

**AI-BASED QUALITY CONTROL OF HERBAL MEDICINES****Ifat Shaikh\*, Chetan Zaware, Kalyani Chande**

\*Students, Dr D.Y. Patil College of Pharmacy, Akurdi, Pune.

Assistant Professor, Dr D.Y. Patil College of Pharmacy, Akurdi, Pune.

Article Received on 15 April 2026,

Article Revised on 05 May 2026,

Article Published on 16 May 2026,

<https://doi.org/10.5281/zenodo.20265633>**\*Corresponding Author****Ifat Shaikh**Students, Dr D.Y. Patil College of  
Pharmacy, Akurdi, Pune.**How to cite this Article:** Ifat Shaikh\*, Chetan Zaware, Kalyani Chande (2026). Ai-Based Quality Control Of Herbal Medicines. World Journal of Pharmaceutical Research, 15(10), 1400-1412.

This work is licensed under Creative Commons Attribution 4.0 International license.

**ABSTRACT**

Traditional Drug (TM) has played a pivotal part in global healthcare, conceded for its literal practices and comprehensive approach to mending. At the same time, Artificial Intelligence (AI) has fleetly surfaced as a potent resource, able of recycling large datasets, relating trends, and supporting intricate decision-making tasks. The integration of these two fields — nominated Artificial Intelligence for Traditional Medicine (AITM) — presents fresh openings for advancements in healthcare.<sup>[1]</sup> This review examines AITM from two primary perspectives developments in AI ways and their practical operations in TM. It emphasises the significance of Machine literacy, Deep Learning, and Large Language Models in colorful functions, including individual procedures (ahead, during, and after treatment) and exploration disciplines similar as medicine

discovery, knowledge organisation, and data- driven analysis. The perpetration of AI methodologies.<sup>[2]</sup>

**KEYWORDS:** This review examines AITM from two primary perspectives developments in AI ways and their practical operations in TM.

**INTRODUCTION**

Chronic inflammatory diseases (CIDs), including rheumatoid arthritis, inflammatory bowel disease, atherosclerosis, and Alzheimer's disease, impact more than 350 million individuals worldwide and contribute significantly to illness, death, and healthcare expenditures exceeding \$500 billion each year.<sup>[3]</sup> These disorders are marked by persistent inflammation and abnormal immune activity, which result in gradual tissue damage and systemic

complications such as cardiovascular and neurodegenerative conditions. Existing treatments—such as nonsteroidal anti-inflammatory drugs (NSAIDs), corticosteroids, and biologics—primarily provide symptomatic relief but are limited by side effects like gastrointestinal damage and immunosuppression, high costs, and insufficient ability to halt disease progression. This highlights the urgent need for safer, more affordable, and sustainable therapies that target both symptoms and the root causes of inflammation.<sup>[4]</sup>

Herbal medicines, deeply rooted in traditional systems like Ayurveda, Traditional Chinese Medicine, and Persian medicine, present promising alternatives due to their long history of use and growing scientific support. Bioactive compounds such as curcumin (from *Curcuma longa*), resveratrol (from *Vitis vinifera*), and boswellic acids (from *Boswellia serrata*) exhibit strong anti-inflammatory, antioxidant, and immunomodulatory properties, making them attractive candidates for further research.<sup>[5]</sup> These compounds influence key signalling pathways, including NF- $\kappa$ B, MAPK, and JAK-STAT, thereby reducing cytokine production and oxidative stress, as demonstrated in preclinical and early clinical studies. However, their broader clinical application is hindered by challenges such as inconsistent bioactive composition, low bioavailability, and a lack of large-scale clinical trials. Although advances in phytochemistry and pharmacology are beginning to address these issues, a cohesive framework to fully optimise herbal therapies—especially using modern technologies—remains underdeveloped.<sup>[6]</sup>

Artificial intelligence (AI) is rapidly reshaping drug discovery by expediting compound screening, improving formulation design, and enabling personalised treatment approaches.<sup>[7]</sup> Despite its success in synthetic drug development through techniques such as network pharmacology, deep learning, and pharmacokinetic modelling, its application to herbal medicine for inflammatory diseases remains limited.<sup>[8]</sup> This represents a significant missed opportunity, as AI could help standardise herbal compounds, enhance their bioavailability through advanced delivery systems such as nanoformulations, and tailor therapies based on individual genetic and microbiome profiles. Current literature tends to address either herbal mechanisms or AI in conventional drug discovery, leaving a clear gap in integrated analyses.<sup>[9]</sup>

While some recent studies have explored AI applications in traditional medicine—particularly in Traditional Chinese Medicine and systems-based approaches—they often do not specifically address chronic inflammatory diseases.<sup>[10]</sup> This review seeks to fill that gap

by providing a comprehensive overview of advancements in herbal therapies for inflammation alongside the emerging role of AI in drug development. Specifically, it aims to: (1) assess the effectiveness and molecular mechanisms of major herbal compounds in regulating inflammatory pathways, (2) summarize AI-driven progress in compound discovery, formulation enhancement, and personalised medicine, and (3) propose strategies for integrating traditional knowledge with AI-based tools to develop evidence-based treatments.<sup>[10]</sup> By focusing on inflammation-specific challenges such as microbiome interactions and nanotechnology-driven bioavailability improvements, this work highlights AI's potential in advancing precision medicine for CIDs. Ultimately, this approach holds significant clinical promise for improving patient outcomes, offers societal benefits through reduced healthcare costs—especially in resource-limited settings—and contributes academically to the advancement of precision pharmacology and interdisciplinary research.<sup>[11]</sup>

### Need for AI in herbal quality control.



Artificial intelligence (AI) is a field within computer science dedicated to solving complex problems and developing systems capable of performing tasks that typically require human intelligence. Broadly, AI involves designing and applying algorithms that can process data, learn from it, and derive meaningful interpretations.<sup>[12]</sup> It incorporates diverse areas such as machine learning, logical and probabilistic modelling, pattern recognition, and biologically inspired techniques—including neural networks, evolutionary algorithms, and fuzzy systems—collectively referred to as computational intelligence. As AI becomes increasingly

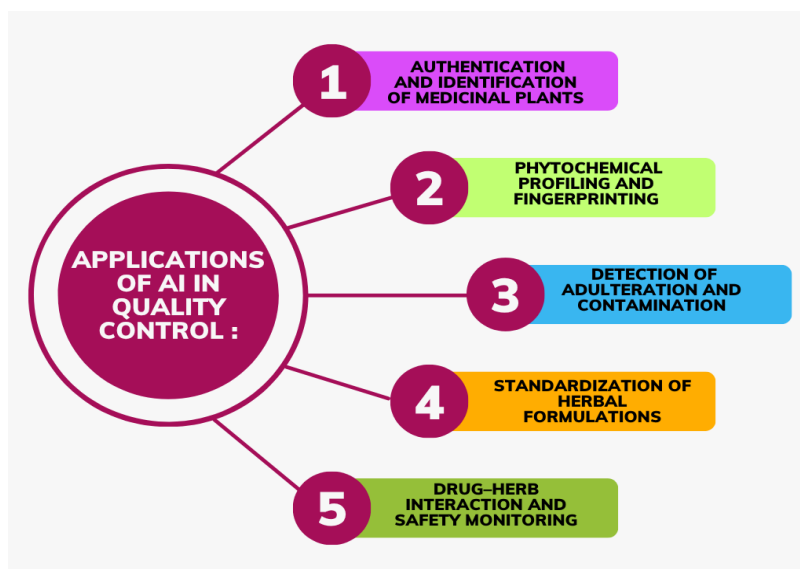
integrated into medical science, it is driving notable changes in healthcare practices and biomedical research. Its adoption is expanding rapidly, not only in conventional medicine but also in complementary and alternative approaches.<sup>[13]</sup>

In the context of herbal medicine, AI offers significant potential to improve the identification, authentication, and quality assessment of traditional remedies, enabling more accurate and reliable evaluation methods.<sup>[14]</sup> For instance, the Traditional Chinese Medicine Formula Prediction (TCMFP) system represents an advanced approach that combines traditional knowledge with AI and network-based algorithms to predict optimal herbal combinations for conditions such as Alzheimer's disease, asthma, and atherosclerosis.<sup>[15]</sup>

AI-driven tools, particularly neural networks, are capable of analysing complex botanical datasets, interactions among compounds, and therapeutic outcomes to design more effective herbal formulations.<sup>[16]</sup> In some cases, AI-assisted development has produced compounds aimed at regulating blood pressure with enhanced efficacy and reduced adverse effects, highlighting its potential to improve cardiovascular treatment outcomes.<sup>[17]</sup>

Additionally, AI can deepen our understanding of interactions between conventional drugs and herbal products, helping to identify possible risks and improve safety profiles.<sup>[18]</sup> It also enables highly accurate predictions in the standardization of herbal medicines, such as forecasting calibration curves with accuracy rates as high as 95.67%, thereby improving the consistency and effectiveness of these natural therapies.<sup>[19]</sup>

### Applications of Ai in quality control



Artificial intelligence(AI) brings a important set of ways that are transubstantiating herbal medicine technology, making it more precise, effective, and scientifically robust. Rather of counting solely on traditional trial- and- error approaches, AI helps experimenters more understand herbal drugs and optimize their use in ultramodern healthcare.<sup>[29]</sup> Machine literacy plays a crucial part by assaying large datasets of factory composites and relating patterns that would be delicate to descry manually. It can prognosticate the natural exertion of phytochemicals, classify medicinal shops, and indeed descry contamination, helping insure the quality and authenticity of herbal products. Deep literacy, a more advanced form of AI, uses neural networks to handle complex data.<sup>[30]</sup> It's especially useful for feting factory species through images, studying relations between herbal composites and natural targets, and interpreting intricate phytochemical data. This allows for more accurate identification and better understanding of how herbal drugs work. Another important approach is network pharmacology, which looks at how multiple composites in a condiment interact with colorful targets in the body.<sup>[31]</sup> Since herbal drugs frequently work through multiple pathways rather than a single target, this fashion helps explain their synergistic goods and overall remedial potential. AI is also extensively used in molecular docking and virtual webbing, where computer models pretend how factory- deduced composites bind to specific proteins in the body. This helps experimenters snappily identify promising medicine campaigners, saving both time and coffers compared to traditional laboratory styles.<sup>[32]</sup> Natural language processing(NLP) enables scientists to prize precious information from ancient medical textbooks and ultramodern scientific literature. This makes it easier to combine traditional knowledge systems like Ayurveda and Traditional Chinese Medicine with current scientific research. In addition, chemoinformatics and bioinformatics tools allow experimenters to study the relationship between chemical structures and natural exertion. These tools can also prognosticate how a emulsion behaves in the body, including its immersion, metabolism, and implicit toxicity. Predictive modeling further enhances herbal medicine development by vaticinating the stability, effectiveness, and optimal lozenge of phrasings.<sup>[33]</sup> This reduces query and improves the trustability of herbal treatments. Computer vision ways add another subcaste of delicacy by enabling automated identification and quality assessment of raw factory accoutrements. They can descry contaminations and insure thickness in herbal products. Finally, optimization algorithms and data analytics help upgrade birth processes, ameliorate expression design, and uncover new remedial perceptivity from large datasets Overall, AI is helping to contemporize herbal medicine technology by making it more data-driven, dependable, and effective. By combining traditional knowledge with advanced

computational tools, it opens the door to safer, more effective, and substantiated herbal curatives.<sup>[34]</sup>

### Techniques Used

Artificial intelligence(AI) brings a important set of ways that are transubstantiating herbal medicine technology, making it more precise, effective, and scientifically robust. Rather of counting solely on traditional trial- and- error approaches, AI helps experimenters more understand herbal drugs and optimize their use in ultramodern healthcare.<sup>[29]</sup> Machine literacy plays a crucial part by assaying large datasets of factory composites and relating patterns that would be delicate to descry manually. It can prognosticate the natural exertion of phytochemicals, classify medicinal shops, and indeed descry contamination, helping insure the quality and authenticity of herbal products. Deep literacy, a more advanced form of AI, uses neural networks to handle complex data.<sup>[30]</sup> It's especially useful for feting factory species through images, studying relations between herbal composites and natural targets, and interpreting intricate phytochemical data. This allows for more accurate identification and better understanding of how herbal drugs work. Another important approach is network pharmacology, which looks at how multiple composites in a condiment interact with colorful targets in the body.<sup>[31]</sup> Since herbal drugs frequently work through multiple pathways rather than a single target, this fashion helps explain their synergistic goods and overall remedial potential. AI is also extensively used in molecular docking and virtual webbing, where computer models pretend how factory- deduced composites bind to specific proteins in the body. This helps experimenters snappily identify promising medicine campaigners, saving both time and coffers compared to traditional laboratory styles.<sup>[32]</sup> Natural language processing(NLP) enables scientists to prize precious information from ancient medical textbooks and ultramodern scientific literature. This makes it easier to combine traditional knowledge systems like Ayurveda and Traditional Chinese Medicine with current scientific research. In addition, chemoinformatics and bioinformatics tools allow experimenters to study the relationship between chemical structures and natural exertion. These tools can also prognosticate how a emulsion behaves in the body, including its immersion, metabolism, and implicit toxicity. Predictive modeling further enhances herbal medicine development by vaticinating the stability, effectiveness, and optimal lozenge of phrasings.<sup>[33]</sup> This reduces query and improves the trustability of herbal treatments. Computer vision ways add another subcaste of delicacy by enabling automated identification and quality assessment of raw factory accoutrements. They can descry contaminations and insure thickness in herbal

products. Finally, optimization algorithms and data analytics help upgrade birth processes, ameliorate expression design, and uncover new remedial perceptivity from large datasets. Overall, AI is helping to contemporize herbal medicine technology by making it more data-driven, dependable, and effective. By combining traditional knowledge with advanced computational tools, it opens the door to safer, more effective, and substantiated herbal curatives.<sup>[34]</sup>

### **Advantages**

Artificial intelligence(AI) is bringing a new position of clarity and effectiveness to herbal medicine technology, helping to upgrade and contemporize practices that have traditionally reckoned on experience and trial- and- error. One of the most conspicuous benefits is how important faster medicine discovery becomes. Rather of spending times testing factory composites one by one, AI can snappily overlook and dissect large datasets to identify which herbal notes are most likely to be effective. This significantly speeds up the exploration process. AI also helps break a major challenge in herbal drug — inconsistency. Since factory-grounded products can vary depending on growing conditions and processing styles, maintaining invariant quality has always been delicate. With AI, experimenters can produce detailed chemical biographies and insure that each batch of a product meets the same norms, making herbal treatments more reliable. Another important advantage is better quality control. AI systems can descry impurity, contamination, or the presence of unwanted substances with high perfection.<sup>[35]</sup> This improves the safety and authenticity of herbal products, which is essential for both consumers and nonsupervisory approval. AI also provides deeper sapience into how herbal drugs actually work. Numerous sauces contain multiple active composites that affect different pathways in the body. AI helps collude these complex relations, making it easier to understand their combined remedial effects. In addition, AI opens the door to substantiated herbal treatments. By assaying individual factors like genetics, metabolism, and indeed gut microbiota, it becomes possible to conform herbal curatives to suit each person, perfecting issues and minimizing side effects. It also plays a part in perfecting phrasings and birth styles. AI can suggest the stylish combinations of sauces, ideal tablets, and the most effective ways to prize active composites, leading to more potent and effective products. From a practical viewpoint, AI helps reduce both time and cost.<sup>[36]</sup> By minimizing the need for repeated trials and streamlining exploration processes, it makes the development of herbal drugs more economical. Safety is another area where AI adds value. It can prognosticate possible side goods, toxin, and relations between herbal and

conventional medicines before they come a problem, helping insure safer use. Finally, AI acts as a ground between traditional knowledge and ultramodern wisdom. It can dissect ancient medical textbooks and combine that wisdom with current exploration, creating a further substantiation- grounded and encyclopedically accepted approach to herbal medicine. Overall, AI is making herbal medicine technology more precise, reliable, and forward-looking, while still conserving the substance of traditional mending systems.<sup>[37]</sup>

### Limitations

One of the biggest challenges is the lack of reliable and standardized data. Herbal medicines naturally vary depending on factors like where and how plants are grown, harvested, and processed. Because of this variability, the data used to train AI systems is often inconsistent, which can affect the accuracy of results. Another issue is the inherent complexity of herbal medicines. Unlike conventional drugs that usually contain a single active ingredient, herbal formulations are made up of multiple compounds that work together in different ways. Capturing and accurately predicting these complex interactions remains difficult, even for advanced AI models. There is also a gap when it comes to clinical validation. Although AI can generate useful predictions and insights, many of these findings still need to be confirmed through large-scale human studies. Without proper clinical evidence, it is hard to fully (اعتماد trust) these results in medical practice. A further limitation is the lack of transparency in some AI systems. Many advanced models, especially deep learning ones, operate like “black boxes,” where the decision-making process is not clearly understood. This can make researchers and healthcare professionals hesitant to rely on them. In addition, implementing AI requires significant resources and expertise. It involves advanced technology, skilled professionals, and financial investment, which may not be easily available in all settings—particularly in regions where traditional medicine is most commonly used. There are also regulatory and ethical concerns. Clear guidelines for using AI in herbal drug development are still evolving, which can slow down its acceptance and integration into mainstream healthcare systems. Another challenge lies in combining traditional knowledge with modern technology. Systems like Ayurveda and Traditional Chinese Medicine are often based on qualitative, experience-driven knowledge, which can be difficult to convert into structured data suitable for AI analysis. Lastly, there is a risk of over-dependence on AI. While it is a powerful tool, it cannot replace human expertise, laboratory testing, and clinical judgment. Relying solely on AI without proper validation could lead to misleading conclusions. In short, although AI has great potential to improve herbal drug technology, it still requires careful use

and further development to overcome these limitations and ensure safe, effective applications.<sup>[38]</sup>

### **Future Scope**

The future of AI in herbal drug technology is full of exciting possibilities that could transform how we discover, use, and standardize herbal medicines. One major opportunity is faster and smarter drug discovery. AI can quickly analyze thousands of plant compounds to identify the ones most likely to be effective, cutting down years of traditional trial-and-error research. AI also opens the door to personalized herbal treatments. By considering a person's genetics, metabolism, lifestyle, and even gut microbiome, AI could help design herbal therapies tailored to each individual, making them more effective and safer. Quality control and standardization is another area where AI shines. It can monitor chemical profiles, detect impurities or adulteration, and predict the stability of formulations, ensuring consistent and reliable herbal products. AI also helps bridge traditional knowledge with modern science. By analyzing ancient texts and combining them with contemporary biomedical research, it can uncover insights that were previously hard to access, allowing herbal medicine to evolve in a more evidence-based direction. Optimizing formulations and extraction methods is another benefit. AI can suggest the best herb combinations, ideal dosages, and efficient extraction processes, resulting in stronger, more reliable treatments. Safety is improved too. AI can predict potential interactions between herbs and conventional drugs, helping prevent adverse effects and making herbal therapies safer for wider use. In the bigger picture, AI can make high-quality herbal medicines more accessible and cost-effective, especially in areas where modern healthcare is limited. Looking further ahead, AI could integrate with technologies like nanotechnology or wearable devices to improve delivery, monitor effectiveness, and enhance bioavailability. In short, AI has the potential to transform herbal medicine from a largely experience-based practice into a precise, evidence-driven, and personalized form of therapy. It promises faster discoveries, safer treatments, and a smarter way to combine traditional wisdom with modern science.<sup>[39]</sup>

### **CONCLUSION**

In summary, the use of artificial intelligence (AI) in herbal drug technology represents a major leap forward in bringing traditional medicine into the modern era. AI offers powerful tools to speed up the discovery of new herbal compounds, improve quality and consistency, optimize formulations, and predict both safety and effectiveness. By connecting the rich

knowledge of traditional herbal practices with modern scientific research, AI makes herbal therapies more evidence-based, reliable, and tailored to individual needs. However, there are still hurdles to overcome. Issues like inconsistent data, the complex nature of multi-component herbal formulations, and the need for thorough clinical testing must be addressed to fully realize AI's potential in this field. Looking ahead, AI has the potential to make herbal medicine safer, more efficient, and more widely accessible. It could also pave the way for innovations such as personalized herbal treatments, advanced delivery systems using nanotechnology, and better integration with conventional healthcare. Ultimately, combining AI with herbal medicine could transform natural therapies into precise, standardized, and globally trusted solutions for managing a wide range of chronic and inflammatory diseases.<sup>[40]</sup>

## REFERENCE

1. Ekor M. The Growing Use of Herbal Medicines: Issues Relating to Adverse Reactions and Challenges in Monitoring Safety. *Front. Pharmacol*, 2014; 4: 177.
2. Spanakis M, Tzamali E, Tzedakis G, Koumpouzi C, Padiaditis M, Tsatsakis A, Sakkalis V. Artificial Intelligence Models and Tools for the Assessment of Drug-Herb Interactions. *Pharmaceuticals (Basel)*, 2025 Feb 20; 18(3): 282.
3. Pujari S, Singh R, Soon GC, Nesari T, Ghelman R, Zhao Y, Kalra K, Alsalamah S, George R, Kuruvilla S, Labrique A. Artificial intelligence in traditional medicine: policy and governance strategies. *Bull World Health Organ*, 2025 Nov 1; 103(11): 738-740.
4. Wang H, Chen Y, Wang L, Liu Q, Yang S, Wang C. Advancing herbal medicine: enhancing product quality and safety through robust quality control practices. *Front Pharmacol*, 2023 Sep 25; 14: 1265178.
5. Wang A, Luo Q, Tan X, Yao Y, Peng X, Luo H, Hu Y. Development and application of artificial intelligence in traditional Chinese medicine research and development. *Chin Med*, 2026 Jan 8; 21(1): 17.
6. Hou C, Gao Y, Lin X, Wu J, Li N, Lv H, Chu WC. A review of recent artificial intelligence for traditional medicine. *J Tradit Complement Med*, 2025 Feb 21; 15(3): 215-228.
7. Hou C, Gao Y, Lin X, Wu J, Li N, Lv H, Chu WC. A review of recent artificial intelligence for traditional medicine. *J Tradit Complement Med*, 2025 Feb 21; 15(3): 215-228

8. Coxeter P., McLachlan A., Duke C., Roufogalis B. Herb-Drug Interactions: An Evidence Based Approach. *Curr. Med. Chem*, 2012; 11: 1513–1525.
9. Fasinu P.S., Bouic P.J., Rosenkranz B. An Overview of the Evidence and Mechanisms of Herb-Drug Interactions. *Front. Pharmacol*, 2012; 3: 69.
10. Brantley S.J., Argikar A.A., Lin Y.S., Nagar S., Paine M.F. Herb-Drug Interactions: Challenges and Opportunities for Improved Predictions. *Drug Metab. Dispos*, 2014; 42: 301–317.
11. Soleymani S., Bahramsoltani R., Rahimi R., Abdollahi M. Clinical Risks of St John's Wort (*Hypericum Perforatum*) Co-Administration. *Expert. Opin. Drug Metab. Toxicol*, 2017; 13: 1047–1062.
12. Parvathaneni M., Awol A.K., Kumari M., Lan K., Lingam M. Application of Artificial Intelligence and Machine Learning in Drug Discovery and Development. *J. Drug Deliv. Ther*, 2023; 13: 151–158.
13. Ayush sector all set to provide efficient, holistic, affordable and quality health services through 'Ayush Grid' and artificial intelligence. New Delhi: PIB Delhi, 2023.
14. Traditional medicine and intellectual property rights: law and policy perspectives. New Delhi: Forum on Indian Traditional Medicine, 2022.
15. Liu Y, Ho T, Omar R, Ning B. AI-enabled governance in traditional Chinese medicine enterprise clusters: a lifecycle and stakeholder perspective for sustainable development. *Bus Strategy Dev*, 2025; 8.
16. Agustika D. K., Mercuriani I., Purnomo C. W., Hartono S., Triyana K., Iliescu D. D., et al. (2022). Fourier transform infrared spectrum pre-processing technique selection for detecting PYLCV-infected chilli plants. *Spectrochim. Acta A Mol. Biomol. Spectrosc*, 278: 121339.
17. Kalyani U Chande, Nikhil S Ekhande, Mayuri H Padwal Phytochemical and pharmacological activities of black turmeric *Research Journal of Pharmacognosy and Phytochemistry*, 2023; 15(4): 327-330.
18. Cheng S. C., Huang M. Z., Shiea J. (2011). Thin layer chromatography/mass spectrometry. *J. Chromatogr. A*, 1218: 2700-2711.
19. Chen Y. C., Chen Y. H., Pan B. S., Chang M. M., Huang B. M. (2017). Functional study of cordyceps sinensis and cordycepin in male reproduction: A review. *J. Food Drug Anal*, 25: 197-205.

20. Chande K, Nirmal R, Varpe N, Doke R, Vinchurkar K, Singh S. Alkaloid's undiscovered neuroprotective potential: a multi-target strategy to fight against neurodegenerative illnesses. *3 Biotech*, 2025 Dec; 15(12): 409.
21. Kalyani U Chande, Nikhil S Ekhande, Mayuri H Padwal Phytochemical and pharmacological activities of black turmeric *Research Journal of Pharmacognosy and Phytochemistry*, 327 to 330.
22. Doke, R., Lokhande, R., Chande, K. et al. Recent advances in therapeutic strategies of Erdheim-Chester disease. *Naunyn-Schmiedeberg's Arch Pharmacol*, 2025; 398: 6407–6428.
23. Chande, K., Nirmal, R., Varpe, N. et al. Alkaloid's undiscovered neuroprotective potential: a multi-target strategy to fight against neurodegenerative illnesses, 2025; 3 *Biotech* 15, 409.
24. HARITAKI A REVIEW Kalyani U. Chande Nikhil S. Ekhande, Purvarja L. Deshpande and Shweta S. Aher *World Journal of Pharmaceutical Research*, 11(7): 302-317.
25. Illuminating Shadow: Anticancer Management Through Green Synthesized Metallic Nanoparticles Kalyani Chande, Shubangi Pharande, Smeeta Sadar, Henry O. Edete, Diana O. Ochoule, Rohit Doke, Sudarshan Singh, and Pooja V. Nagime.
26. Doke, R., Chande, K., Dingare, S. et al. Demystifying the role of postbiotics in inflammation mediated metabolic disorders: an updated review. *Food Sci Biotechnol*, 2026; 35: 463–484.
27. Digital Twin Technology in Biopharmaceutical Research: Creating Predictive Models of Human Biology Kalyani U. Chande Dr. Shubangi Pharande Dr. Revan Karodi *BIOPRESS JOURNAL OF COMPUTATIONAL LIFE SCIENCES*, 2025; 1(9).
28. Tushar nandode kalyani U.Chande Toxic Diffuse Goiter: A review 024 *Journal Internationala journal of pharmaceutical sciences*, 2: 176-181.
29. Ms.divya more kalyani U.Chande, Ms, divya jadhvar Obesity and its treatment with natural product *international journal of advanced research in science, communication and technology*, 4(1): 16-25.
30. Kalyani chande Sahil Sahikh, Pallavi Gholpa The development of a formulation of topical nanaoemulgel of eberconazole nitrate, 2024; 2023: 2250-6727.
31. Shreyashi dekhmukh kalyani U.Chande, shrikant naik Benincasa hispida, an ailment bliss *international journal of pharmacy & pharmaceutical research*, 27(1): 63-73.
32. Aniket magar kalyani U.Chande, shraddha suryawanshi Herbal immune booster plant *international journal of pharmacy & pharmaceutical research*, 27(2): 742-768.

33. Jagruti narkhede kalyani U.Chande, Yash kulkarni nutraceutical: functional food and dietary supplements International journal of pharmacy & pharmaceutical research, 26(2): 2262-281.
34. Yusuf khan kalyani U.Chande, suyog shah, druv akbari, vedant mulange sea Buckthorn international journal of science and research methodology, 25(2): 28-36.
35. Nikhil Ekhande kalyani U.Chande psoriasis: Nutritional Management for patients with psoriasis Indian journal of natural science, 14(79): 58642-58648.
36. Ms. Kalyani U. Chande Ms. Shubhanngi C.Kamble, Dr, Pramod L. Ingale Preparation and Evaluation of Polyherbal Hair Oil – An Effective in Cosmetic Journal of Emerging Technologies and Innovative Research, 9(12): 667-673.
37. Kalyani U. Chande, Nikhil S. Ekhande, Shivraj D. Jdhav Food safety in the 21<sup>st</sup> century International journal of pharmacy & Pharmaceutical Research, 25(4): 571-585.
38. Kalyani Chande, Aishwarya Shinde, Dr. Dinesh Hase, Dr. Sharad Pawar In-Vitro Hepatoprotective Activity of Glycyrrhiza Glabra Root extract on Hepg2 cell line International Journal of Innovative Research in Technology, 9(5): 320-322.
39. Chande kalyani, shraddha dingare CORONA VIRUS COVID-19 Human Corona virus International journal of analytical & experimental modal analysis, 4: 1751-1757.
40. Chande Kalyani Uttam, Sonali Ramnath Sonawane, Shraddha Hrishikesh Dingare, Rishikesh Kailas Jagzap, Durgesh Nandkishor Boob, Rutuja Madhukar Shinde Heterogeneity of helicobacter pylori in diabetic and nondiabetic patients International Journal of Health Sciences, 6(S3): 11263-11272.