



Review Article

Ayurvedic research and methodology: Present status and future strategies

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Abstract

Ayurveda is a science of life with a holistic approach to health and personalized medicine. It is one of the oldest medical systems, which comprises thousands of medical concepts and hypothesis. Interestingly, Ayurveda has ability to treat many chronic diseases such as cancer, diabetes, arthritis, and asthma, which are untreatable in modern medicine. Unfortunately, due to lack of scientific validation in various concepts, this precious gift from our ancestors is trailing. Hence, evidence-based research is highly needed for global recognition and acceptance of Ayurveda, which needs further advancements in the research methodology. The present review highlights various fields of research including literary, fundamental, drug, pharmaceutical, and clinical research in Ayurveda. The review further focuses to improve the research methodology for Ayurveda with main emphasis on the fundamental research. This attempt will certainly encourage young researchers to work on various areas of research for the development and promotion of Ayurveda.

Key words: Ayurvedic research and methodology, personalized medicine, *Rasayana*, traditional medicine

Introduction

Ayurveda, the traditional Indian medicinal system remains the most ancient yet living traditions with sound philosophical and experimental basis. It is a science of life with a holistic approach to health and personalized medicine. It is known to be a complete medical system that comprised physical, psychological, philosophical, ethical, and spiritual health.^[1] In Ayurveda, each cell is considered to be inherently an essential expression of pure intelligence hence called self-healing science.^[2] In addition, to the self-healing concept, the use of herbal treatment is equally important in this Indian traditional system of medicine.

According to the World Health Organization, about 70–80% of the world populations rely on nonconventional medicines mainly of herbal sources in their healthcare.^[3] Public interest for the treatment with complementary and alternative medicine is mainly due to increased side effects in synthetic drugs, lack of curative treatment for several chronic diseases,

high cost of new drugs, microbial resistance, and emerging diseases, etc.^[4]

Ayurvedic treatment is although highly effective; proper mode of action, pharmacology, pharmacokinetics, and pharmacovigilance of many important Ayurvedic drugs are still not fully explored. Moreover, the comprehensive knowledge of the basic ideologies of Ayurveda is poorly acceptable scientifically due to lack of evidence. In the modern time, when the Western medicinal system is reached almost at the top because of validated research and advanced techniques, there is an urgent need to validate basic principles as well as drugs used in the ayurvedic system of medicine with the help of advanced research methodology. Therefore, advancements in the ongoing research methodology are highly required for the promotion of Ayurveda.

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Why Ayurvedic System of Medicine Lagging Behind?

Undoubtedly, in comparison to allopathic treatment, Ayurvedic treatment is more effective in most of the chronic diseases. However, the popularity of Ayurveda is rather lesser as the majority of the global population prefers modern medicine because of its ability to give fast relief from diseases as compared to Ayurvedic treatment. Recently, the awareness and thus fear of toxicity to allopathic drugs and the high cost of healthcare are causing an increasingly large number of people to seek alternatives. Rather than competing and veering towards the Western medicine, the Ayurvedic scientists should work to enhance the core competency of Ayurveda without compromising its fundamental principles.^[5] Some major points which are responsible for trailing the Ayurveda are as following.

- Young Ayurvedic scholars, although enthusiastic, are not clear about their views on the future of Ayurveda. Moreover, they are not even very clear that how to expose their valuable research outputs on Ayurveda
- Only a few organizations have well-established research infrastructure for exclusive research in Ayurveda. Experienced researchers with knowledge of modern technologies are required to conduct advance and quality research in Ayurveda
- There is a lack of cooperation and willingness of Biomedical Scientists who are often unduly skeptical and carry prejudice
- More than a thousand Ayurvedic postgraduates pass out each year and enter into the streamline of academics and practice. Among them, only a few choose their profession as researcher in Ayurveda
- Neither has the Ayurvedic teaching changed in the last 50 years nor have the textbooks enriched with new research methodologies.

These are some of the following major points those should be highly needed to consider in the Ayurvedic research for its advancement.

Improvement in research methodology

Research methodology is a way to systematic collection, analysis, and interpretation of data to solve a research problem. India does not need to prove the validity of Ayurveda to its people, authorities, and own scientific community because it is a recognized traditional medical system of the country. There is a need of fundamental research on Ayurveda to refresh and upgrade the tremendous knowledge diluted through time particularly during the British rule. This kind of research will certainly upgrade the fundamental knowledge of Ayurveda, which will be benefitted not only to Indian but also to foreign nationals. This will assure Ayurveda to be practiced with its whole potential and allowed to gain wide recognition. Research is a process that converts data into information, information into knowledge, and knowledge into wisdom. In the present scenario, Ayurvedic researches are failing in this aspect as these are unable to disseminate the knowledge gained from the exercises.^[6]

The glorious past of the research methodology of Ayurveda is based on the tools of examination known as *Pareeksha*

and inspired from the philosophical term *Pramaana*, which refers to the evidence.^[7] These tools of the examination include (i) the direct observation (*Pratyaksha*), (ii) the inference (*Anumana*), and (iii) the authoritative testimonies or literature (*Aptopadesha*). The modern day research also depends on these three basic tools whose efficacy has been augmented by the utility of the scientific and technological innovative devices. These methods of investigations have been planned to develop the backbone of the Ayurveda system in the form basic principles under the fundamental research. The quality researches on Ayurveda basics with advanced scientific techniques can expand the knowledge and path of current medical science. Predominantly, drug researches done in the field of Ayurveda in the last six decades have not enriched the Ayurvedic understandings or Ayurvedic concepts. However, these researches have created a better understanding of Ayurveda by the modern medical fraternity.

Now, it is the time to define Ayurveda itself that whether the use of herbs is Ayurveda or the use of herbs and other treatment modalities as per Ayurvedic principles is Ayurveda. The research methodology should be planned and adopted accordingly. At the time of deciding research methodology in Ayurveda following things should be kept in mind.^[8]

- Basic differences between Ayurveda and modern science should be taken into account when designing the research protocols
- The main concern must be given to the classical approach of Ayurveda
- Research protocols should be designed on the basic concepts of Ayurveda, i.e., *Prakriti*, *Agni*, *Dhatu*, *Srotas*, *Rasayana*, *Shatkriyakala*, *Agnibala*, *Ojabala*, *Manobala*, etc.
- The research work should involve experts both from Ayurveda and biomedical specialties
- The holistic and integrative approach involving body, mind, and spirit should be considered for research
- Before starting the clinical studies; a complete knowledge about diagnosis of the disease, materials to be used, process to be adopted, and accurate dosage form is highly needed
- The approach of personalized medicine should be followed during treatment.

Research methodology in the advancement of Ayurveda varies with each assignment or project. The major areas of research can be divided into five major areas, namely, literary, fundamental, drug, pharmaceutical, and clinical research. Although there is no single way to conduct research, certain methods and skills can make research efforts more efficient and effective.

Encouragement of research on Ayurvedic fundamentals

Fundamental research needs to be done in the fields of Ayurvedic physiology, pathology, pharmacology (fundamental and clinical), and pharmaceuticals. The basic concept of *Srotovijnana* (knowledge of channels) as a main matrix of Ayurvedic biology has been highlighted both by fundamental and applied knowledge.^[9] A living body is a system which comprised innumerable channels designed as an inner transport system for a variety of functions. The health and disease depend on the system of *Srotas*, which is prone to

lose its function by various factors including erroneous food and lifestyle. Ayurveda developed a therapeutic technology for *Samshodhana* (biopurification) familiarly known as *Panchakarma* therapy. Ayurveda can be better understood through philosophy and physics rather than modern biology because the study of the full spectrum of the *Srotas* can help to define the phenomenon of relationships in structural and functional biology.^[10] Moreover, the fundamental concept of Ayurveda for a perfect health including restoration and maintenance can also be understood through quantum theory.^[11,12]

The fundamental research in Ayurveda caters demands of the society and the medical fraternity; the modern scientific research has been initiated in Ayurveda in the field of basic principles. The aim of basic research in Ayurveda is to explore the scientific innovations and opportunities in fundamental concepts of Ayurveda. The fundamental research includes replacement of faith and suppositions with the scientific reasoning complimented with the facts and figures. The objectives of the investigation in the fundamental research are categorized into the human body (*Purusha*), the disease (*Vyadhi*), the medicine (*Aushadha*), and the right time for action (*Kriyakala*).^[13]

Validation of Ayurvedic drugs with reverse pharmacology

The reverse pharmacology refers to reversing the routine clinic practice to the laboratory examination for the proper validation of a traditional medicinal system.^[14] It is an interesting and important scientific approach to develop new drug candidates or formulations from already known facts in traditional medicines through sound preclinical and clinical researches.^[15]

Previous researches, particularly for the past few decades, validated a few concepts of herbal drugs by reverse pharmacology, which is obviously tremendous work for Ayurveda. These researches also supported the use of crude drugs rather than plant isolates or purified fractions for clinical trials due to the combined effects of phytoconstituents. Such researches generated a lot of interest in researchers towards herbal medicines and consequently, in the last decade a demand of Ayurveda and other traditional medicines has increased in the medical world.

In addition, the reverse pharmacology approach can help in reducing failure rates of clinical implication of the herbs or their formulations which are already described in Ayurveda. This approach gives an opportunity to seek new synergistic combinations and improvements in bioavailability and innovative strategies that can play a significant role in drug development. Various previous studies on piperine revealed that its combination improves the bioavailability of synthetic drugs such as propranolol, theophylline, and rifampicin.^[16]

Day by day, drug industry is facing serious challenges, as the drug discovery process has become extremely expensive, riskier, and critically inefficient. Postmarketing failures of blockbuster drugs and a serious innovation deficit are the major concerns of big pharma companies. Consequently, there has been a remarkable shift in favor of single to multitargeted drugs, especially for polygenic syndrome based on the traditional medicinal knowledge.

Evidence-based benefits of traditional approaches

There are many evidences, which supported Ayurveda performances better than Western medicine, mainly in case of chronic diseases, but it needs to validate with advanced scientific procedures. Ayurveda recommends the use of copper pot for water-purification as copper pot has antibacterial effect against important diarrheagenic bacteria including *Vibrio cholerae*, *Shigella flexneri*, enterotoxigenic *Escherichia coli*, enteropathogenic *E. coli*, *Salmonella enterica typhi* and *Salmonella paratyphi*, which is scientifically validated.^[1,17] Ayurveda also has the ability of wound healing via a topical route with the help of various preparations.^[18] Moreover, many Ayurvedic formulations and *Rasayanas* have scientifically validated in various *in vivo* models. In this connection, *Amalaki*, an Ayurvedic *Rasayana*, and *Rasa Sindoor*, an organometallic derivative of mercury are effective in longevity, development, fecundity, stress tolerance, and heterogeneous nuclear ribonucleoprotein levels of *Drosophila melanogaster*.^[19]

On the other hand, *Bhasma*, an ash obtained through incineration of plants and animal derivatives (horns, shells, feathers, etc.), metallic, and nonmetallic minerals, etc., is another example of traditional approach in which the starting material undergoes an elaborate process of purification (*Shodhana*), followed by the reaction phase, which involves the incorporation of some other mineral and herbal extracts.^[20] *Bhasma* preparation is similar to the present-day nanotechnology having nano-size (25–50 nm) particles. Although *Bhasmas* are complex materials, physicochemical analysis using modern techniques can be most attractive for the standardization of *Bhasma* medicines. This can be certainly helpful in building confidence in the use of such products for medication by ensuring safety, efficacy, and batch to batch uniformity.^[21]

Encouragement of interdisciplinary research

There is a need of involving all basic sciences such as Physics, Chemistry, Molecular Biology, and Biotechnology together with Ethnopharmacology, Ayurvedic Drug Discovery, Pharmacoepidemiology, Reverse Pharmacology and various other areas for the better understanding, and optimistic outcome of Ayurveda research. In the past few years, the interdisciplinary concept of research is also introduced in Ayurveda mainly for integrative medicine.^[8]

In Western countries, the multidimensional approach by combining traditional and modern medicine is growing day by day. The clinical efficacy of many traditional medications for a variety of diseases has been found comparatively better than that of modern medicine.^[22] The Ayurvedic system of medicine is very safe that can help in reducing the enormous burden of mortality and morbidity caused by the various side effects of conventional prescribed drugs. This traditional system is also found effective against various diseases where pathogens developed antibiotic resistance. Thus, interdisciplinary researches are highly needed to fight against most chronic diseases.

Improvement in quality of herbal drugs

Most of the Ayurvedic *Rasayanas* (*Medhya*, *Jeevaniya*, and *Lekhaniaya*, etc.) are based on the herbal products. Many herbs such as *Ashwagandha* (*Withania somnifera* Dunal.), *Shatavari* (*Asparagus racemosus* Willd.), *Guduchi* (*Tinospora cordifolia*

(Thunb.) Miers), *Amalaki* (*Embelica officinalis* Gaertn.), and *Bhallataka* (*Semecarpus anacardium* Linn.) are well-known Ayurvedic *Rasayanas*, which are proven immunomodulators. Adjuvants are required for many of weak immunogenic vaccines, and Ayurvedic *rasayanas* may offer better and safer immune drugs that can be used as adjuvants in such vaccines and also in cancer treatment.^[23]

Herbal extracts of therapeutic relevance are of great importance as reservoirs of structural and chemical diversity. Interestingly, more than 120 distinct phytochemicals from different plants have capability as lifesaving medicines. These compounds have been achieved through chemical and pharmacological screening of only 6% of the total plant species.^[24] The National Institute of Health has already started extensive research for anti-inflammatory compounds from turmeric, ginger, and *Boswellia* with the aid of Ayurvedic knowledge. The screening of numerous herbs for treating cancer has been done using traditional knowledge on such herbs.^[25] Moreover, a variety of drugs of immunomodulating capacity from traditional medicine can provide newer opportunities to improve therapeutic spectrum.^[26]

In case of herbal drugs, consistency in the chemical composition and bioactivity are essential requirements for their safe and effective use because the quality is the primary need for safety and efficacy of plant-derived medicines. In case of Ayurvedic preparations, most of the drugs are polyherbal formulations, and proper quality control is still a serious issue. Consequently, till the date, the acceptability of Ayurvedic drugs in the international market is very poor. There must be some procedures and techniques to analyze these drugs (extracts or formulations) for their composition and strength.^[27] Thus, there is a need to insure the standard quality of Ayurvedic products.

Active involvement of government

The government should be prepared a timeframe roadmap for the progressive development of Ayurvedic education and research. Science-based approaches may be promoted, utilized, and inculcated in the education of Ayurveda like traditional Chinese medicine (TCM). It is most appreciable that China has about 95% of Department of Traditional Medicine in their government hospitals. That is why their traditional medicinal system got global recognition and acceptable everywhere.^[28] Recently, Youyou Tu, has won Nobel Prize in Medicine for discovering Artemisinin, a drug that has significantly lowered mortality rates from malaria, based on a TCM remedy.^[29] India has to develop similar type of policies in the healthcare system for the development of Ayurveda.

Development of Ayurvedic pharma sector

The drug manufacturing industries and other supporting industries play important role in the development of Ayurvedic medicine. The whole supporting system, i.e., raw material collectors, dealers, processing and manufacturing industries, Ayurveda practitioners, and consumers must be encouraged. Around 1100 medicinal plants are used as medicine and among them at least 60 plants are of great demand.^[30] Today, as the demand for herbal products is increasing day by day, enough availability of raw materials with reasonable prices is a big challenge for the industries. Hence, some strict steps must be taken by the government as well as industries itself

to fulfill the supply and meet market demand. There is a need to ensure correct raw materials for the medicine and for this purpose, it is important to carefully monitor entire cycle of raw material collection such as harvesting, processing, transportation, and storage before their use. Moreover, selection of the correct germplasm using modern DNA fingerprinting and chemoprofiling techniques be used taken on priority basis.^[31]

Upgradation of Ayurveda literature

Ayurveda is continuously facing constraints and difficulties from regulatory authorities and the scientific community, which is coming in the way of its global acceptance.^[32] The available literature on the use of Ayurveda for the treatment of diseases is still not evidence based. There is a need of more evidence-based researches in this area to make the literature adequate. In this connection, Digital Helpline for Ayurveda Research Articles provides a first of its kind resource to access research articles on Ayurveda must be improved and updated. More than thousands of articles indexed in renowned PubMed every year, unfortunately, out of them a very few belong to Ayurveda research. However, the articles based on TCM cover around 12% of total published papers.^[33] Therefore, Ayurvedic literature has to make its huge contribution in PubMed for the international recognition.

Revalidation of clinical trials

The clinical trials on Ayurvedic medicines must be revalidated to find out better treatment modalities by improving scientific procedures, dose forms, and side effects of any given drug. The development of a method to allow placebo controls for changing and individualizing therapies is an important step in providing the basis for a meaningful comparison of not only classic Ayurveda but also other traditional medicinal systems with allopathic treatment in ways acceptable to Western standards. This approach also shows that double-blind, placebo controlled, randomized studies are possible when testing classic Ayurvedic versus allopathic medications. Larger trials are needed and are clearly possible.^[34] The Ayurvedic clinical trials must follow consolidated standards of reporting trials statement for global recognition.

Combination of Ayurveda and Western medicine

No doubt, Indian system of medicine has already received much attention in academic fields. The popularity of Ayurveda is mainly due to its therapeutic efficiency against most chronic diseases where modern medicines are ineffective.^[35] The Western medicine, on the other hand, introduced in Asian countries in early 16th century, when travelers from Western countries began to settle and found themselves in greater contact with native people.^[36] This medicinal system got high popularity within a very short period due to its fast action over traditional medicinal systems.

Interestingly, there are certain examples of Ayurveda and Western medicine work well when used in combination. For example, rheumatoid arthritis, a chronic and immune-mediated disease that causes pain and inflammation are not well treatable in modern Western medicine. Present, methotrexate achieves a response in 40–60% patients which cannot say satisfactory at all. Furthermore, methotrexate is associated with distressing and potentially serious side effects. As a result, 68–94% of arthritis patients use complementary and alternative medicine therapy

including Ayurveda.^[34] Therefore, Ayurveda and Western medicine should be considered as two sides of a coin, and they must come together to work for humankind.

Resolution of controversies in Ayurvedic drug

It is not always the case that Ayurvedic medicines do not show adverse effects. In a random sample of commercially prepared Ayurvedic drugs purchased online via internet, it has found that nearly 21% contained detectable levels of lead, mercury, and arsenic. The *Rasa shastra* medicines were more than twice as likely as non-*Rasa shastra* medicines to contain detectable levels of such metals which are said to be highly toxic for the body.^[37] Such reports are to be addressed appropriately, so that the concerns can be answered in time preventing further damage to the heritage. These Ayurvedic formulations must have to critically standardized before their marketing.

Improvement in personalized medicine with modern technology

The concept of Ayurveda treatment is broad, which heal the human being as a whole whereas Western system of medicine has traditionally operated from only a cure model. Now, the time has come to create a new model of the medicinal system by combining both healing and cure models. The value of health care could be increased tremendously through personalized medicine that could be helpful to predict disease risk, prevent progress of disease, and manage treatments more efficiently. Moreover, the developments in the area of pharmacogenetics and pharmacogenomics can help the practitioner to achieve the target of personalized medicine.^[38] A personalized medicine does not mean just the right drug for the right individual but the right drug for the specific disease affecting a specific individual.^[39] This concept will surely make clinical trials more efficient by reducing the cost usually raises due to side effects, and prescription of drugs those are not effective in certain genotypes.^[40]

The concept of personalized medicine is very old and used as long as people have been practicing medicine.^[7] In recent time, the personalized medicine is all about DNA while single nucleotide polymorphism and epigenetic factors influence drug response and form the basis of personalized medicine.^[41] Hence, the personalized medicine must be improved with the help of modern scientific techniques to promote Indian system of medicine.

Conclusion

Today, the cost of health care is constantly rising, and affecting people's ability to afford health coverage. Drug-based medicines are being unaffordable for economically poor countries like India and problematic in the Western countries due to numerous side effects. The drug should be the last rather than first mean of treatment, beginning with the natural healing method like Ayurveda. One of the Ayurvedic treatment modalities such as *Panchkarma* can remove disease before its manifestation. Having all the above beauties, Ayurveda is still lagging behind because of the lack of scientific evidence in many cases and poor research methodology.

The development of guidelines for methodology in Ayurveda requires a huge professional work both by academicians and practitioners who must have the necessary knowledge and motivation for this task. Otherwise, Ayurveda will gradually lose its identity and will become a history of medicine. Although the process of research is time taking but it is the only way to overcome the difficulties in the promotion of Ayurveda worldwide. The work in a coordinated and well-organized manner with no bias can improve Ayurveda. Nevertheless, it also a bitter truth that modern researches have not been very rewarding for Ayurveda itself as most of these researches is being used Ayurveda to extend modern bioscience. Hence, there is an urgent need to design advanced research methodology for the validation of Ayurvedic fundamentals as well as its treatments.

There is a huge difference in the approach of allopathic and Ayurvedic medicines. Ayurveda has evolved as a holistic system having an understanding of physiology enabling it to maintain and restore health with a few side effects and will focus rather on health, while allopathy whose analytic understanding of physiology leads mainly to suppression of symptoms with many side effects. Similarly, there is a great contribution of allopathy in the fields of emergency medicine, diagnostic techniques, and surgery where the existing practice of Ayurveda cannot compete. Thus, both systems have to complement each other in the benefit of ailing. Ayurveda requires more researches in the areas of fundamental principles and diagnostic tools in place of drug research. In the present scenario, the research methodology of Ayurveda is not good enough, which needs further advancements in the development and promotion of Ayurveda.

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हिन्दी सारांश

आयुर्वेदिक शोध एवं कार्यप्रणाली-वर्तमान स्थिति एवं भावी रणनीति

आषुतोश चौहान, दीपक कुमार सेमवाल, सत्येन्द्र प्रसाद मिश्रा, रुचि बाडोनी सेमवाल

आयुर्वेद स्वास्थ्य एवं व्यक्तिगत चिकित्सा के लिए एक समग्र दृष्टिकोण वाला जीवन का विज्ञान है। यह सबसे पुरानी औषधीय प्रणालियों में से एक है। जिसमें हजारों चिकित्सा अवधारणायें एवं परिकल्पनायें शामिल हैं। दिलचस्प बात यह है कि आयुर्वेद में कैंसर, मधुमेह, आमवात एवं अस्थमा जैसे कई चिरकालिक रोगों का इलाज करने की क्षमता है, जिनका इलाज आधुनिक चिकित्सा में आज भी नहीं है। दुर्भाग्यवश आयुर्वेद की कई अवधारणाओं में वैज्ञानिक साक्ष्यों की कमी के कारण हमारे पूर्वजों का यह अनमोल उपहार, आधुनिक चिकित्सा की तुलना में पिछड़ रहा है। अतः आयुर्वेद की वैश्विक मान्यता एवं स्वीकृति के लिए तथ्यपरक शोध एवं अनुसंधान अत्यधिक आवश्यक है। इस लेख के माध्यम से आयुर्वेद के साहित्यिक, मौलिक, औषध एवं नैदानिक शोधों सहित अनुसंधान के विभिन्न क्षेत्रों पर प्रकाश डाला गया है। यह लेख आयुर्वेद के मूलभूत सिद्धांतों पर अनुसंधान एवं शोध पद्धति में सुधार करने पर केंद्रित है। हमारा यह प्रयास निश्चित रूप में आयुर्वेद के विकास के लिए लाभकारी होगा तथा साथ ही आयुर्वेद के विभिन्न क्षेत्रों में शोध करने वाले युवाओं को प्रोत्साहित करेगा।