



Review Article

ARTIFICIAL INTELLIGENCE (AI) IN AYURVEDA: ITS APPLICATION AND RELEVANCE

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Article info

Article History:

Received: 11-11-2024

Accepted: 19-12-2024

Published: 15-01-2025

KEYWORDS:

Ayurveda, Artificial Intelligence, Personalized treatment.

ABSTRACT

As the world develops, people are becoming increasingly obsessed with modern technology. Every system, including healthcare, is adapting to this trend, particularly through the use of Artificial Intelligence (AI) to provide quick, easy, and convenient services. The Ayurveda system of medicine, an ancient practice originating over 5,000 years ago, is inherently holistic and individualized, focusing on the balance of body, mind, and spirit. This article aims to investigate where and how AI can be integrated into Ayurveda and to what extent it can support Ayurvedic physicians. Various research articles and classical Ayurvedic texts were reviewed, and expert opinions were gathered for this analysis. The integration of AI into Ayurveda represents a transformative approach to traditional medicine, offering innovative solutions for diagnosis, treatment, and personalized healthcare. With its advanced data analytics, machine learning, and predictive modelling, AI can enhance the understanding and application of Ayurvedic principles. By analysing vast amounts of historical and contemporary data, AI can assist in identifying patterns in patient health, predicting disease susceptibilities based on *Prakriti* (body constitution), and optimizing personalized treatment plans. Additionally, AI-driven tools can support the discovery of new herbal formulations and their applications, thus expanding the scope of Ayurvedic treatments. The synergy between AI and Ayurveda holds the potential to revolutionize healthcare by merging ancient wisdom with modern technology, ultimately leading to more effective, personalized, and preventive healthcare solutions.

INTRODUCTION

In present time, the world is developing enormously in the sector of technology particularly Artificial Intelligence (AI). Almost every system is embracing and adopting AI. Artificial Intelligence (AI) has permeated nearly every sector of human endeavour, revolutionized industries and transforming the way we live, work and interact with the world around us. Ayurveda is a traditional system of medicine with a history of more than 5,000 years. The major role of Ayurveda is to bring the *Doshas* (*Vata*, *Pitta*, *Kapha*) in balance through

various treatments, including herbal medicines, lifestyle modifications, therapies and dietary recommendation.^[1]

As Ayurveda is a holistic system of medicine originated in ancient India, the diagnosis and treatment of diseases have been practiced in classical Ayurvedic methods i.e., *Roga pariksha* and *Rogi pariksha* including *Nadi pariksha* (pulse diagnosis). Ayurveda focuses on personalized, holistic healthcare tailored to an individual's unique constitution and *Dosha* imbalances. Traditionally, Ayurvedic practitioners rely on their observations, expertise, and experience to diagnose and treat patients. The integration of AI into Ayurveda has the potential to streamline and optimize various processes, leading to more accurate, personalized and effective treatments as well as prevention from diseases. Moreover, AI-driven tools can support the discovery of new herbal formulations and their

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<https://doi.org/10.47070/ayushdhara.v11i6.1653>

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applications, thus expanding the scope of Ayurvedic treatments. Moreover, the incorporation of AI into Ayurveda is reshaping the way doctors diagnose, treat, and manage a wide range of health conditions. There are various sectors where AI can make a significant change and plays a crucial role in the development of Ayurveda.

Application of AI in Ayurveda

Ayurgenomics (Personalized Treatment)

Ayurgenomics, an evidence-based approach to personalized medicine that combines traditional ayurveda, modern genomics and molecular biological techniques.^[2] According to Ayurveda, each person is born with a unique basic constitution called *Prakriti*, which largely determines individual variations in susceptibility to diseases and responses to the environment, diet, and medications. So, here AI can play a vital role in the field of Ayurgenomics by analysing patient data, genetic information and life-style factors to provide personalized treatment recommendations based on Ayurvedic principles. AI algorithms can be developed based on huge data of patients *Prakriti* characteristic features, their effect on body, their patterns ultimately making an AI system to analyse the *Prakriti*, according to which treatment, diet and life-style can be recommended. This allows Ayurvedic practitioners to provide therapies that resonate with an individual's constitution i.e., *Prakriti* and imbalances i.e., *Vikriti*. AI can also predict potential health issues and suggest preventive measures by identifying patterns in patient data, enhancing the preventive aspect of Ayurveda.

Diagnosis and Prognosis

Traditionally, Ayurvedic practitioners use their knowledge, experience, and observational skills to evaluate a patient's condition. Integrating AI can greatly enhance this diagnostic process. One of the critical areas where AI can contribute significantly to *Ayurveda* is in the field of diagnostics. Ayurveda diagnosis is often relying on a detailed analysis of a patient's *Dosha* (*Vata*, *Pitta*, *Kapha*), *Prakriti* (nature) and various other factors such as pulse, tongue and eye examination.^[3] AI can analyze vast amounts of data from these diagnostic techniques through machine learning and deep learning algorithms. For instance, AI systems can be trained to recognize patterns in pulse diagnosis (*Nadi pariksha*) that might be too subtle for the human senses.^[4] By using image recognition technologies, AI can also assist in analysing tongue

and eye images to detect anomalies and suggest potential imbalances in the body's *Doshas*. This leads to more accurate and early diagnosis, thereby improving treatment outcomes. AI can monitor the status of imbalance of *Doshas* and *Vikriti* by which one can know the prognosis of the diseases.

Preventive Measures and Health Monitoring

Ayurveda emphasizes the importance of maintaining a balanced lifestyle and preventing diseases before they manifest. AI can contribute to this preventive approach by monitoring and analysing an individual's lifestyle patterns, environmental factors and genetic predispositions through wearable devices and home monitoring. AI has the capability to process real-time health data and offer immediate insights. By incorporating Ayurvedic principles and integrating this data, AI can suggest personalized recommendations for diet, exercise, stress management, Ayurvedic remedies and other lifestyle modifications to promote overall well-being and reducing the risk of chronic diseases.

Virtual consultation and Knowledge Dissemination

AI powered chatbots and virtual assistants can help both practitioners and patients by providing information, answering queries and offering guidance on Ayurvedic practices. AI-powered platforms can provide initial consultations, answer patient queries and offer preliminary health advice based on Ayurvedic principles. This is particularly advantageous in remote or underserved regions. Virtual consultation platforms powered by AI can provide individuals with access to expert guidance, facilitating remote consultations and enabling widespread dissemination of Ayurvedic principles. Additionally, AI-driven knowledge repositories can serve as comprehensive databases, housing vast amounts of information on Ayurvedic texts, herbs and treatment protocols, making this ancient wisdom more accessible to practitioners and enthusiasts alike.

Textual analysis by Natural Language Processing (NLP)

Classical texts of Ayurveda are in Sanskrit language. So, it is quite difficult to analyse and understand them by Ayurveda, modern practitioners and researchers. So, Natural Language Processing (NLP) can be used to process and analyse ancient Ayurvedic texts written in Sanskrit or other traditional languages. This can help in extracting valuable insights, translating texts and making ancient knowledge more accessible.

Medicinal Plant Recognition & Identification

A major challenge in Ayurveda is the precise identification of herbs. Because of identification problem, adulteration of drugs had been going on in the market and so many controversies had been developed in the present time. Some AI-system like Google Lens and many other apps are there by which plants can be identified to some extent but couldn't completely dependent. Traditional methods often rely on manual observation, which can be time-consuming, labour-intensive, need subject experts and can subject to human errors. With the rising global demand for Ayurvedic products, it is essential to ensure the authenticity and quality of herbs. Here AI steps in as a game-changer. AI based image recognition technologies could revolutionize the process of identifying herbs. Through DNA pattern and spectral analysis, AI can identify the unique DNA finger-print and chemical fingerprint of each herb. This system will helps in accurate identification of medicinal plant and also ensures the absence of adulterant. Furthermore, Natural Language Processing (NLP) through AI-system can extract relevant information from ancient Ayurvedic texts which helps for recognition and identification of plants.

Herbal Formulations and Drug Discovery

Ayurvedic medicine heavily relies on the use of herbal formulations, each with its unique composition and therapeutic properties. AI could play a crucial role in optimizing these formulations by analysing vast databases of traditional knowledge, modern scientific research and clinical data. AI-algorithms could identify potential synergies between different herbs, predict their efficacy in treating specific conditions.^[5] Through network pharmacology and molecular modelling techniques, AI can analyse the chemical composition of various herbs and their interactions with the human body, facilitating the development of more potent and targeted herbal formulations. AI-system through molecular docking can predict other various properties which is not mentioned in Ayurvedic text books leading to drug discovery. Furthermore, AI can assist in the discovery of new plant-based active compounds with therapeutic potential, accelerating the drug development process and potentially leading to ground-breaking Ayurvedic treatments.

Quality control and Standardization of Drugs

Ayurvedic formulation contains multiple herbs and each herb has active chemical compounds which indicates their quality and level of potency.

For instance, *Arogyavardhani vati* had main ingredient *Katuki* i.e., *Picrorrhiza kurroa*.^[6] The active compound of *Katuki* is Picrorrhizin,^[7] the quantity of which, going to specify the quality of *Katuki*. So, if chemical structure of picrorrhizin can be incorporated to the AI-system then it can easily find out whether *Katuki* is present or not in the given sample of *Arogyavardhani vati* rather than going for time taking analytical test. Likewise, AI can help in several many single and multiple drug formulations to maintain their quality and standard. Additionally, AI-powered systems can carry out quality control checks at every stage of production, from raw materials to final products, reducing the risk of contamination and enhancing consumer safety. Machine learning algorithms can analyse samples to detect any impurities or deviations from standard formulations.

Disadvantages and Limitations of AI in Ayurveda

- **Loss of Traditional Wisdom:** Ayurveda is based on thousands of years of holistic knowledge and traditional practices. AI, which relies on data, might not fully capture the experiential, intuitive, and philosophical aspects of Ayurveda. Over-reliance on AI could lead to a neglect of this traditional wisdom.
- **Data Limitations:** AI requires large amounts of data for generating AI algorithm, but Ayurveda practices are often personalized and case-specific. The complexity and variability in individual constitutions (like *Doshas*) might make it difficult to collect comprehensive and accurate data that represents the full spectrum of Ayurvedic medicine.
- **Over-simplification of Treatment:** AI algorithms are often designed to streamline decision-making processes, which might lead to the oversimplification of Ayurvedic treatments. Ayurveda emphasizes personalized care based on factors like body constitution (*Prakriti*), lifestyle, and emotional well-being, which AI may struggle to fully account for.
- **Ethical Concerns:** Introducing AI into traditional medicine raises ethical questions about data privacy, particularly in patient records and health data. There might be concerns about who controls the data and how it is used, especially in a system that traditionally values doctor-patient confidentiality.
- **Cultural Disconnect:** AI systems might not be able to grasp the cultural, spiritual, and contextual subtleties that are an integral part of

Ayurveda. This disconnect could limit the efficacy of AI-driven treatment recommendations or health monitoring tools in Ayurvedic practices.

- **Misinterpretation of Ayurvedic Concepts:** Ayurvedic terms and principles like *Agni* (digestive fire), *Dhatu* (tissues and body fluids), or the balance of the *Doshas* (*Vata*, *Pitta*, and *Kapha*) may not easily translate into quantitative data. This can lead to misinterpretation or reduction of these concepts in AI-driven diagnostics or treatments.
- **Lack of Regulation and Standards:** There are currently few standardized regulations for integrating AI into Ayurveda. Without proper guidelines, AI-driven Ayurvedic solutions could lead to inconsistent or unreliable results.
- **Over-reliance on Technology:** Practitioners may become overly dependent on AI for diagnostics and treatment plans, potentially diminishing the human element, intuition, and patient-focused care that are central to Ayurveda.

RESULTS AND DISCUSSION

Despite of all these uses of AI, the question arises whether it is practically possible in behaviour and can be bring it in action or not. Till now, AI had been developed in Ayurveda up to some extent like analysing *Dosha* imbalance, *Prakriti* determination, herb identification. But the question is, it can be completely dependable and trustable in terms of accuracy, result and transparency. The answer is no, it can't be because AI needs lots of different information to work well, but right now, there is not enough diverse data available. Making more varied and strong databases is very much important for AI to get better results and to work in a fair and responsible way. Ayurvedic formulations are not like Allopathic medicine that has specific composition and fixed indications but Ayurvedic medicine contain multiple active compounds and have multiple indications and properties by which it works. So, AI in Ayurveda is relevant only to some extent but one cannot be completely depending on it rather than AI can be used as a tool to support and help the Ayurveda practitioners to diagnose, treat and many more in the field of Ayurveda. The variables in Ayurveda, such as *Doshas*, dietary habits, and individual constitutions, present challenges for AI integration because of their inherent complexity and subjective nature. The researchers in AI should address the difficulty of integrating these diverse variables into AI-system while maintaining precision and relevance for

personalized health care solutions, striking a balance between Ayurvedic wisdom and data-driven capabilities.

While AI holds immense potential for enhancing Ayurveda, it is essential to address ethical and practical considerations. Safeguarding data privacy and security is essential, especially considering the sensitive nature of healthcare information. Additionally, there must be a balance between technological integration and the preservation of traditional Ayurvedic principles and practices. The collaboration between AI and Ayurveda should be seen as complementary rather than replacement. Practitioners and AI systems can work together to improve patient outcomes, with AI providing additional insights and support to the human touch and intuition that are central to Ayurveda. Furthermore, Ayurvedic practitioners must be aware of the potential limitations and risks of AI technology. Since AI algorithms can be imperfect and may produce biased or inaccurate results, it is crucial for practitioners to apply critical thinking and clinical judgment when using AI tools. They need to ensure that the insights and recommendations from AI align with their expertise and serve the best interests of their patients. Additionally, practitioners should be transparent about how AI is used in their practice, providing patients with clear explanations of how the technology supports their healthcare decisions.

CONCLUSION

The integration of AI in Ayurveda has the potential to revolutionize healthcare by improving personalized treatments, diagnostic accuracy, and healthcare efficiency. Key figures in the field are driving advancements in AI technology to enhance traditional Ayurvedic practices. While there are challenges and concerns to address, the future of AI in Ayurveda holds promise for improving patient outcomes and modernizing this ancient system of medicine. As technology continues to evolve, it is essential to strike a balance between innovation and tradition to ensure that the benefits of AI in Ayurveda are realized while preserving the timeless wisdom of this ancient healing system. AI has the potential to transform Ayurveda by integrating advanced technology, improving diagnostics, personalizing treatments, and aiding in drug discovery. However, balancing tradition with innovation and addressing ethical concerns are essential to unlocking AI's full potential in Ayurveda. Collaboration between Ayurvedic practitioners, data

scientists, and technologists will be key to leveraging AI's capabilities to revitalize and promote the ancient wisdom of Ayurveda.

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Cite this article as:

Sanjay Gupta, Narasimha V, Vijaya Lakshmi A. Artificial Intelligence (AI) in Ayurveda: Its Application and Relevance. AYUSHDHARA, 2024;11(6):165-169.

<https://doi.org/10.47070/ayushdhara.v11i6.1653>

Source of support: Nil, Conflict of interest: None Declared

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