:** In situations of septic arthritis or osteomyelitis, MRI can reveal joint effusions, synovial thickening, and bone marrow oedema.
5. **Soft Tissue Infections:** By imaging tissue planes and fluid collections, MRI is useful for assessing soft tissue infections such as cellulitis, abscesses, and necrotizing fasciitis. The excellent soft tissue contrast of MRI can also detect abnormalities of the gastrointestinal tract [5].

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Review Article

Artificial Intelligence Meets Computational Chemistry in Drug Discovery

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Abstract

The integration of artificial intelligence (AI) with computational chemistry has opened new frontiers in drug discovery. This systematic review explores recent advances in the convergence of AI-driven approaches with molecular dynamics (MD), quantum machine learning (QML), and physiologically based pharmacokinetic (PBPK) modeling. These tools enhance predictive accuracy, reduce experimental workload, and facilitate the discovery of novel drug candidates. We systematically analyze peer-reviewed literature from ScienceDirect and Scopus-indexed journals from 2020 to 2025, providing an overview of emerging methodologies and their applications. Key findings highlight the synergistic impact of integrating machine learning algorithms with physical and chemical modeling to predict drug–target interactions, optimize pharmacokinetics, and model complex biological systems.

Keywords

Artificial intelligence, Molecular dynamics, Quantum machine learning, PBPK modeling, Drug discovery, Computational chemistry

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1. Introduction

Artificial intelligence (AI) has rapidly transformed many scientific domains, and its integration with computational chemistry offers promising advancements in early-stage drug discovery [1]. Molecular dynamics (MD), quantum machine learning (QML), and physiologically based pharmacokinetic (PBPK) modeling are now increasingly leveraged through AI algorithms to better predict drug behavior, improve virtual screening, and model complex biological interactions [2]. This review focuses on the intersection of these technologies and their applications in pharmaceutical chemistry. Artificial intelligence (AI) has emerged as a transformative force across scientific disciplines, particularly in pharmaceutical chemistry, where early-stage drug discovery demands high precision, large-scale data analysis, and time efficiency. Traditionally, drug development relied on experimental methods that were time-consuming and costly. The convergence of AI with computational chemistry—specifically molecular dynamics (MD), quantum machine learning (QML), and physiologically based pharmacokinetic (PBPK) modeling—has led to a new paradigm in predictive drug modeling. These technologies allow for efficient virtual screening, accurate property prediction, and simulation of human biological systems. This review aims to highlight how AI augments each of these computational methods to improve drug discovery outcomes.

2. Molecular Dynamics and AI Integration

Molecular dynamics simulations model the movement of atoms and molecules over time. AI can significantly enhance MD by predicting simulation outcomes, reducing computational cost, and improving force field accuracy [3]. Deep learning models can be trained on MD trajectories to detect conformational changes, protein folding mechanisms, and ligand interactions with greater efficiency [4]. Molecular dynamics (MD) simulations allow the modeling of atomic movements over time, providing insight into the behavior of complex biomolecular systems. Despite their value, MD simulations are limited by high computational costs. AI, particularly deep learning, has been employed to enhance these simulations by predicting conformational changes and developing surrogate force fields like ANI and DeepMD. This integration reduces simulation time while maintaining or even improving predictive accuracy. AI-driven MD is revolutionizing how researchers understand ligand binding, protein folding, and membrane interactions.

3. Quantum Machine Learning in Drug Discovery

Quantum machine learning (QML) combines quantum computing with AI, allowing faster resolution of chemical simulations involving electron interactions and complex quantum states [5]. Although still nascent, QML has shown promise in predicting molecular properties and simulating reactions that are otherwise computationally intensive [6]. Quantum machine learning (QML) combines quantum computing with artificial intelligence to solve problems that are infeasible for classical computers. It offers advantages in calculating molecular energies, electronic structures, and chemical reactivity,

making it idealfor early-stage drug discovery. Algorithms such as Variational Quantum Eigensolver (VQE) and Quantum Support Vector

Table 1. Applications of AI in Molecular Dynamics Simulations

MD Application Area	AI/ML Technique Used	Purpose	Example Reference
Force Field Development	Neural Networks	Predict potential energy surfaces	[7]
Accelerated Sampling	Reinforcement Learning	Identify rare event transitions	[4]
Conformational State Prediction	Deep Learning (Autoencoders)	Reduce dimensionality and cluster states	[4], [6]
Protein Folding Simulations	AlphaFold + MD	Predict structure, validate via dynamics	[2]
Solvent Interaction Modeling	Graph Neural Networks (GNNs)	Represent atomic environments dynamically	[27]

Machines (QSVM) are currently being explored for drug design. QML is particularly valuable for modeling systems with strong electron correlation, and although it remains an emerging field, its potential for breakthroughs is significant.

4. AI-Augmented PBPK Modeling

Physiologically based pharmacokinetic (PBPK) models simulate drug absorption, distribution, metabolism, and excretion. By incorporating AI, these models can be personalized using patient-specific data, leading to better predictions of therapeutic windows and dosing strategies [7]. Machine learning algorithms such as random forests and neural networks enhance PBPK parameter estimation and sensitivity analysis [8]. Physiologically based pharmacokinetic (PBPK)models simulate drug behavior across human tissues and organs. Traditional PBPK models depend on precise physiological data and complex parameter estimation. By incorporating AI—especially machine learning models like neural networks and decision trees—PBPK modeling becomes more adaptable and predictive. AI helps individualize PBPK models by learning patterns from real-world data and clinical studies, which enhances their utility in regulatory settings and personalized medicine.

Table 2: Comparative analysis of classical ML and quantum ML for applications in drug discovery.

Feature	Classical Machine Learning	Quantum Machine Learning (QML)
Data Encoding	Uses fixed vector representations	Uses quantum states (amplitudes/phases)
Computational Scaling	Polynomial	Potential exponential speedup
Feature Space	Fixed	Can explore high-dimensional Hilbert space
Noise Sensitivity	Robust to noise	Prone to decoherence
Hardware Maturity	Fully developed (CPUs/GPUs)	Still developing (Quantum processors)
Current Drug Discovery Use Case	ADME/Tox prediction, docking	QSAR modeling, protein folding, retrosynthesis
Example Algorithms	Random Forest, CNN, GNN	VQE, QNN, Quantum SVM

Table 3. Comparison of Traditional vs AI-Augmented PBPK Modeling Approaches[13, 14]

Feature	Traditional PBPK Modeling	AI-Augmented PBPK Modeling
Parameter Estimation	Mechanistic, time-consuming	Fast, data-driven using ML/AI algorithms
Data Requirements	Requires extensive preclinical data	Can work with sparse/heterogeneous datasets
Model Flexibility	Rigid structure, difficult to scale	Adaptable, can learn nonlinear relationships
Predictive Accuracy	Moderate	High (depending on data quality)
Extrapolation to Special Populations	Complex and limited	AI can infer and adjust models dynamically
Use in Early Drug Discovery	Limited	Highly suitable for early screening

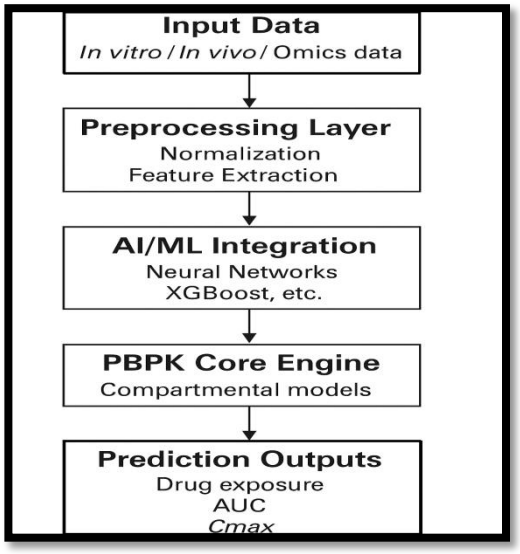

Figure 1. Schematic workflow of AI-augmented physiologically based pharmacokinetic (PBPK) modeling.The process integrates traditional PBPK compartmental models with artificial intelligence and machine learning tools—such as neural networks and gradient boosting methods (e.g., XGBoost)—to enhance parameter estimation, handle complex biological data, and improve prediction accuracy for pharmacokinetic outcomes like drug exposure, AUC, and C_{max}[32, 33].

5. Applications and Case Studies

Recent studies have shown the efficacy of AI-augmented MD and PBPK models in predicting drug toxicity, bioavailability, and blood–brain barrier penetration [9]. QML has been used to simulate potential inhibitors for key disease targets, including kinases and viral proteins [10, 28]. These tools have improved compound prioritization and reduced reliance on costly wet-lab experiments. AI-integrated computational chemistry is being applied in various real-world contexts. For example, AlphaFold has transformed protein structure prediction. AI-enhanced MD simulations have guided the design of HIV-1 protease inhibitors. QML approaches have been used to simulate drug interactions for COVID-19 targets. PBPK models augmented with AI have supported pediatric dosing and prediction of brain drug penetration. These case studies illustrate the potential of AI-driven computational tools to streamline drug discovery and reduce development timelines [10, 22-26].

6. Challenges and Future Perspectives

Despite their advantages, challenges such as data scarcity, model interpretability, and the requirement for quantum hardware limit current applications [11-17]. Collaborative efforts between computational chemists, AI experts, and pharmaceutical scientists are essential to unlock the full potential of these technologies [12, 31]. Despite their benefits, integrating AI with computational chemistry presents challenges. Data quality, interpretability, and model validation remain key obstacles. The “black box” nature of deep learning raises issues for regulatory approval. Quantum computing, while promising, still faces hardware and scalability limitations. Ethical concerns related to data use, reproducibility, and fairness must also be addressed. The future lies in developing hybrid AI-physics models, creating standardized datasets, and advancing explainable AI frameworks to foster greater adoption in pharmaceutical research.

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