Contemporising Ayurvedic Product Development Processes - A proposed guideline for developing appropriate technologies

Rahi Jain^{*}, Padma Venkatasubramanian^{**}

^{*} Corresponding Author, PhD Student, Centre for Technology Alternatives for Rural Areas (CTARA), Indian Institute of Technology (IITB), Mumbai, E-mail: rahi.official@gmail.com

^{**} Head, School of Integrative Health Sciences, Trans-disciplinary University, Bangalore, India

Abstract

Ayurveda is a traditional medical system of the Indian sub-continent, catering to healthcare of millions of people in India. In today's times, *Ayurveda* requires scaled-up production and scientifically proven products. This in turn requires trans-disciplinary methodologies for product development that can leverage the existing knowledge in both *Ayurveda* and modern science and technology. Product Development in general has two steps, research and development (R&D) and manufacturing. Among the two, unlike in allopathic drugs, R&D in *Ayurveda* for new product development is in its nascent stage, lacking adequate references on modern methodologies. Such references are important in particular to new comers in the sector. The scope of this paper is to provide a write-up of the Ayurvedic processes and to propose a guideline for Ayurvedic product development that can be used for R&D. The methodology proposed was arrived at by referring selected classical *Ayurveda* texts and interacting with traditional and modern bio-medicine experts at the Trans-disciplinary University, Bengaluru, Karnataka, India. The study documents three components in Ayurvedic product development namely product formulation-identification, product formulation-preparation and product formulation-validation which can be used to design the Ayurvedic product development methodology. The study also provides the role of different stakeholders in the Ayurvedic product development process. The study provides a methodology to design new Ayurvedic products before being taken up for manufacturing.

Keywords: *Ayurveda*; Ayurvedic product development; Methodology; Herbal drug; Ayurvedic research and development; traditional medicine

1 Introduction

Any conventional drug (or, allopathic drug) or a herbal product available in the market undergoes two steps, first is research and development (R&D) where resources are invested to identify and develop a product and second is manufacturing the developed product on a scale for the consumer. For allopathic products, both steps are well documented, streamlined and standardized (Figure 1) ¹. Similar to the allopathic drugs manufacturing, herbal product manufacturing is regulated, and process documented. In India, State Food and Drug Administration (FDA) is responsible for regulating the products manufactured in their respective states ². Further, the Ministry of Ayurveda, Yoga, Unani, Siddha and Homeopathy (AYUSH), Government of India, under the Schedule T, has made it mandatory for industries to obtain Good Manufacturing Practices (GMP) certificate for manufacturing AYUSH products (GMP) ^{3,4}. Additionally, pharmacopoeias and formularies have been developed by AYUSH that provide quality standards for ingredients and formulations that need to be adhered to ^{5,6}.

R&D process guidelines for traditional medicine (TM) (like Ayurveda) based products have not been adequately published for a new industry. World Health Organization (WHO) has provided a basic framework for research and evaluation of any herbal medicine for its safety and efficacy through the lenses of conventional medicine ⁷. The guidelines for clinical trials of Ayurvedic drugs like the Good Clinical Practices Guidelines are provided that focus on measures which need to be taken when testing the product on human subjects ⁸. Other guidelines related to herbal medicine contamination testing ⁹ and pharmacovigilance ¹⁰ are also provided. Classical Ayurvedic texts and formularies describe formulations but not the steps for R&D for new product development nor the industrial processes for manufacturing. This lack of literature on the appropriate R&D processes to be adopted is a critical concern ¹¹.

Demand for natural products and low cost medicines brought the focus on TM systems like Ayurveda ^{12,13}. There is also a demand from the modern consumer to have products that are convenient, have a long

shelf life and aesthetically appealing. The traditional approach of medicine preparation that happened in a de-centralized manner, wherein the physician prepared the medicines at a household level using conventional tools and methods keeping the disease and patient in view ^{14,15}, are no longer economically viable due to the rise in demand, the reach and convenience. The physician no longer prepares the medicines but only prescribes those produced by the Ayurvedic industry.

In order to meet the rising demand and to scale up production, the TM manufacturing industries have mainly adopted or innovated on existing conventional pharmaceutical technologies or those used by the food and beverage industry. The scaling-up of production in today's AYUSH industry requires an understanding of the scientific rationale behind Ayurvedic formulations and dosage forms before adopting existing modern technologies, since these were specifically designed for allopathic medicines.

The current trends indicate that the health seeking behaviour of the consumer has changed, wherein both allopathic and TM are both sought after and therefore there is a need to address this demand through systematic and scientific integration of the two systems rather than in an ad hoc manner ^{11,16,17}. For example, powder (churna) and decoction (Kwatha), a regular Ayurvedic medicine dosage forms have been converted to tablet form by the modern Ayurveda industry for long shelf life, ease of carry and consumption ^{18,19}. These new formats of classical preparations need to be validated for efficacy and safety using both the Ayurvedic and modern science principles and techniques. For example, the study on Rheumatoid arthritis and Osteoarthritis Ayurvedic formulations prepared and tested using Ayurvedic principles were successfully analysed for its safety and efficacy using the modern science principles ²⁰. Another study had proposed the application of modern scientific principles in Ayurvedic drug formulation processes ²¹.

The lack of guidelines for R&D to develop appropriate technologies based on TM principles, make it difficult for any new entrant like an entrepreneur/researcher to contribute to the development of the sector. The difficulty would arise in identifying and engaging with different experts, retracing the product

development steps adopted by predecessors and standardizing good R&D practices for product development. It could create unnecessary lag period for new entrants to become fully functional. At worst, it could lead to wastage of new entrant's limited resources and could lead to product development failure. This paper proposes steps to be adopted for R&D in new Ayurveda product development.

2 Methodology

Methodology for Ayurvedic product development was arrived at through interactions with experts and literature analysis of classical Ayurveda texts.

2.1 Interactions with experts

Interactions with various experts of modern and traditional medicine and allied sciences at the Institute of Trans disciplinary Health Sciences and Technology (previously known as the Institute of Ayurveda and Integrative Medicine) and I-AIM Healthcare Center in Bengaluru, Karnataka, India were undertaken to delineate the Ayurvedic product development methodology (Table 1). The initial expert from each category was randomly selected and remaining experts were selected based on the recommendations of the experts interacted during the survey. The interactions with scientists and Ayurveda scholars at these two locations were carried over a period of five months from August 2011 to December 2011. Open ended discussions and interactions were held with experts from various disciplines to understand modern biomedicine and Ayurveda processes in product formulation and development process.

2.2 Books referred

The books selected for study were based on the recommendations given by the Ayurvedic practitioners interacted during the study. English translated editions of classical Ayurvedic books, namely Bhaishajya Kalpana Vijnanam, Sarngadhara Samhita of Sarngadharacarya, Caraka Samhita, Sushruta Samhita and Ashtanga Hridayam by Vagbhata related to herbal drug formulation and preparations were referred for this study. This understanding was used to design and document the Ayurvedic product development methodology.

3 Results and Discussion

Interactions with the experts from necessary disciplines helped identify different components involved in Ayurvedic product development. The interactions also indicated that while experts had a broad understanding of the process in Ayurvedic product development, the complete process was not documented. Therefore the different components were firstly organized to prepare the methodology for Ayurvedic product development (Figure 2).

3.1 Components in Ayurvedic Product Development

The Ayurvedic product development can be divided into three major steps: (i) product formulation-selection (PFS), (ii) product formulation-preparation (PFP) and (iii) product formulation-validation (PFV). Documentation at every step along with provision of reasoning and logic based on modern and Ayurvedic principles, is very important to be maintained so that the decisions taken at every step are transparent and can be corrected later if necessary.

These components will more or else remain the same based on whether the product is planned for usage as a drug or food/ food supplement / beverage. The main differences lie in the licensing authority that gives regulatory clearances for manufacturing and selling as well as the prerequisites for obtaining the license. A wellness drink formulation developed as a Ayurvedic beverage would require clearance from Food Safety and Standards Authority of India ²² and organoleptic tests could be of greater significance for a beverage than efficacy. In case, a formulation is an Ayurvedic drug, it would require clearance from State Authority ²³ (like Food and Drug Administration in Maharashtra ²⁴) and organoleptic tests could be of lesser significance and stringency than efficacy test. For the sake of better understanding, iron deficiency anemia has been taken as an example for describing the steps, since it is one of the main research area of Institute of Trans disciplinary Health Sciences and Technology and I-AIM Healthcare Center.

3.1.1 *Product Formulation-Selection (PFS)*

PFS involves ‘selection of the disease/condition’, ‘selection of the key ingredients’ and ‘selection of formulation’. Ayurvedic classical literature and the Ayurvedic Formulary of India ⁶ list many ready formulations which could be selected for developing products. For example, a study by Jain and Subramaniam (2017), for a condition like *Pandu* (a disease correlated with anemia), showed that more than 10 formulations have been provided in Ayurvedic textbooks like Caraka Samhitha and Sushruta Samhitha ²⁵. In such a scenario it is important to identify and select the formulation best suited for the

purpose before developing it into a product. In the allopathic drug development process, it is similar to the determination disease condition and the specific biomarkers like the target receptor/protein.

The ‘Selection of Disease/Condition’ is important for starting the ayurvedic product development process and defining the research problem disease/condition for which the Ayurvedic product is being developed. This component is further divided into three steps:

- i. The first step is identifying disease/condition of interest that normally involves selecting potential diseases/conditions for which the resource investment for further research can be justified. Health statistics, field experience, key stakeholders (like the funders, investors or the marketing department), can influence decision. Example, selection of anemia based on interaction with the key decision-maker of the project.
- ii. The second step involves confirmation of identified conditions/diseases including support through a quick literature survey and expert interactions. Some of the disease parameters that can aid in selection and evaluation can be a brief market survey and information on disease prevalence and impact. For example, literature survey indicated that iron deficiency anemia is prevalent in more than 75% of children aged 6-35 months ²⁶. Additionally, government programmes like National Health Mission supported it ²⁷, thus it is a major public health problem.
- iii. The third step is to select the disease subtype through extensive literature survey and interactions with *Ayurveda* practitioners. It is applicable for diseases with multifactorial aetiology like selection of iron deficiency anemia as subtype among various anemia causes like loss of blood ²⁸, nutrient deficiency ²⁹ or genetic disorder ³⁰.

After selecting the disease/condition, the ‘Selection of Ingredient’ is important for deciding on the key ingredients, which possess the desired bioactivity. The key ingredient selection is based on multi-criteria decision-making process. It incorporates criteria relating to ayurvedic and non-ayurvedic properties. Ayurvedic properties are based on the rasapanchaka of the ingredients. Rasapanchaka comprises of rasa (taste), guna (properties), virya (potency), vipaka (post-digestive effect) and karma (overall pharmacological effect). Non-Ayurvedic criteria incorporate ingredient’s technical and non-technical characteristics to enable better scaling-up and product dissemination to masses. Non-technical characteristics are ease of availability, cost, social/cultural/religious acceptance and organoleptic characters. Technical characteristics are physical, chemical and biological properties of the ingredients. Ingredient selection is done through Ayurvedic literature review and discussion with the *Ayurveda* practitioner and the project key decision-makers of the project. The discussions with key decision-maker at this early stage can help in reducing time lag and cost to get product development support. For

example, among the various key ingredients ^{31,32}, sugarcane was selected because it is easily available and acceptable across the population.

Finally, ‘Selection of Formulation’ is important for deciding upon the main formulation that would be used for PFP and PFV. Among the key ingredient based shortlisted formulations, the formulation of desired characteristics/close to desired characteristics is identified using Ayurvedic literature and *Ayurveda* practitioners’ opinion. The involvement of medical science experts would enable validating the conceptual soundness of formulation from both the Ayurvedic and modern science perspective. For example, among the various formulations, sugarcane based ones, sugarcane and Indian gooseberry (*Phyllanthus emblica*) juice mixture is selected as final formulation because it is easy to prepare, analyse and disseminate.

3.1.2 Product Formulation- Preparation (PFP)

The product formulation selected will be prepared for testing and scale-up trials with or without formulation modification/optimization. In the modern drug development process, it is similar to the drug design and production. This step has three sub-components as

1. ‘Modification of formulation composition’ involves improving formulation effects, safety, aesthetics, stability and sustainable production, reduce cost or make proprietary product, e.g., improving the taste of an Ayurvedic herbal cough syrup by sweetening it. The process requires identification of parameters for improvement followed with identification of ingredient/s that could be added, removed or substituted for desired improvement. Analytical software (if available or developed) and *Ayurveda* practitioners’ opinions can be used to estimate the effect of formulation modification on safety and efficacy. The software application in Ayurvedic products could be similar to that found in modern drug design. Bioinformatics and pharmacogenomics ³³ as well as modeling and simulation techniques ³⁴ can be used to understand and simulate the various physical, chemical and biological properties of the core compounds with various ingredients within the product and with the human body.
2. ‘Formulation scale-up design’ is performed to arrive at the scale-up strategy. The design initiates by addressing technical issues like product shelf life, product monitoring indicators, and product preparation time are identified. Solutions for the issues are identified using literature review, and interactions with industrial food and drug processing experts and *Ayurveda* practitioners. For example, final total dissolved solids can be used as an indicator to monitor the end point of the Ayurvedic decoction.

3. 'Formulation scale-up trials' is performed to test scale-up design initially using laboratory trials followed with pilot level. The successful completion of this step would lead to completion of Ayurvedic product development and the end of the R&D step with product eligible to enter into the manufacturing step.

3.1.3 Product Formulation Validation

The product developed through the formulation process is validated for its efficacy, safety, palatability and quality assurance. This step involves 'ingredient standardization', 'classical Ayurvedic product standardization' and 'modified product assessment'. In the modern drug development process, it is similar to drug testing and would involve implementation of regulatory clearances wherever animal and human subjects are used for formulation testing. The 'ingredients standardization' provides standardization of raw materials quality and is divided into three steps.

- i. The first step is ingredients procurement in sufficient stock from a reliable source.
- ii. The second step is authentication of procured ingredients especially the biological material. The biological material is provided botanical authentication by taxonomist and Ayurvedic authentication by *Ayurveda* practitioner. The botanical authentication provide scientific name of plant based modern taxonomy that allow in identifying good supply source, Ayurvedic authentication provide validation based on Ayurvedic literature for correctness in terms of identity, quality and maturity.
- iii. The third step is standardization of the authenticated ingredients based on microbial, physical and chemical characteristics for raw material quality assurance.

The 'classical Ayurvedic formulation standardization' provides baseline values for the different product characteristics (microbial, physical, chemical, efficacy, safety, palatability and stability) of the formulation. It is divided into three steps.

- i. The first step is classical formulation preparation and its authentication by *Ayurveda* practitioner.
- ii. The second step is testing the formulation for its product characteristics based on modern scientific principles and techniques.
- iii. The final step is the formulation standardization for various product characteristics.

The 'modified product assessment' compares the final/modified Ayurvedic product with classical formulation (as a practitioner would prepare) for various product characteristics followed with standardization of final product characteristics.

3.2 Role of Various Stakeholders and Experts in the Methodology

The different components in the drug development require the involvement of different stakeholders and experts. Stakeholders' role identification is important to prevent over-dependence on particular stakeholder and under-utilization of critical stakeholder.

Ayurveda practitioner is the important and critical stakeholder in the product development as it helps in understanding, selecting, modifying and validating formulations based on Ayurvedic principles. Life-science researchers like taxonomist, botanist, pharmacist and biotechnologist play a critical role in providing modern science perspective to characterize, develop, test and validate the ingredients and product.

Allopathic doctors are critical to provide understanding of the diseases from modern science perspectives and for product efficacy and safety studies done on human subjects. Bioprocessing expert is needed for the 'scale-up design' and 'scale-up trial' sub-components for preparation of the product using the modern instruments. Industry expert can be helpful in understanding the real time scale-up and manufacturing challenges.

Additionally, a co-ordinator who understands the techno-business aspects and who can interface between the experts in modern science and Ayurveda plays a crucial role of smoothening knowledge transfer process from one domain to another by translating each domain knowledge language to other domain language. Finally, the consumers will be involved in determining the product acceptability.

3.3 Ayurvedic Product Development Methodology

The components and sub-components of the Ayurvedic product development are arranged in a flow chart shown in Figure 2. The process starts with the 'Disease / condition Selection' sub-component of PFS. Only, the acceptance of 'disease validation' step outcome initiates 'disease subtype selection' step, which is followed sequentially by 'Ingredient Selection' and 'Formulation Selection' and completes PFS. PFP and PFV can be initiated in parallel.

PFV initiates with sub-component 'Ingredient standardization', in which successful completion of 'ingredient procurement' step sequentially initiates 'Ingredient authentication' and 'Ingredient characteristics standardization' steps. However, 'ingredient procurement' step failure restart process from 'Ingredient selection' sub-component of PFS because failure indicates that ingredients sources are not reliable to meet the demand. The successful completion of sub-component 'Ingredient standardization' sequentially initiates sub-components 'Classical Ayurvedic formulation standardization' and

‘Modified/test product assessment’. However, failure of ‘Formulation testing’ step in ‘Classical Ayurvedic formulation standardization’ restarts process from sub-component ‘Formulation selection’ in PFS as it indicates that formulation is not meeting the desired product requirements. Further, the process restarts from ‘Composition modification’ in PFP, if modified product performance is poor than the classical product.

PFP initiates with the ‘Composition Modification’ sub-component, which if fails, takes the process back to ‘Ingredient Selection’ step in PFS. The successful completion of ‘Composition Modification’ and PFV is needed to sequentially initiate ‘Scale-Up Design’ and ‘Scale-up Trials’ and completes PFP that provides final product for regulatory clearances and manufacturing and closure of R&D step. In case ‘Laboratory Trial’ step of ‘Scale-up Trials’ fails, process restarts from ‘Scale-up Design’. In case of R&D objective is to manufacture classical formulation, PFP do not need to perform composition modification and PFV do not need to perform modified product assessment.

4 Conclusion

The study was performed to understand and provide general guidelines for R&D into Ayurvedic product development. The methodology recommends the inclusion of Ayurveda scholars and modern scientific technologists in developing the appropriate product. The study found that experts’ knowledge and understanding of Ayurvedic product development had not been documented. Accordingly, this study documents the steps involved in Ayurvedic product development for dissemination in public domain. It provides the need to involve experts from various fields and the role that different experts can play in the different steps of the Ayurvedic product development.

This study will help reducing the learning time of the new entrants in the field of Ayurvedic product development by providing a critical and basic understanding of the process. The development of any Ayurvedic product, classical or proprietary, both at small and large scale could benefit with this study. Further, the use of feedback loops could allow methodology automation and creating checklist for keeping track of progress in the product development activity.

Reference

1. Pharmaceutical Researchers and Manufacturers of America (PhRMA). Drug discovery & development. Washington DC; 2007.

2. Central Drugs Standard Control Organisation. Functions of State Licensing Authorities [Internet]. [cited 2017 Jun 17]. Available from: <http://www.cdsc.nic.in/writereaddata/statefunction.pdf>
3. Ministry of AYUSH. Revised Draft GMP of AYURVEDA, SIDDHA AND UNANI Drugs [Internet]. [cited 2017 Jun 17]. Available from: <http://ayush.gov.in/sites/default/files/Revised Draft GMP to be published in Website for seeking comment.pdf>
4. Ministry of Health and Family Welfare. Schedule T: Good Manufacturing Practices for Ayurvedic, Siddha and Unani Medicines. New Delhi; 2003.
5. Ministry of AYUSH. The Ayurvedic pharmacopoeia of India. New Delhi; 2016.
6. Department of Indian Systems of Medicine & Homoeopathy. The Ayurvedic formulary of India: Volume 1. New Delhi; 2003.
7. World Health Organization. General Guidelines for Methodologies on Research and Evaluation of Traditional Medicine. Geneva, Switzerland; 2000.
8. Ministry of Health and Family Welfare. Good Clinical Practice Guidelines for Clinical Trials in Ayurveda, Siddha and Unani Medicine (GCP-ASU). New Delhi; 2013.
9. World Health Organization. WHO guidelines for assessing quality of herbal medicines with reference to contaminants and residues. Geneva, Switzerland; 2007.
10. World Health Organization. WHO guidelines on safety monitoring of herbal medicines in pharmacovigilance systems. Geneva, Switzerland; 2004.
11. Chauhan A, Semwal D, Mishra S, Semwal R. Ayurvedic research and methodology:

- Present status and future strategies. Ayu. 2015;36(4):364–9.
12. Deshpande SM. Study of Current Market Scenario & Marketing Prospects against Changing Attitude of Consumers towards Buying Of Ayurvedic Medicines in India. Int J Bus Manag Invent. 2015;4(6):48–54.
 13. Market AP. Ayurvedic Products Market to Grow at 16 % through 2021 [Internet]. TechSci Research,. 2016 [cited 2017 Jun 17]. Available from: <https://www.techsciresearch.com/news/1436-ayurvedic-products-market-to-grow-at-16-through-2021.html>
 14. Rao G. A textbook of Bhaisajya Kalpana Vignanam. New Delhi: Chaukhambha Sanskrit Sansthan; 2008. 119-306 p.
 15. Murthy PHC. Sarngadhara Samhita of Sarngadharacarya. Varanasi: Chowkhamba Sanskrit Series Office; 2007. 102-245 p.
 16. World Ayurveda Foundation and Trans-Disciplinary University Bangalore. Journal of Ayurveda and Integrative Medicine: Aims and Scope [Internet]. Elsevier. 2016 [cited 2017 Jul 21]. Available from: <https://www.journals.elsevier.com/journal-of-ayurveda-and-integrative-medicine/>
 17. Rastogi S. Building bridges between Ayurveda and Modern Science. Int J Ayurveda Res. 2010;1(1):41–6.
 18. Deole YS, Chavan SS, Ashok BK, Ravishankar B, Thakar AB, Chandola HM. Evaluation of anti-depressant and anxiolytic activity of Rasayana Ghana Tablet (A compound Ayurvedic formulation) in albino mice. Ayu. 2011;32(3):375–9.

19. Baragi UC, Baragi PC, Vyas MK, Shukla VJ. Standardization and quality control parameters of Dashanga Kwatha ghana tablet: An Ayurvedic formulation. *Int J Ayurveda Res.* 2011;2(1):42–7.
20. Chopra A, Saluja M, Tillu G. Ayurveda-modern medicine interface: A critical appraisal of studies of Ayurvedic medicines to treat osteoarthritis and rheumatoid arthritis. *J Ayurveda Integr Med.* 2010;1(3):190–8.
21. Jain R, Venkatasubramanian P. Proposed correlation of modern processing principles for Ayurvedic herbal drug manufacturing: A systematic review. *Anc Sci Life.* 2015;32(4):205–11.
22. Ministry of Law and Justice. Food Safety and Standards Act, 2006. New Delhi; 2006.
23. Ministry of Health and Family Welfare. Drugs and Cosmetics Act and Rules. New Delhi; 2016.
24. FDA Maharashtra. Grant of Drug and Cosmetic Manufacturing Licence in Own Premises [Internet]. 2017 [cited 2017 Oct 9]. Available from: <https://fda.maharashtra.gov.in/guidelinesown.aspx>
25. Jain R, Venkatasubramanian P. Sugarcane Molasses – A Potential Dietary Supplement in the Management of Iron Deficiency Anemia. *J Diet Suppl.* 2017;14(5):589–98.
26. International Institute for Population Sciences (IIPS) and ORC Macro. National Family Health Survey (NFHS-2), 1998–99: India. Mumbai; 2000.
27. Ministry of Health and Family Welfare. A strategic approach to reproductive, maternal, newborn, child and adolescent health (RMNCH+A) in India. New Delhi; 2013.

28. Walker HK, Hall WD, Hurst JW. Clinical Methods: the history, physical, and laboratory examinations. 3rd ed. Boston: Butterworth; 1990. 439-442 p.
29. Ochei J Kolhatkar A. Medical Laboratory Science: Theory And Practice. 10th ed. Vol. 52. New Delhi: Tata McGraw Hill; 2008. 303-313 p.
30. Steinberg MH. Sickle Cell Anemia, the First Molecular Disease: Overview of Molecular Etiology, Pathophysiology, and Therapeutic Approaches. Sci World J. 2008;8(1):1295–324.
31. Murthy KRS, editor. Susruta Samhita: Uttara Sthana. 3(3). Varanasi: Chaukhamba Orientalia; 2008. 355-358 p.
32. Sharma R, editor. Caraka Samhita: Chikitsa Sthana. 4th ed. Varanasi: Chaukhamba Krishnadas Academy; 2007. 81-116 p.
33. Katara P. Role of bioinformatics and pharmacogenomics in drug discovery and development process. Netw Model Anal Heal Informatics Bioinforma. 2013;2(1):225–30.
34. Deshmukh R. Modeling and Simulation in Drug Discovery and Development. J Bioequiv Availab. 2012;4(6):27–8.

Table 1: Details of experts consulted

S. No.	Area of expertise	Number of experts consulted
1	Botany	1
2	Ayurveda practitioner/ scholar	9
3	Yoga	1
4	Bio-medicine	2
5	Life Sciences researchers	5

Figure 1 General Allopathic Drug Development Methodology

Figure 2 Proposed Ayurvedic Product Development Methodology- the R&D step

Figure 1 General Allopathic Drug Development Methodology

Figure 2 Proposed Ayurvedic Product Development Methodology- the R&D step (Bold Lines: Connection between components, Dotted Line: Scenario when R&D objective is to manufacture Classical Formulation Only)