

## Polyherbal formulation: Concept of ayurveda

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### Abstract

*Ayurveda* is one of the traditional medicinal systems of Indian. The philosophy behind *Ayurveda* is preventing unnecessary suffering and living a long healthy life. *Ayurveda* involves the use of natural elements to eliminate the root cause of the disease by restoring balance, at the same time create a healthy life-style to prevent the recurrence of imbalance. Herbal medicines have existed world-wide with long recorded history and they were used in ancient Chinese, Greek, Egyptian and Indian medicine for various therapies purposes. World Health Organization estimated that 80% of the world's inhabitants still rely mainly on traditional medicines for their health care. The subcontinent of India is well-known to be one of the major biodiversity centers with about 45,000 plant species. In India, about 15,000 medicinal plants have been recorded, in which the communities used 7,000-7,500 plants for curing different diseases. In *Ayurveda*, single or multiple herbs (polyherbal) are used for the treatment. The *Ayurvedic* literature *Sarangdhar Samhita* highlighted the concept of polyherbalism to achieve greater therapeutic efficacy. The active phytochemical constituents of individual plants are insufficient to achieve the desirable therapeutic effects. When combining the multiple herbs in a particular ratio, it will give a better therapeutic effect and reduce the toxicity. This review mainly focuses on important of the polyherbalism and its clinical significance.

**Keywords:** *Ayurveda*, *panchamahabhutas*, polyherbal formulation

### OVERVIEW OF AYURVEDA

*Ayurveda* is one of the traditional medicinal systems with an established history of many centuries. Furthermore known as *Ayurvedic* Medicine, this ancient Vedic knowledge is considered to be one of the oldest healing sciences and has survived until the present generation over many centuries of tradition. Originated in India thousands of years ago, *Ayurveda* is known as the “Mother of All Healing”.<sup>[1]</sup> Etymologically speaking, it is the combination of the Sanskrit words *ayur* (life) and *veda* (science or knowledge), which means “the science of life,” focusing on bringing harmony and balance in all areas of life including mind, body and spirit.<sup>[2]</sup>

In *Ayurveda*, *Panchamahabhutas* or the five elements: *Vayu* (air), *Teja* (fire), *Aap* (water), *Prithvi* (earth) and *Akasha* (aether) are believed to build up the living microcosm (human beings) and the macrocosm

(external universe). When combined in pairs, the *Panchamahabhutas* form *Tridosha* or the three humors namely *Vata* (responsible for body movement), *Pitta* (responsible for bodily chemical reactions such as metabolism and temperature) and *Kapha* (responsible for growth, protection, lubrication and sustenance). All these present the constitution or *Prakriti* of an individual, which determines the physical as well as mental characteristic of human. The concept is that health is achieved when there is a balance between these three fundamental *doshas*, whereas imbalance causes diseases. Based on these *Panchamahabhutas* and *Tridosha*, the *Prakriti* of an individual is determined and a distinctive treatment plan can be prescribed according to their unique constitution.[3]

The philosophy behind *Ayurveda* is preventing unnecessary suffering and living a long healthy life. Unlike the allopathic medicines which uses mainly synthetic chemicals designed for specific target receptors and primarily give symptomatic relief, *Ayurveda* involves the use of natural means such as diet, herbs, spices, minerals, exercise, meditation, yoga, mental hygiene, sounds, smells and mechano-procedures to eliminate the root cause of the disease by restoring balance, at the same time create a healthy life-style to prevent the reoccurrence of imbalance. *Ayurveda* is said to be holistic as it aims to integrate and balance body, mind and spirit to prevent illness and promote wellness, longevity, vitality and happiness.

## THE HISTORY OF AYURVEDA

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In terms of literature, the fourth Veda written during Indian Civilization, *Atharva-veda* serves as the earliest authentic text discussing on the nature of existence, health and disease, pathogenesis and principles of treatment. Here in *Atharva-veda*, the healing verses of *Ayurveda* can be primarily found, in which more than a hundred hymns were mentioned as the cures for diseases, including fever, leprosy, consumption, heart diseases, wounds, headaches, parasites, eye and ear diseases, poisoning, rheumatism and epilepsy. The uniqueness of this ancient medical system lies behind the vast variety of healing method used: Charms, plant and animal juices, natural forces (sun and water) as well as human contrivances.[4] The eight branches of treatment, *Ashtanga* was mentioned here as well: *Kaya Chikitsa* (Internal medicine), *Shalya Tantra* (Surgery), *Shalakya Tantra* (Ear, nose, throat and eye diseases), *Kaumarbhritya* (Pediatrics), *Agada Tantra* (Toxicology), *Bhuta Vidya* (Psychiatry), *Rasayana* (Rejuvenation therapy) and *Vajeekarana* (Aphrodisiac therapy).

From the knowledge in *Atharva-veda*, early texts of *Ayurveda* such as *Chakara Samhita* and *Sushruta Samhita* were developed. Although the former focuses on the causes of diseases and the constitution of a person, the later emphasizes on *Ayurvedic* surgery and the details of its techniques.[5]

The history of *Ayurveda* can be traced back to the period between the pre-vedic periods (4000 B. C.-1500 B. C.). According to *Ayurvedavatarana* (the descent of *Ayurveda*), Lord Brahma, the Hindu God of Creation passed on his “knowledge of life” to Daksha Prajapati and Ashwins, subsequently to Indra. This knowledge is then transferred to different rishis (sages), in which these disciples of *Ayurveda* wrote different treatises based on their interpretations. Here, both Bhardwaj and Dhanvantari received the knowledge from Indra. They later developed school of medicine and school of surgery respectively.[6]

In *Chakara Samhita*, it was stated that the *Ayurvedic* teaching is transferred by Indra to Bhardwaj, who in turn taught this to Atreya.[7] The disciples of Atreya wrote their own *samhitas*, with *Agnivesha Samhita* being the one well-accepted. It is then revised, edited and supplemented by Chakara about 800 years later. On the other hand, *Sushruta Samhita* mentioned the transfer of knowledge from Indra to Dhanvantari, along with Bhardwaj. The disciples in this school such as *Sushruta* wrote *Sushruta samhita*, compiling Dhanvantari's teaching and his additional findings.[8]

## HISTORY OF HERBAL DRUGS

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Since the prehistoric period, herbal medicines have existed world-wide with long recorded history. They

were used in ancient Chinese, Greek, Egyptian and Indian medicine for various therapies purposes; whereas the Native American and African use herbs in their healing rituals as a part of their culture. The Indian *Ayurvedic* system has included herbals as one of its most powerful healing ingredients, which are recorded in the literature such as Vedas and Samhitas.

Due to the availability of chemical analysis methods in the early 19<sup>th</sup> century, scientists started to extract and modify active compounds from the herbals, resulting in transition from raw herbs to synthetic pharmaceuticals. This is when the use of herbal medicines started to decline.[9] Synthetic pharmaceuticals, however, are found out to be relatively more expensive and produce numerous undesirable side-effects despite their strong pharmacological action. Thus people nowadays are shifting back to herbal drugs, which are originated from the nature and claim to be safer. [Table 1](#) shows a few synthetic drugs used extensively which are derived from plants.[10]

### **Ayurvedic herbals**

Based on the material of origin, *Ayurvedic* medicines are divided into three classes, namely herbal, mineral and animal. Among this, herbal formulation has gained great importance and rising global attention recently. This scenario is obvious as major increase in the herbal formulation usage has been observed throughout the last few years in developed world, where market expansion occurred in European countries and USA.[11] The World Health Organization (WHO) estimates that 80% of the world's inhabitants still rely mainly on traditional medicines for their health care.[12]

The subcontinent of India is well-known to be one of the mega biodiversity centers with about 45,000 plant species.[13] This richness of flora has contributed to its status as a reservoir of herbals throughout the history of mankind. In India, about 15,000 medicinal plants have been recorded, in which the communities used 7,000-7,500 plants for curing different diseases. *Ayurveda* has about 700 type of plants listed in its medicinal systems.[14] The use of such herbals is mentioned in the ancient *Ayurvedic* literature such as *Chakara Samhita* and *Sushruta Samhita*.

The discovery of herbals is further complemented with knowledge on the method of isolation, purification, characterization of active ingredients and type of preparation. The term “herbal drug” determines the part/parts of a plant (leaves, flowers, seeds roots, barks, stems and etc.) used for preparing medicines. Each and every part of the herbs are fully utilized for the different pharmacological action they may produce and made into a range of herbal preparations including *Kwatha* (Decoction), *Phanta* (Hot infusion), *Hima* (Cold infusion), *Arka* (Liquid Extract), *Churna* (Powders), *Guggul* (Resins and balsams), *Taila* (Medicated oil) and etc.[15]

Due to the scientific advancement today, more and more pharmacologically active ingredients of the *Ayurvedic* medicines as well as their usefulness in drug therapy have been identified. Basically, it is the phytochemical constituent in the herbals which lead to the desired healing effect, such as saponins, tannins, alkaloids, alkenyl phenols, flavonoids, terpenoids, phorbol esters and sesquiterpenes lactones. A single herb may even contain more than one of the aforementioned phytochemical constituents, which works synergistically with each other in producing pharmacological action.[14]

There are a few examples of *Ayurvedic* herbs to be pointed out here: Arjuna (*Terminalia arjuna*) contains saponin glycosides, which accounts for its primary activity in improving cardiac muscle function and pumping activity of the heart, whereas the flavonoids afford antioxidant action and vascular strengthening;[16] The volatile oil of ginger (*Zingiber officinale*) on the other hand contains phenolic compounds (shogaols and gingerols) as well as sesquiterpenes (bisapolene, zingiberene and zingiberol) producing analgesic, sedative, antipyretic and antibacterial activities. Both *in vitro* and in animals;[17] clove oil and cinnamon leaf oil obtained from the dried flower buds of *Syzygium aromaticum* and leaves of *Cinnamomum zeylanicum* respectively, contain eugenol as their main constituent and thus possess

antimicrobial activities, i.e. antibacterial and antifungal activities.[18] Another example is lemongrass (*Cymbopogon citrates*) essential oil which contains three major phytoconstituent: Geranial, neral and myrcene. The former two showed *in vitro* antibacterial action individually, but not myrcene. However when mixed with any of the two components, myrcene enhanced their activity.[19]

In *Ayurveda*, herbals are known to regulate bodily functions, cleanse and nourish human body. Each herb has five categories known as *rasa*, *veerya*, *vipaka*, *prabhava* and *karma*. [3]

*Rasa* (taste or sensation that the tongue experiences when in contact with the herbals)

- There are six tastes (*Madhura*-Sweet, *Amla*-Sour, *Lavana*-Salty, *Katu*-Pungent, *Tikta*-Bitter, *Kashaya*-Astringent) and each one is made of two out of the five elements
- Each of the taste has an effect on *dosha*.

*Veerya* (energy a herb releases when ingested)

- It can be *sheeta* (cooling) or *ushna* (heating)
- The former is said to be present in sweet, astringent and bitter herbs, which refreshes body, reduces irritation and inflammation; whereas the latter is obtained from sour, salty and pungent herbs that improves circulation, helps digestion and promotes sweating.

*Vipaka* (Post-digestive effect)

- There are three types of *Vipaka*: *Madhura* (sweet), *Amla* (sour) and *Katu* (pungent), each having different effects on the *dosha*.

*Prabhava* (special and unique power of a herb that has variable action)

- These herbs does not fit in the category of other herbs that present the same *rasa*, *veerya* or *vipaka*.

*Karma* (therapeutic action)

- These are classified as *Deepana* (Stimulant), *Pachana* (Digestive), *Shodhana* (Purification), *Anuloman* (Carminative) and *Virechana* (Purgative).

Other than that, the doses, time of intake and *Anupana* (the carrier which the herbal medicines are prescribed with such as hot water, milk, honey, etc.) are also emphasized in the study of herbals under *Ayurveda*.

In general, there are two types of *Ayurvedic* herbal formulations: *Kasthoushadhies* (pure herbal preparations) and *Rasaushadhies* (herbo-bio-mineral metallic preparation), in which the latter contains minerals added for their therapeutic effect.[20]

### Single herbal versus polyherbal formulation

Drug formulation in *Ayurveda* is based on two principles: Use as a single drug and use of more than one drugs, in which the latter is known as PHF. This key traditional therapeutic herbal strategy exploits the combining of several medicinal herbs to achieve extra therapeutic effectiveness, usually known as polypharmacy or polyherbalism.

Historically, the *Ayurvedic* literature “*Sarangdhar Samhita*” dated centuries ago in 1300 A. D. has highlighted the concept of polyherbalism in this ancient medicinal system.[21] In the traditional system of Indian medicine, plant formulations and combined extracts of plants are chosen rather than individual ones. It is known that *Ayurvedic* herbals are prepared in a number of dosage forms, in which mostly all of them

are PHF.[22,23]

Even though the active phytochemical constituents of individual plants have been well established, they usually present in minute amount and always, they are insufficient to achieve the desirable therapeutic effects. For this, scientific studies have revealed that these plants of varying potency when combined may theoretically produce a greater result, as compared to individual use of the plant and also the sum of their individual effect. This phenomenon of positive herb-herb interaction is known as synergism. Certain pharmacological actions of active constituents of herbals are significant only when potentiated by that of other plants, but not evident when used alone.

There are a few *Ayurvedic* herbs combinations to be cited here: Combination of ginger with black pepper and long pepper enhances their heating and mucous-reducing effects; bitter and cold herbs are combined with warmer herbs (combination of neem and ginger) to positively offset any extreme effects. Cumin, black pepper and asafoetida are used together traditionally to reduce bloating due to weak digestion; whereas guduchi and turmeric combination booster one's immunity.[24,25,26]

Based on the nature of the interaction, there are two mechanisms on how synergism acts (i.e., pharmacodynamics and pharmacokinetic).[27] In terms of pharmacokinetic synergism, the ability of herb to facilitate the absorption, distribution, metabolism and elimination of the other herbs is focused. Pharmacodynamic synergism on the other hand, studies the synergistic effect when active constituents with similar therapeutic activity are targeted to a similar receptor or physiological system. Other than that, it is believed that multiplicity of factors and complications cause diseases in most of the cases, leading to both visible and invisible symptoms. Here, combination of herbals may act on multiple targets at the same time to provide a thorough relief.[28]

Due to synergism, polyherbalism confers some benefits not available in single herbal formulation. It is evident that better therapeutic effect can be reached with a single multi-constituent formulation. For this, a lower dose of the herbal preparation would be needed to achieve desirable pharmacological action, thus reducing the risk of deleterious side-effects. Besides, PHFs bring to improved convenience for patients by eliminating the need of taking more than one different single herbal formulation at a time, which indirectly leads to better compliance and therapeutic effect. All these benefits have resulted in the popularity of PHF in the market when compared to single herbal formulation.

Many of the PHF have been pharmacologically and clinically proven to possess therapeutic activities as desired. Examples of some of the PHF are shown in [Table 2](#).

In the formulation of polyherbal preparations, it is crucial to note that herbs are sometimes considered to be incompatible (*viruddha*) and thus should not be taken together. Such incompatibility may be due to quantitative incompatibility, energetic incompatibility or functional incompatibility. For instances, ghee should not be taken in same proportions with honey by weight due to conflicting tastes and temperatures; whereas laxative and astringents brings to antagonistic action in which they negate each other's activities.[24] To ensure compatibility of multiple herbs in the formulation of PHF, there are needs of well-designed clinical trials prior to marketing.

### **Reason of using PHF**

As mentioned before, PHF starts to gain its popularity recently worldwide, owing to the fact that PHF possesses some advantages which is not available in allopathic drugs.

Firstly, PHFs are known to express high effectiveness in a vast number of diseases. As aforementioned, the therapeutic effect of herbal medicines are exerted due to the presence of different phytoconstituents and the effects are further potentiated when compatible herbals are formulated together in PHFs. Until date, many researches have been done on PHF to evaluate their effectiveness and these are published on international

journals. For instance, Srivastava *et al.* in their study have reported a number of anti-diabetic PHFs such as Dihar, Diabet, Diasol, Dianex, DRF/AY/5001, Diashis, Diabrid, Diakyur, Diasulin and etc., which are confirmed to have compatible effect as those of standard allopathic drug. In a statistical study performed in UK, it was found out that the main reason underlying the use of medical herbalism is the effectiveness and favorable outcomes of the treatment.[37]

Secondly, PHFs are usually found to have wide therapeutic range. Most of them are effective even at a low dose and safe at high dose, thus they have superior risk to benefit ratio. A good example will be the hypoglycemic PHF “Diakyur” used in diabetes. Joshi *et al.* reported that through acute toxicity test, Diakyur at a high dose of 12800 mg/kg p.o. shows no toxic symptoms in the experimental animals up to 72 h; whereas subacute toxicity test reveals that this PHF is safe for long term treatment at the dose of 1600 mg/kg p.o. Their subsequent study also proved that the PHF shows hypoglycemic and antioxidant at the dose of 1600 mg/kg (p.o.).[38] This is in contra with sulfonylureas, the allopathic hypoglycemic drugs such as tolbutamide, glipizide and glicazide which are known to have narrow therapeutic index.[39]

Often, PHFs (confined to those appropriately manufactured and used) result in fewer side effects as compared to allopathic drugs. Although modern allopathic drugs are designed for efficacious therapeutic results, administration of most of them come with unwanted side-effects, such as insomnia, vomiting, fatigue, dry mouth, diarrhea, seizures, impotency, confusion, hair loss, organ toxicities and even death! Patients prescribed with non-steroidal anti-inflammatory drugs for rheumatoid arthritis (RA) treatment may experience mainly gastrointestinal and renal side effects, including dyspepsia, gastric ulceration, salt and fluid retention, as well as hypertension. For this, they may opt for *Ayurvedic* treatment in which these side effects are absent or minimal. Through study, one year *Ayurvedic* treatment using internal herbal medicines was shown to result in a positive effect in RA patients, without evidence of organ toxicities.[40] Besides, Jawla *et al.* reported that in their study, none of the 500 questionnaire respondent found adverse effects of herbal drugs and 48% of them prefer *Ayurvedic* system in the case of common ailments. It seems that the side-effect criterion affects the medication system acceptance by the public.[41,42]

Due to the fact that PHFs are a product of the nature, they are relatively cheaper, eco-friendly and readily available than allopathic drugs. Their better affordability and greater accessibility account for increasing demand globally, especially in rural areas and some developing countries, where costly modern treatments are not available. Moreover, throughout the history, polyherbal remedies have long stand as traditional beliefs, norms and practices in certain tribes, which are based on centuries’ old experience of trials and errors. Put it simply, PHF are more readily acceptable culturally and socially.

All the above reasons: Effectiveness, safety, cheap, ubiquity and better acceptance, made PHF an ideal treatment of choice, hence higher compliance by the patients and excellent therapeutic effect is ensured.

### **Major problems related to PHF usage**

Despite the fact that *Ayurvedic* PHFs are beneficial to mankind in many aspects, they are still challenged by some unavoidable drawbacks, affecting their ability and efficacy in treatments. These problems lie within the PHFs’ sources and manufacturing process, patients, *Ayurvedic* practitioners, as well as the law and regulations.

There is a strong misconception that *Ayurvedic* PHFs are always safe, which is untrue. *Charaka Samhita* itself has described that *Ayurvedic* medicines have adverse effects when prepared or used inappropriately.[43] The concurrent use of PHFs with allopathic drugs is increasing as most of the individual patients do not inform their medical practitioners on the concomitant treatments.[44] However, many have not noted the possible drug-herb interactions, which may affect their pharmacological or toxicological effects, subsequently results in adverse effects that deteriorate health.[45,46] Many *Ayurvedic* herbs commonly used in formulation of PHFs are reported to contribute to drug-herb interactions [Table 3

].[47,48,49]

The clinical reproducibility of *Ayurvedic* PHFs is hard to achieve. *Ayurvedic Pharmacopoeia of India*, also known as “*Ayurvedic* formulary of India,” provides monographs on the preparation of *Ayurvedic* PHF, thus aided in standardizing the preparation of *Ayurvedic* PHFs. Still, this would not suffice to ensure reproducibility of every batch of PHFs. *Charaka samhita* has stressed on the factors to be considered while selecting the starting material of the PHFs, including habitat, season in which it grows, harvesting conditions, method of storage and pharmaceutical processing.[50] However, the constituents of crude raw herb materials may vary as an effect of different geographical locations, climatic conditions, environmental hazards, harvesting methods, collection protocols and etc., thus it is not easy to standardize the end product for a reproducible quality.[51] This batch to batch variation would directly affect the effectiveness and safety of the PHFs. The need to alter the dosage regimen to obtain required therapeutic effect also seems to be tedious.

The toxicity cases of *Ayurvedic* herbal formulations is prevailing but remained unsolved. It is known that presence of heavy metals in pharmaceuticals is not allowed, even in trace amount, to avoid toxicity. In contra, the concept of *Rasa shastra* is being practiced in a huge number of *Ayurvedic* PHFs, in which metals are added for their therapeutic applications, forming *Rasausadhies*.(herbo-bio-mineral metallic preparations) They claimed to have innate qualities such as quick action, lesser dose, tastelessness, prolonged shelf life and better palatability.[20] Drug experts have estimated that approximately 6000 medicines in the “*Ayurvedic* Formulary” which intentionally contain at least one metal, with mercury and lead the most widely used. These toxic elements are known to be potent nephrotoxic, hepatotoxic, neurotoxic and hematotoxic agents.[52] Researches have revealed the metal content in a vast number of *Ayurvedic Rasausadhies* and toxicity cases due to *Ayurvedic* herbal consumptions have been reported throughout the last decade.[53,54,55] Center for Disease Control and Prevention also reported lead poisoning cases in pregnant women associated with the use of *Ayurvedic* medications, which may adversely affect the health of both mother and child.[56] Fortunately, this problem is not found in *Kasthoushadhies*, which are pure herbal preparations free from metals.

Although these toxicity cases are now in alarming level, the attitude of the *Ayurvedic* practitioners towards this problem is nevertheless passive. At the global level, the number of adverse reactions reported or recorded through pharmacovigilance programs is still negligible, primarily due to the false belief that *Ayurvedic* PHFs are always safe. Despite the facts that toxicity cases have occurred, the toxic effect of heavy metals added are still claimed to be removed by *Shodhana*, a process involved in *Rasashastra* to purify and detoxify toxic materials.[20] A survey conducted shows that some *Ayurvedic* physicians in India are reluctant to accept truth on the herbal formulation adverse effect, whereas some blame only the improper manufacturing and irrational prescribing for the problem.[57]

In India, whereas most of the *Ayurvedic* PHFs are manufactured and exported, the regulation of *Ayurvedic* herbal preparation manufacturing is somewhat less stringent, despite the establishment of *Drugs and Cosmetic Act* to control the manufacture and quality control. According to the good clinical practices, toxicity studies and clinical trials on herbal formulations are not mandatory for application of patents and grant of manufacturing licenses to the *Ayurvedic* herbal formulation manufacturer.[58,59] Besides, individual physicians today require no license to prepare medicines and administer them to patients. [58,59,60] Regardless of the efforts put by the Department of *Ayurveda*, *Yoga and Naturopathy*, *Unani*, *Siddha* and *Homeopathy*, India in the issuing of good manufacturing practice guidelines and safety standards based on WHO guidelines, the poor implementation of regulatory controls has also made space for non-compliance of the guidelines. Undetected adulteration, substitution, contamination and short cuts during manufacturing are common, bringing to incidents such as presence of synthetic anti-inflammatory drugs in anti-arthritic *Ayurvedic* medicines, excessive heavy metals contamination, lacking of proper processing and storage of marketed products under undesirable conditions.[61]

## CONCLUSION

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The use of *Ayurvedic* PHFs has stood the test of time. Using the *Ayurvedic* concept of *Panchamahabhutas* and *Tridoshas*, PHFs provide treatment of diseases in a holistic approach. The scientific advancement carries with it the improvement in *Ayurvedic* formulation of PHFs, through the study of various phytoconstituents and discovery of useful herbs combinations which work synergistically to produce desirable effect. Today, the “renaissance” of *Ayurvedic* PHFs has occurred the world over, owing to its comparable efficacy, fewer side effects and better acceptability than allopathic drugs. Most of the time, they produce satisfactory effect and safety, making them one of the highly selected drugs of choice. Nonetheless, public's inadequate knowledge and misconception on the safety of PHFs may result in the opposite effect such as toxicity and undesired interaction. Poor regulatory control and manufacturers' irresponsibility has also affected the quality of the PHFs manufactured, which can be dangerous to the consumers' health. For this, preventive and corrective steps are crucial to reduce the hazardous risks, including the practice of strict regulatory control and public education on the correct use of PHFs. Only with correct and rational use, *Ayurvedic* PHFs can exert the best effect in human health.

## Footnotes

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## Figures and Tables

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**Table 1**

<b>Synthetic drugs</b>	<b>Function</b>	<b>Plants derivation</b>
Aesculetin	Anti-dysentery	<i>Fraxinus rynchophylla</i> (Oleaceae)
Ajmalicine/ δ-yohimbine	Circulatory disorders	<i>Rauwolfia serpentina</i> (Apocynaceae)
Artemisinin	Antimalarial	<i>Artemisia annua</i> (Asteraceae)
Atropine	Anti-cholinergic	<i>Atropa belladonna</i> (Solanaceae)
Digitalis	Cardiac glycoside	<i>Digitalis purpurea</i> (Plantaginaceae)
Ephedrine	Sympathomimetic	<i>Ephedra sinica</i> (Ephedraceae)
Morphine	Analgesic	<i>Papaver somniferum</i> (Papaveraceae)
Noscapine	Antitussive	<i>Papaver somniferum</i> (Papaveraceae)
Picrotoxin	Analeptic	<i>Anamirta cocculus</i> (Menispermaceae)
Reserpine	Anti-hypertensive	<i>Rauwolfia serpentina</i> (Rauvolfoideae)
Quinine	Anti-malarial	<i>Cinchona ledgeriana</i> (Rubiaceae)
Salicylic acid (precursor of aspirin)	NSAID	<i>Filipendula ulmaria</i> (Rosaceae)
Sennosides	Laxative	<i>Cassia angustifolia</i> (Fabaceae)
Vincristine	Anticancer	<i>Cantharthus rosues</i> (Periwinkle)
Xanthotoxin	Leukoderma; vitiligo	<i>Ammi majus</i> (Apiaceae)

NSAID=Non-steroidal anti-inflammatory drug

Synthetic drugs derived from plants

**Table 2**

PHF (company)	Herbals	Pharmacological action
Dihar (Rajsha Pharmaceuticals, Ahmedabad, India) <sup>[29]</sup>	<i>Syzygium cumini</i> <i>Momordica charantia</i> <i>Embelica officinalis</i> <i>Gymnema sylvestre</i> <i>Encicostemma littorale</i> <i>Azadirachta indica</i> <i>Tinospora cordifolia</i> <i>Curcuma longa</i>	Used for the treatment of hyperlipidemia
Diabet (Herbal Galenicals, India) <sup>[30]</sup>	<i>Curcuma longa</i> <i>Coscinium fenestratum</i> <i>Strychnos potatorum</i> <i>Tamarindus indica</i> <i>Tribulus terrestris</i> <i>Phyllanthus reticulatus</i>	Antidiabetic
Arthosansar (Pradhan Herbal Company, India) <sup>[31]</sup>	<i>Comiphora wightii</i> <i>Boswellia serrata</i> <i>Pluchea lanceolata</i> <i>Ricinus communis</i> <i>Zingiber officinale</i> <i>Withani somnifera</i>	Antiarthritic
Kutajarista (Laboratory preparation) <sup>[32]</sup>	<i>Madhuca longifolia</i> <i>Holarrhena antidysenterica</i> <i>Gmelina arborea</i> <i>Woodfordia fruticosa</i> <i>Vitis vinifera</i> Honey Jaggery	Useful in the treatment of sprue, dysentery and diarrhea
Vidakana Choomam <sup>[33]</sup>	<i>Embelia ribes</i> <i>Morigna oleifera</i> <i>Piper longum</i>	Useful for liver disorders especially jaundice and steatosis
Triglize (Apex Laboratories Ltd., India) <sup>[34]</sup>	<i>Terminalia arjuna</i> <i>Cissus quadrangularis</i> <i>Boerhaavia diffusa</i> <i>Commiphora mukul</i> <i>Phyllanthus embilica</i> <i>Terminalia bellirica</i> <i>Terminalia chebula</i> <i>Tribulus terrestris</i> <i>Allium sativum</i> <i>Trigonella foenumgraecum</i>	Used for the treatment of obesity, hypertension, ischemic heart diseases and peripheral vascular diseases
Bharangyadi <sup>[35,36]</sup>	<i>Clerodendrum serratum</i> <i>Hedychium spicatum</i> <i>Inula racemosa</i>	Antiasthmatic

PHF=Polyherbal formulation

Examples of marketed PHFs

**Table 3**

<b>Ayurvedic herbs contained in PHF</b>	<b>Possible drug-herb interaction</b>
Garlic ( <i>Allium sativum</i> ), ginger ( <i>Zingiber officinale</i> ), ginkgo ( <i>Gingko biloba</i> )	Interfere with NSAIDs and warfarin by increasing the risk of bleeding, mainly due to Inhibition of platelet aggregation Limited production of coagulation mediators Antagonism of platelet activating factor
St John's wort ( <i>Hypericum perforatum</i> ) for depression treatment	Induce hepatic microsomal enzyme cytochrome P-450, thus increases the metabolism of certain drugs such as digoxin and theophylline, rendering them less effective
Meadowsweet ( <i>Filipendula ulmaria</i> ) for anti-inflammatory action	Displace highly protein-bound drugs such as warfarin and carbamazepine, thus increasing the adverse effects of these drugs

NSAIDs=Non-steroidal anti-inflammatory drugs, PHF=Polyherbal formulation

Examples of possible drug-herb interaction