**A SCIENTIFIC OUTLOOK ON TECH INNOVATION IN AYURVEDA : A FUTURISTIC APPROACH**

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**ABSTRACT**

*Ayurveda,* one of the world’s oldest medical science, is now slowly rising to the forefront globally.There is a large void in the proper communication of *Ayurveda’s* core messages to common people and Standardized output of product and services. Creative thinking and Tech Innovation is needed to communicate the health benefits of *Ayurveda* to general public. Metaverse platforms like Augmented Reality, Virtual Reality and Artificial Intelligence with Robotics can be incorporated for filling the gap in Public Relations, Drug Manufacturing and Drug Research in *Ayurveda*. **Objectives:** a)Discuss the future possibilities of Augmented Reality , Virtual Reality, Artificial Intelligence and Machine Learning which can transform Practice, Education Communication Drug discovery Cultivation and Smart Drug Research in Ayurveda Medical System b) Discuss the possibility of metaverse Platform in which some one can experience the benefits of Ethnic health practices of Ayurveda (Eg: Dinacharya (Daily Regimens) ,Rithu Charya (Seasonal Regimens) and Rithu Sodhana (Seasonal Detoxification Procedures)**.Methodology:** Scientific outlook and Detailed evaluation of advanced technologies like Augmented Reality , Virtual Reality and Artificial Intelligence and Robotics in Public Relations ,Data Mining, Drug Manufacturing and Smart Drug Research in Ayurveda **Conclusion :** By making use of new-age technologies like Artificial Intelligence and virtual immersive platforms like Metaverse, can bring innovative visual ideas into *Ayurveda* sector and thus promote awareness about the scientific basis of *Ayurveda*and can make the ancient medicine of *Ayurveda* ready for future .

**Key Words**: Technology Innovation in Ayurveda, Artificial Intelligence and *Ayurveda* , Augmented and Virtual Reality in *Ayurveda*

**INTRODUCTION**

*Ayurveda*, one of the world’s oldest medical sciences, is now getting recognized globally as a system of medicine and health stabilizer. *Ayurveda* as an Industry achieved noticable growth in last 3 decades. According to the the report of Research and Information System for Developing Countries (RIS), on ‘Ayush Sector in India: Prospects & Challenges’, the global market size of the herbal medicines was estimated at US$ 657.5 billion (INR 54,28,977 Crore as per current INR-Dollar rate) in 2020. In the case of overall exports, the total Ayush export of India has increased from US$ 1.09 billion (INR 9,000 Crore as per current INR-Dollar rate) in 2014 to US$ 1.54 billion (INR 12,715 Crore as per current INR-Dollar rate) in 20201.Two basic factors should be in focus to increase the global market, one is improved public relations for creating awareness of *Ayurveda* in general Public and the other one is Standardized output of Services and Products. To sustain the market Large Scale Production, Quality Control , Technology Interventions are needed in *Ayurveda* Industry. There is a large void in the proper communication of Ayurveda’s core messages to common people. Creative thinking and Tech Innovation is needed to communicate the health benefits of *Ayurveda* to general public. Metaverse platforms like Augmented Reality ,Virtual Reality ,Artificial Intelligence and Robotics can be incorporated for filling the gap in Public relations, Data Mining , Drug Manufacturing and Smart Drug Research .With the latest advances in technology innovation, the field of medicine and healthcare is rapidly expanding and as a result, many different areas such as human health diagnostics, treatment and patient care are getting modernized . Wireless technology is advancing very fast and 5G mobile technology allows the Internet of Medical Things (IoMT) to greatly improve patient care and more effectively prevent illness from developing2.

**OBJECTIVES**

a) Discuss the future possibilities of Augmented Reality , Virtual Reality, Artificial Intelligence and Machine Learning which can transform Practice, Education Communication Drug discovery Cultivation and Smart Drug Research in *Ayurveda* Medical System.

b) Discuss the possibility of Metaverse Platform in which some one can experience the benefits of Ethnic health practices of Ayurveda (Eg*: Dinacharya (Daily Regimens) ,Rithu Charya (Seasonal Regimens), Rithu Sodhana (Seasonal Detoxification Procedures)* )

**MATERIALS AND METHODS**

Technology have a major role in healthcare delivery since last century. It is useful for people to get updated about health conditions, gain medical support support, it can help monitor patient care and support healthcare professionals in their daily tasks. While technologies are helpful in uplifting the quality and reach of both healthcare information and communication, which technologies can be used for for which specific conditions is still an open research area as it have ethical and legal concerns. With Digital Innovations in healthcare and education through new age technologies like Augmented Reality, Virtual Reality , Artificial Intelligence and Robotics , which can only succeed if design is deeply informed by practice and timely tested through healthcare interventions3.

In times of crisis, immense creativity often comes to the fore front, contributing major changes. This has been the case in the Coronavirus disease 2019 (COVID-19) era. Healthcare technology has moved forward to age of two decades which have helped healthcare providers in manage their patients better by reducing the dangers inherent in direct personal contact, reducing crowding in waiting rooms or laboratories, and hospitality management in all Medical systems including *Ayurveda*.

**Artificial Intelligence and Chat GPT In Health Care5**

Artificial intelligence is the simulation or action of pretending human intelligence processes by machines, especially computer systems. Specific areas of development in Artificial Intelligence include [expert systems](https://www.techtarget.com/searchenterpriseai/definition/expert-system), [natural language processing](https://www.techtarget.com/searchenterpriseai/definition/natural-language-processing-NLP) (NLP) , Chat GPT, speech recognition and machine learning6.Artificial Intelligence (AI) technology is being used in the diagnosis of diseases, treatment plan as per protocol and post treatment analysis on success rates. Human will depend more on Chat GPT for initial diagnosis based on precipitated symptoms and will depend doctor for its confirmation and treatments. Possible and effective proven treatments will also be suggested by AI assisted Chat GPT. In medical systems it will spare physical investigators, lab assistants and physicians to attend patients, besides providing advanced - precise supplementary information in medical care of all conventional and alternative medical systems.

**Augmented and Virtual Reality in Health Care5**

Augmented reality and virtual reality are new age technologies that either enhance or replace a real-life environment with a simulated one which comes under the spectrum of **Metaverse**.

* **Augmented Reality (AR)** is a technology which amalgamates the digital world with real elements and help us to visualized digitally created models resembling the original field. It helps in visualizing digital components in the real world through a smart phone or specialized goggles . 12
* **Virtual reality (VR)** provides a complete immersive experience that replaces a real-life environment with a simulated one. The core difference between Augemented Reality(AR) and Virtual Reality(VR) is that VR is a completely a  **computer generated simulation** where reality or an alternative world is generated graphically.

 By using appropriate specialized goggles(headsets), it is possible for the user to be fully immersed in the digital world .There is an important differences between AR headsets and VR headsets **.Augmented Reality(**AR) is hardware geared whereas Virtual reality (VR) requires sensory devices that translate real-world movements or fields into a modeled reality.

Augmented and virtual reality is being used to train medical students outside the hospital/laboratories in subjects like human anatomy, human physiology, human pathology with digital models and without the risk of harm to actual patients . A hands-free mode of operation is also enabled, allowing providers to access patient records or other information without leaving the patient or stopping the procedure they are engaged in . It can be used to distract nervous patients from surgical procedures keeping them involved in digital experience of calm down from fear and stress of procedure.

## Telemedicine5

[Telemedicine](https://www.news-medical.net/health/What-is-Telemedicine.aspx) is an important tech assisted innovation now practiced worldwide mostly after pandemic restrictions in all health systems . With this technology, clinical practitioners see patients virtually, avoiding personal contact, while still being able to diagnose and treat patients for with virtual communication. The saving of time and money has made this an attractive option for both patient and practitioner. *Ayurveda* Health care system have also adopted possibilities of Tele medicines with critical thinking on lack of *Drashana*(Direct Inspection) and *Sparshana*(Real time Touch) examinations which are key factors in patient examination.

## The Internet of Medical Things5

The Internet of Medical Things (IoMT) includes a network of devices and applications that track and prevent serious events in the course of chronic illness, linking patients and doctors for better monitoring and management of such conditions. For example wearable electrocardiography (ECG) monitors are now available in market from all leading gadget companies ,through which patients with troublesome changes to be identified early enough to abort heart attacks. Wearable which helps in monitoring fever, oxygen saturation level and pulse rate are already been launched . It is estimated that almost a third of the IoT (Internet of Things) market worldwide will come from the Internet Of Medical Things (IoMT). In case of *Ayurveda* medical system there is possibility of same wearables with bio sensors that can access the qualities in body and give conclusion on Pathological *Dosha(*Humours*)* state/ *Dhathu(*Tissue*)* State in body and be indicator in possible short term and long term diseases outcomes through *Ayurvedic* principles.

**Artificial Intelligence and Robotics in Ayurveda Healthcare**

Artificial Intelligence is based on computer programming which can process large data and reach to precise conclusions. It can be used in assessment of constitution(*prakruthi*) and humours(*doshas*) of individual based on qualities (*gunas*) .Health Robots can be incorporated which will take the roll of home physician where all health data of family members will be stored. It will act as a health data board which includes all medical history and constitutional data of subscribed members of each family. It can give customized health advice for each individual according to their constitution. Remind *Dina Charyas(Day Regimens)* and *Rithu Charyas(Seasonal Regimens)* based on Weather forecast sensors. Health robots will get connected with your *Ayurveda* family physician who can monitor the health status of family members.

**Artificial Intelligence In Data Mining6**

Data mining is an analytical process which finds useful patterns and systematic relationship between variables from large amount of data. It is a practice of analyzing large database in order to generate new information. It have three steps like Data Exploration, Pattern Identification and Deployment of Data . *Ayurved*a Literary /Manuscript Research, Pharmaceutical Research and Drug Reserch use Data Mining for scientific outcomes. Currently data mining software like TARANGA, EDM(Enterprise Data Mining) , Statistic Data Miner , IBM SPSS Modeler are used. Artificial Intelligence will help in Large Data processing and reach more precise data for scientific research in *Ayurveda*.

**Artificial Intelligence In Medicinal Plant Cultivation and Drug Recognition13**

Herbal medicines including Ayurveda is gaining attention in the pharmaceutical industry due to having less side effects and its wholesomeness to human system . There is a big space in the research of automatic medicinal plants recognition considering the demand of herbal medicines in global market. There is a big challenge in *Ayurveda* Pharma to recognize exact drug mentioned in references of medicines due to variation in species and geographical diversification. There is a need for advancement in producing a robust segregator that has the ability to classify medicinal plants accurately in real-time. Option of effective and reliable machine learning algorithms for plant categorization using leaf images that have been used in recent years . This includes the image processing methods used to detect leaf and extract important plant taxonomical features for some machine learning classiﬁers. These machine learning plant segregators are categorized according to their performance when classifying leaf images based on typical plant feature namely shape, vein, texture, leaf borders and a combination of multiple features. This will enable pharmacognosy documentators in classification and creating data base of drugs in each geographical areas with same pharmaceutical action and prepare medicinal preparation with plants domestic in origin .The leaf databases that are publicly available for automatic plants recognition will be useful for *Ayurveda* Pharma Industry in Drug Standardization and helpful in Updating *Ayurveda* Pharmacopeia of India(API).

**Artificial Intelligence and Robotics in Ayurveda Pharmacy10**

In *Ayurveda* pharmacy major technology requirements are in automated production, packing quality control in large scale production, quality control labs for drug testing and standardization of end product. Automation technologies can robust the speed of the manufacturing process and make it safer and efficient, and also helps in reducing manpower cost. The benefits of automation and robotics can be noticed in multiple production aspects related to health, safety and environment, quality and production efficiency. When a robot is assigned for given operation, whether in an aseptic environment or not, one can assume that the robot is going to repetitively execute the given instructions without errors or faults in every cycle. Its evident that robot is the perfect solution for having the certainty of having a prescribed standard operating procedure respected in every step, with fully automatic tracking of operations performed and directly stored in the batch records.

**Health, safety and environment —**Operational safety is one of the major concern in pharmaceutical industry due to exposure continuous exposure to raw drugs, processing drugs and heat .The robot can reduce the impact of non-ergonomic or risky operations. In Ayurveda pharmacy medicine preparation high temperature boilers, grinders and crushers are used, which always have high chances of casualties. Robotics and automation can reduce the work hazards with more efficiency including in working hours.

**Quality —**The greatest source of contamination in any pharmaceutical environment is given by the presence of the operators (even with proper gowning protection), when large number of operations are assigned to a robot instead of an operator which will reduce the risk of contamination, with safer process and increasing the quality of production. In addition, the same is true within barrier systems, where the risk of contamination is reduced, and it is also true for Grade A environments where there are no barrier systems, like a conventional clean room where the operator performs operations at a safe distance from the product being handled by robots.

**Production Efficiency —**Smart-data management and quality of the batch record is part of standardized production in *Ayurveda* Pharmacy. Operations performed by the robot can be recorded in every detail with the corresponding environmental parameters and with standard output .Its known that an operation that, if carried out manually by an operator, would be extremely time-consuming and less robust. In addition, by increasing the number of sensors to equip robots and grippers, critical process parameters can be produced for more in-depth analysis (with machine learning and artificial intelligence tools). This will help in early identification of drift trends and manufacturing nonconformities, with more tools for a proper root cause analysis. Through which corrective action and preventive action can be implemented with priority, limiting the risk of losing control of production quality.

**Artificial Intellegence In Ayurveda Smart Drug Research8**

*Charaka samhita* and *Susruta samhita* are the two main *Ayurvedic* classics where in more than 700 plants along with their classification, pharmacological and therapeutic properties (*Rasa, Guna, Virya, Vipaka, Karma, Pratbhava*) have been described Drug used in *Ayurveda* are mostly herbs (Crude processed), mineral products, metals (in different oxidized forms by special manufacturing techniques) and animal products, these drugs were used as singly, in combinations (different yoga) and herbo-mineral combinatíons and weredeveloped gradually.

The processing steps were mentioned in the classics to assure the quality of the products and to reduce the potential toxicity. A Separate branch "*Rasa shastra & Bhaishajya kalpana*" were designed- which mainly deals with collection and selection of Ayurvedic drugs, purification as well as preparation, preservation besides mode of administration and dosage specification and preparation of *Rasa Aushadi* (metallic preparations). The ancient Ayurvedic scholars were very much rational and had a strong scientific background in fundamental principles which are concerned with drug discovery and manufacturing.

Another branch *Dravyaguna vigyana* includes identification (Pharmacognosy -*Naamarupavigyana*), preparation (Pharmacy-*kalpa vigyana*) and administration (clinical pharmacology yogavigyana). The later deals with the effects of drugs on various systems (Pharmacodynamics -*Guna-karma vigyana*) and their application in different diseases (Therapeutic- *prayoga vigyana*). The guidelines if followed properly the Pharmacodynamics and Pharmacokinetic standards of these preparations are maintained to reverse the pathological steps involved in the disease.

**Concept of Drug Rediscovery8**

Most of the *Ayurvedic* drugs/ herbs are in use since times immemorial and experience of thousands of physicians is available to indicate their safety and efficacy. Thus drug discovery process needs to be modified if benefits from *Ayurvedic* science are to be tapped. Many scholars have previously reported different approaches for this Reverse pharmacology. These approach start with clinical studies and goes up to the mechanistic preclinical studies. Drug Rediscovery' is more relevant terms for research involving *Ayurvedic* herbs and drugs. As *Ayurvedic* drugs are already in use as part of the medicinal system, and further research on these drugs would aid only in understanding their mechanism and help in optimizing their doses either alone or in combination. Thus the term Drug rediscovery would help differentiate process of discovering a drug from totally new medicinal combination from the process of understanding a drug which is existing in practice .

Stage 1- Drug Rediscovery on *Ayurvedic* drugs

1)Proven *Ayurvedic* drugs to be studied for Phyto-constituents

2)Activity guided fractionation of Biomarkers

3)Severe Adverse Reactions (SAR) studies of active constituents

4)Mechanistic studies (Preclinical and Clinical)

All these lead to optimized therapy based on new evidences to be clubbed with traditional

knowledge

Stage 2 - Drug Discovery: Outputs of Severe Adverse Reactions (SAR)

Studies (Stage I) from *Ayurvedic* Rediscovery program

1)Unique mechanism with multiple targets

2)New target identification and validation

3)System biology approach potentiating

4)Single drug or molecule working on multiple targets or even multiple systems

5)Multi-herb, multi target.

Historically drugs were discovered through identifying the active ingredients from traditional remedies by serendipitous discovery. The Traditional drug discovery process is educated guesswork in the beginning. It is a long (up to 15 years), complex (takes the effort of several experts), and expensive process to complete. It involves several stages, each with high rates of failures:

1. **Target identification11:** The objective of this stage is to identify a biological target that is involved in the disease pathology. Traditionally, this process involves a combination of biochemical assays, cell-based assays, and animal studies.
2. **Lead discovery11:** This step involves identifying a molecule that has the potential to interact with the target and modulate its activity. The traditional approach involves screening large compound libraries to identify active molecules, which is time-consuming.
3. **Lead optimization11:**It is the process of optimizing the pharmacological properties of a lead molecule, such as its potency, selectivity, and bioavailability. This process typically involves medicinal chemistry, computational modeling, and in vitro testing.

Since sequencing of human genomes which allowed rapid cloning and synthesis of large quantity of purified proteins, it became a common practice to use **High Through Put Screening (HTS)** screening of large compounds libraries against isolated biological targets which are hypnotized to be disease modifying in a process known as **Reverse Pharmacology8**

With the advent of Artificial Intelligence, the target identification process can be streamlined by leveraging [machine learning](https://www.v7labs.com/blog/machine-learning-guide) algorithms to analyze large data sets. A machine learning algorithm can help analyze the large-scale genomic data of a disease, identify potential drug targets, and predict the drug's effectiveness. Machine learning algorithms can also analyze scientific literature to identify potential drug targets and assist in identifying genetic biomarkers for disease diagnosis and prognosis.

*Ayurveda* Drug Research methods like *Rasa*(Taste) *Guna* (Quality*) Veerya*(Potency) *Vipaka* (Metabolic Property) *Prabhava*( Non Specified Actions) and *Krama*(Pharmacological Action) of individual drugs can be coded and stored. It can be used in combination of medicines to get potency and action of complex medicine mixtures(Yogams). Pharmacodynamics and Pharmacokinetics of each drug , varieties, substituents , adultrants etc can be stored and used on need. Modern Techniques like Pharmacognosy Analysis(Macroscopic and Microscopic), Physical Examinations, Qualitative and Quantitative evaluation like **TLC, HPTLC, Gas Chromatography, Bio Assays, Screening and Biological Assays** can be fully mechanized and automated. This will help in saving time and effort for basic drug research in *Ayurveda*. Pharmaceutical Drug Standards(PRS) and Botanical Reference Standards(BRS) of various drug available in different region of world can be stored and processed to develop Drugs from regionally available sources.

**Augmented and Virtual Reality For Public Relations**

The metaverse is the next Generation of the internet: a single, shared, immersive, persistent, 3D virtual space where humans experience life in ways they could not in the physical world. It is facilitated by the use of Virtual reality (VR) and Augmented reality (AR) Headsets .Ayurveda Health Education will be transformed to real time experience in which Anatomy, Physiology and Pathology can be experienced and learned **.**Conventional health websites will change to experience portals in which people can have virtual experience of services and decide for subscriptions **.**Brands in Ayurveda can demonstrate/market their products and services with real time experience facility**.**Realtime experience of Treatment modalities/ Daily practices like *Dinacharya(Daily Regimens) ,Rithu Charya(Seasonal Regimens), Rithu Sodhana*(Seasonal Detoxification Procedures) and *Yoga Practices* can be given to people for creating awareness **.** A comprehensive health platform/ecosystem that will disrupt the dissemination of conventional health knowledge and healthcare experience should be its futuristic outcome . This will be made possible by reaching out to the target public through podcasts and creative digital contents by creating more patient-friendly Life Experience Centers.

**DISCUSSION**

Artificial Intelligence and machine learning is already being used in the pharmaceutical industry to identify new drug candidates without the long and expensive traditional method of experiments through drug model libraries while also replacing actual trials with simulations, varying multiple parameters and to do drug research which will be helpful in reverse pharmacology . The whole process is not only much less expensive but also robust than the current process .*Ayurveda* Pharmaceutical Industry can also use the possibilities of Artificial Intelligence in Drug Identification, Big Data Base Creation on Pharmacognosy, Drug Standardization, Product Standardization and New Drug Research. Data security and privacy will be a major concern in digitalization and automation in any medical system. Even as Artificial Intelligence is being used to help healthcare, it can be perverted to steal patient and provider identities, research data, divert funds and misuse information by hacking medical computer systems. This will happen with private systems linked to hospital software, or by wireless networks at health facilities, or through the Internet of Medical Things (IoMT). Considering the risks in data privacy, protection of such systems from AI-driven malware and personalized attacks would perhaps cost more than can be saved by the application of such systems.

**CONCLUSION**

By making use of new-age technologies like Artificial Intelligence and real time immersive platforms like Augmented Reality,Virtual Reality can bring creative and innovative changes into *Ayurveda Health* sector. Artificial Intelligence and Robotics will revolutionaries conventional Health care system, Medicine manufacturing, Data Mining, Drug Identification, Drug Standardization and Drug Research with critical thinking on data safety and privacy. Metaverse platforms like Augmented Reality and Virtual Reality will promote awareness about the scientific basis of *Ayurveda* in general public and can make the ancient system of medicine *- Ayurveda* ready for future generations.

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