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Botanical Drugs in Ayurveda and Traditional Chinese Medicine

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ABSTRACT

Ethnopharmacological relevance: China and India have a long history in the therapeutic application of botanical drugs in traditional medicine. Traditional Chinese Medicine (TCM) and Ayurveda are considered as two of the most ancient systems of medicine, with history of more than two millennia. Medicinal plants are the principal medicinal materials used in both these systems.

Aim of the review: This review discusses about the histories of Ayurveda and TCM, the common medicinal plants species, the drug processing strategies used, and the current statuses of these traditional systems of medicine (TSM). Through the views presented in this article, we aim to provide a new perspective to herbal drug researchers for expanding and improving the utilization of botanical drugs and their therapeutic applications.

Methods: A bibliographic investigation of Chinese and Indian pharmacopoeias, monographs and official websites was performed. Furthermore, information was obtained from scientific databases on ethnobotany and ethno medicines.

Results: The review of Ayurveda and TCM ethno medicine indicates that both these systems have many medicinal materials in common. The studies carried out by the authors for comparison of plants from same genus from both these TSM's have been discussed to further bring focus to the utilization of "qualitatively" similar species which can be utilized and substituted for endangered or economically valued species. The overview of ancient literature and scientific findings for drugs in both these systems suggests that, the botanical drugs used in common and their processing methods can be explored further for extensive utilization in traditional medicine.

Conclusion: This review describes the histories, common medicinal plant species, their processing methods and therapeutic applications in Ayurveda and TCM. The insights provided through this article may be used by herbal drug researchers and pharmacologists for further exploration of botanical drugs from these two traditional systems of medicine.

Keywords:

Traditional Chinese medicine (TCM)

Ayurveda

Ethnomedicine

Chemical compounds studied in this article

Aconitine (PubChem CID: 245005); Mesaconitine (PubChem CID: 441747); Hypaconitine (PubChem CID: 441737); Artemisinin (PubChem CID: 68827); Quinine (PubChem CID: 3034034); Raceanisodamine (PubChem CID: 71711121); Protodioscin (PubChem CID: 441891); Nootkatone (PubChem CID: 1268142); Huperzine A (PubChem CID: 854026)

1. Introduction

Plant based medicines have been used for millennia in different traditional systems of medicine (TSM) for promoting health and well being. Along with the rapid development of research on medicinal plants, the international demand for plant resources has significantly increased due to their increased utilisation (Singh, 2011). The germplasm resources of many plants have been endangered due to the damage and degeneration of the ecological system. The agricultural production and supply of many species has gradually decreased (GBO, 2010). Studies of medicinal plants to identify plant species with similar phytochemical constituents or with similar content of active constituents will help in identifying species which can be “qualitatively” and “quantitatively” substituted. Such studies globally will facilitate the protection and sustainable utilization of medicinal plant resources which have been extensively exploited due to high commercial demand.

WHO describes traditional medicine as “the sum total of the knowledge, skills, and practices based on the theories, beliefs, and experiences indigenous to different cultures, whether explicable or not, used in the maintenance of health as well as in the prevention, diagnosis, improvement or treatment of physical and mental illness” (WHO/EDM/TRM/2000.1). Ayurveda and Traditional Chinese Medicine (TCM) are considered as two of the most ancient systems of medicine, each with histories stretching over several millenia. Ayurveda and TCM have been discussed and compared by many scholars in many reviews (Patwardhan et al., 2005; Kim et al., 2011). They both have long, but different histories in the application of medicinal plants for therapeutic treatments. There are several botanical drugs that are used in common between these two TSM’s for either similar or different therapeutic applications and which are formulated by employing different processing methods.

In the present review, we have made an attempt to put forth information for understanding the systems of medicine of Ayurveda and TCM, their histories and the botanical drugs used in common between these systems. The processing strategies used for the botanical drugs, their therapeutic applications and their current statuses with respect to global prevalence, research and development are also been discussed.

2. Resources of medicinal materials used in China and India

In China, valuable experience has been accumulated from traditional medicine practices in different regions. Medicinal plants and their processed products are widely used in clinical applications under the guidance of TCM theory. The Chinese Pharmacopoeia (2015 edition) records a total of 644 species of medicinal plants. The recently published *Zhong Hua Ben Cao* records 8,980 Chinese medicinal materials including 7,815 herbal substances (The Editorial Committee, 1999). So far, this monograph records the most species of any of its predecessors, and it represents the highest and most up-to-date contemporary compilation on traditional Chinese herbal medicines. Additionally, ethnic and folk medicinal materials also involve many medicinal plants. Ethnic medicinal plants are cultivated and circulated within specific ethnic communities. In addition to the native Han nationality, China has 55 ethnic groups. According to the statistical data available, the medicines used by 44 minority ethnic groups are derived from more than 5500 kinds of medicinal substances including herbs, animal products and mineral-based medicines. About 90% of the medicines are from plant based origins (Jia and Li, 2005). The *Zhongguo Minzhu Yaozhi* (The chronicles of Chinese Nationality Medicines) is the distinguished collection of ethnic medicinal materials and it forms the basis of extensive investigations. The first volume records 120 ethnic medicinal materials involving 425 source species from 39 minority groups; the second volume records 135 ethnic medicinal materials involving 511 source species from 35 minority groups; and the third volume records 115 ethnic medicinal materials involving 161 source species from 34 minority groups (The Editorial Committee, 1990; 2000). The series records abundant medicinal experiences of many minority groups. In the *Zhong Hua Ben Cao*, in addition to thirty volumes on traditional Chinese herbal medicines, four volumes were compiled on ethnic medicines, particularly Tibetan, Mongolian, Uygur, and Dai (The Editorial Committee, 2002; 2004; 2005a; 2005b). The Tibetan, Mongolian, Uygur and Dai ethnic medicines have their own unique theories in application of the medicinal plants for therapeutic effects. These four volumes record a total of 1641 medicinal materials including 1334 herbal substances with distinct therapeutic applications. Folk medicines refer to the medicinal substances passed on by oral instructions, and as they lack systematic theory they are limited to certain regions and are not commercially circulated in the herbal market. According to published statistical data, there are 5,000 folk medicinals used in China (Zhang et al., 1995). As per the national survey on Chinese medicinal materials (1985-1989), China has 11,118 species of medicinal plants

(including 1,208 subspecies, varieties and forms), belonging to 385 families and 2,313 genera (China Medicinal Materials Group, 1995).

Some medicinal plants are used in common between TCM, the folk remedies and therapy systems used by minority ethnic groups present in various provinces of China. However, the medicinal theories for therapeutic use of these common plants are different in each of these systems. The species mentioned in **Table 1** are examples of common drugs used in Tibetan, Mongol, Uygur, Dai ethnic medicines and TCM. The flower buds of *Syzygium aromaticum* (L.) Merr. et Perry (the common kitchen spice, clove); used in Tibetan ethnic medicine for treatment of cardiodynia, gastrosia, anepithymia and dyspnea, are also used in Uygur ethnic medicine for treatment of palsy, arthritis and low libido. Some ethnic herbal medicines are also used in practise of TCM. For example the roots and rhizomes of *Rhodiola crenulata* (Hook. f. et Thoms.) H. Ohba, which are traditionally used by the Zang ethnic group are also mentioned in the 2015 Chinese Pharmacopoeia. In folk remedies, *Rhodiola rosea* is used as a substitute to *Rhodiola crenulata* for Rhodiolae Radix and Rhizoma, and it is used as a blood coagulant and antitussive agent. The aerial parts of *Lamiophlomis rotata* (Benth.) Kudo and the rhizomes of *Acorus calamus* L. used in ethnic herbal medicines are also recorded in the 2015 edition of the Chinese Pharmacopoeia.

India has a rich history of traditional medicines based upon six systems; of these, Ayurveda is the most ancient, and most widely accepted and practiced. The other allied systems of medicine are Unani, Siddha, Homeopathy, Yoga and Naturopathy (Mukherjee, 2001). Ayurveda finds its global prevalence since centuries. After Ayurveda, Siddha, Homeopathy and Unani system of medicine are widely used. Yoga is a discipline which deals with physical, mental and spiritual state of an individual.

In these different Indian traditional systems of medicines, many medicinal materials are used. Sometimes, the same species are used for different therapeutic indications in different traditional medicines. **Table 2** gives several examples of the same medicinal plants used in different traditional medical systems in India. As per the publication of The National Medicinal Plants Board (NMPB), India is stated to have 15 agroclimatic zones. Out of the total 17000-18000 flowering plants species grown in the country, about 7000 species find their usage documented in the folklore medicine of all the five traditional systems of medicines (TSM) of India. The

global natural product trade, reflecting the consumer demands for Indian traditional medicine is about 120 billion USD (Harikrishna, 2010). A reference database named as “Indian medicinal plant database” has been prepared by the NMPB, India. It is an authentic database for medicinal materials used in all the TSM of India and links the usage of each species to different systems of medicine. The first publication based on the database included 7263 plants with their 1,00,000 vernacular names mentioned in nine languages with more than 5000 images of plants (NMPB, 2013; WHO, 2007; Anonymous, 1998). A Traditional Knowledge Digital Library (TKDL) has been designed by the Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH), India, which includes the medicinal plants used in TSM; and it is protected by Intellectual Property Rights (IPR). It includes 25,000 plant-based medicinal formulations accessible in five different languages, viz. English, Spanish, German, Japanese and French for dissemination of the information of Indian traditional medicines (TKDL, Dept of AYUSH, 2011). The TKDL is accepted by the World Intellectual Property Organization (WIPO) and European patent Office (EPO) to promote the quality of traditional medicines (Mukherjee, 2012). The traditional knowledge resource classification (TKRC) which is a part of TKDL helps one to integrate the knowledge of medicinal material popular among vernacular languages but which has lacked recognition and exposure due to language barrier. Such combined efforts by the Government of India, AYUSH and its organisational bodies will improve the standards of Indian TSM and promote its worldwide acceptance. From the above mentioned literature, it is evident that China and India have rich resources of medicinal plants and an extensive collection of information of their medicinal uses.

3. Books and ancient compilations of medicinal materials

The major classics in TCM include, *The Divine Husbandman’s Classic of Materia Medica (ShenNong Ben Cao Jing)*, *Collection of Commentaries on the Classic of the Materia Medica (Ben Cao Jing Ji Zhu)*, *Newly Revised Materia Medica (XinXiu Ben Cao)*, *Materia Medica Arranged According to Pattern (Zheng Lei Ben Cao)*, and *Compendium of Materia Medica (Ben Cao Gang Mu)*. The *Charaka Samhita*, *Sushruta Samhita* and *Ashtanga Hridaya* are the major classic book contributions in Ayurveda including recent publications viz. *Integrative Approaches for Health* and *Ayurvedic medicine* (Patwardhan, et al., 2015; Pole, et al., 2006). Since early history, the Chinese medicine scholars have attempted to document and facilitate the use of

natural medicinal materials. Throughout history, the various *Bencao* texts, the unique name of the Chinese traditional materia medica, have recorded knowledge of Chinese medicinal materials. The history of Chinese medicinal plants forms an important part of *Bencao* texts. *The Divine Husbandman's Classic of Materia Medica (ShenNong Ben Cao Jing)* is thought to be the earliest material medica in China compiled in the late Eastern Han Dynasty (c. 200 AD). In this book, 365 medicinals including 237 herbal substances are recorded. Entries for each substance include definition, compatibilities, properties, harvesting details, processing methods, and medical applications. The geographical regions of growth and the macroscopic features for identification of the listed plants are also described in this book. Through such vital information *Bencao* texts from *Shen Nong Ben Cao Jing*, contribute to the knowledge of Chinese medicinal materials. Some prominent representative *Bencao* texts include, *Collection of Commentaries on the Classic of the Materia Medica (Ben Cao Jing Ji Zhu)*, *Newly Revised Materia Medica (XinXiu Ben Cao)*, *Materia Medica Arranged According to Pattern (Zheng Lei Ben Cao)* and *Compendium of Materia Medica (Ben Cao Gang Mu)* (The Association of Chinese Culture Research, 1999). Among these books, the *Compendium of Materia Medica* records 1,095 herbal substances which are classified into five categories: herbs, crops, vegetables, fruits, and trees, according to their properties, morphological characteristics, and growth environments. Ayurveda is believed to have a divine origin wherein the knowledge of healing was transferred from the Hindu deity Lord *Brahma* to *Dakshas*, and then further to *Ashwini* twins and to Lord *Indra*. *Atreya* was bestowed by this knowledge from Lord *Indra* and the information is believed to be eventually recorded in the *Rig veda* and *Atharvaveda* (Dev, 1999). Thus, Ayurveda is believed to have its lineage from the spiritual and divine power of healing and is rightly called as the "Science of life and longevity". Through centuries, the observations and experiences of scholars and practitioners were recorded in several texts. Tracing back the original scriptures and writings about this great system is difficult; however there are several translations and writings documented by scholars based on the ancient knowledge (Singh et al, 2012). These were translated into various languages including Greek (300 BC), Persian and Arabic (700 AD), Chinese (300 AD) and Tibetan in ancient times, representing the considerable interest and subsequent influence and acceptance in neighbouring cultures (Mukherjee, 2001). Today Ayurveda, Siddha, Naturopathy, Yoga, Unani and Homeopathy are the officially recognized traditional medical systems of India, and various research committees, funding bodies and

organizations are working towards their continued advancement (Anonymus,1977; Anonymus,1979; Anonymus, 1987; Vaidya and Devasagayam, 2007; Ravishankar and Shukla, 2007; and Ko, et al., 2014).

Apart from the classic compilations that detail the use of medicinal material in Ayurveda, there are some allied publications that appeared between the seventh and sixteenth century. Madhavakara wrote the *Madhava Nidana* in 800-900 A.D., which focuses upon the diagnosis of the diseases based upon the etiologies, especially in the branches of pediatrics and toxicology. *Bhava Prakasha* written by *Bhava Mishra* in 1500 B.C. describes about 470 medicinal herbs, written in the form of 10,278 verses. It describes the medicinal applications of trace metals, food products and rejuvenation therapies. The *Sarangadhar Samhita*, written in 1300 B.C. by Sharnagadhara, describes the basis of Ayurvedic Materia Medica, and its medicinal formulations. It describes the diagnostic therapies by study of pulse. More than 70 Nighantu Granthas that describe pharmacy practice for Ayurvedic herbs have been recorded. The two famous Nighantu granthas are the *Raj Nighantu* written by Narhari Pandita and *Madanpala Nighantu* written by Madanpala (Mukherjee, 2006; Mukherjee, 1969). The Ayurvedic Pharmacopoeia of India (API) is published in two parts. Part I comprises of seven volumes and part II comprises of three volumes. In volume I, II, III, IV, V and VI published between the years 1990 and 2008, there were 80, 78, 100, 68, 93 and 101 individual drugs published, respectively. In the years 2008, there were 21 mineral and metal-containing drug monographs published in volume VII. In 2011, there were 60 monographs published for 15 single plants and their extracts. Part II of API comprises three volumes published in 2007, 2008 and 2010. Volume I contains 50 formulations and Volume II and III contain 51 formulations each. The supplementary books for the Ayurvedic Pharmacopoeia include *The Macroscopic and Microscopic Atlas of Pharmacopoeial Drugs* (API Part I, Vol. V) and *Thin Layer Chromatography Atlas of Pharmacopoeial Drugs* (API Part I, Vol. I). E-books of both the parts and all volumes of Ayurvedic Pharmacopoeia have been prepared with a user- friendly interface for benefit of readers worldwide. Thus, comparison of the databases of medicinal materials would be an important and informative aspect to probe the commonalities and differences between the rich medicinal folklore of these systems.

The ancient books which record the medicinal materials used in China and India in different historical periods are listed in **Table 3**. From the above description of histories, it is evident that the medicinal materials used in both TCM and Ayurveda had a long history of their applications.

The therapeutic applications of these medicinal materials were based on the knowledge and experiences accumulated by the scholars, for their use in treatment of human health conditions.

4. Similarities and differences of medicinal materials related to sources and usages

The two TSMS, Ayurveda and TCM share several plant species in common used for therapeutic treatments and they share a common objective of enhancing the well being of individuals through use of natural medicinal materials with a holistic approach. These systems share similar philosophical approach in treatment of diseased conditions considering the human body constituents and elements of universe. Human body is considered as the core and the universe's five elements (water, metal, earth, wood and fire) function with a balance of yin and yang around it. The bodily humors and organs play a vital role in maintaining the homeostatic balance between yin and yang. Ayurvedic therapy is based on the concept of universe been composed of five elements (pancha mahabhutas- the ether, air, fire, water and earth). The human body is believed to be composed of three forces (tridoshas) the vatta, pitta and kapha which are governed by two elements each of the pancha mahabhutas. The tridoshas maintain a physiological balance and govern various processes occurring in the human body (Patwardhan, et al., 2005; Kim et al., 2011). Chinese traditional medicinal materials are mainly of botanical origin. In the Chinese Pharmacopeia (2015 edition), 89.3% of medicinal materials are of botanical origin (Chinese Pharmacopoeia Commission, 2015). Similarly, ayurvedic materials are mostly of botanical origin. Under the auspices of Government of India, Ministry of Health and Family Welfare, The Ayurvedic Pharmacopoeia Committee (APC) of AYUSH has published monographs of 534 single drugs, 21 minerals and metal containing Ayurvedic substances and 152 classical compound formulations in three volumes of Part II of Ayurvedic Pharmacopoeia of India (part II).

In the Ayurvedic pharmacopoeia of India, 540 species of medicinal materials are recorded, of which 364 species can be found in China. About 253 common species are recorded in both the Chinese and Indian pharmacopoeias as per our literature survey of the Pharmacopoeial volumes and published papers regarding common species in Ayurveda and TCM (Jia et al., 2011a; 2011b; 2012a; 2012b). Although the same or closely related plant species are used in China and India, the part(s) used for medicine or their medicinal efficacies are occasionally different. In **Table 4**, the medicinal plants from the same species or genus with different medicinal parts or efficacies

recorded in Chinese Pharmacopoeia and Ayurvedic Pharmacopoeia of India are listed. Studies promoting the detailed comparative investigation of these aspects would help the researchers and traditional medical practitioners to gain deeper insights into the ancient medical texts and their underlying principles. This can be of particular importance where some plants with same therapeutic activity, belonging to same genus but different species can be used as substitutes for each other. For example, *Aconitum* species found in India and China have same therapeutic uses but belong to different species of the same genus. The *Aconitum carmichaeli* Debx. species is widely cultivated in China but the species of *A. heterophyllum* found in India has been declared as endangered species (**Fig. 1 A-C**). In such cases, the species used in China can be used as substitute for the species endangered in India (Shah, 2005; Anonymous, 1977; Anonymous, 1987; Chinese Pharmacopoeia Commission, 2015). This is one example, of how information about the medicinal flora from different traditional systems can benefit each of the systems.

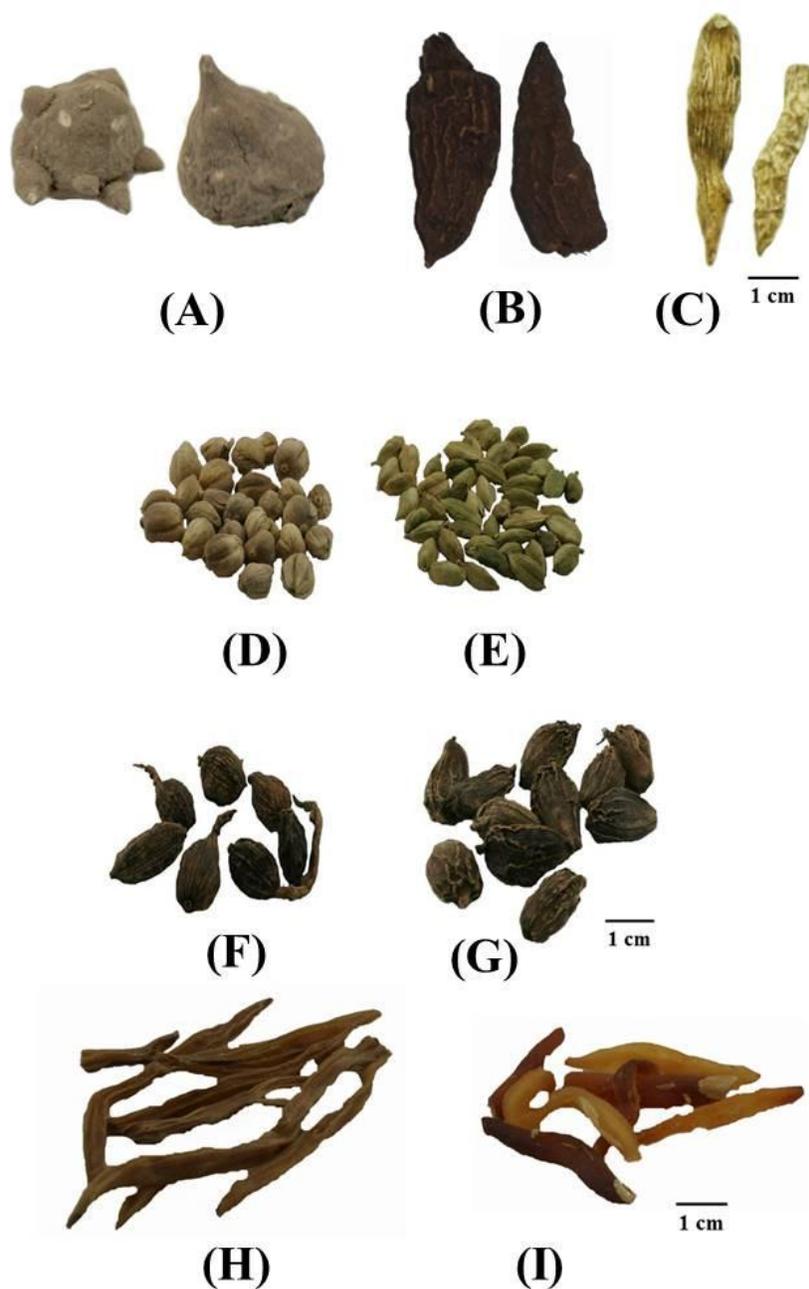


Fig. 1. Various plant species used in Ayurveda and TCM (A) Roots of *Aconitum carmichaeli* Debx. (B) Roots of *A. kusnezoffii* and (C) Roots of *A. heterophyllum*. (D) *Amomum kravanh* Pierre ex Gagnep. (Commonly known as “Baidoukou” in China) (E) *Elettaria cardamomum* (commonly known as green cardamom in India) (F) *Amomum tsaoko* Crevost et Lemaire. (Commonly known as “Caoguo” in China) (G) *Amomum subulatum* Roxb. (Commonly known as black cardamom in India), (H) root tubers of *Asparagus racemosus* and (I) *Asparagus cochinchinensis*.

TCM and Ayurveda, that have different diagnostic principles, different herbs are used for the same purposes (Pole, 2006). For example, in TCM, the fruits of *Amomum kravanh* Pierre ex Gagnep. (*Baidoukou* in Chinese) and *Amomum tsaoko* Crevost et Lemaire. (*Caoguo* in Chinese) are used to enhance the digestive functions of the gastro intestinal tract. In Ayurveda, spices like the fruits of *Elettaria cardamomum* (L.) Maton (Green cardamom in India), and *Amomum subulatum* Roxb. (Black cardamom in India) are used to improve digestion (Menghua et al., 2012; Bhat et al., 2012) (**Fig. 1D and 1E**). There are also several species commonly used in TCM and Ayurveda, but for different therapeutic effects. For example, the rhizome of *Curcuma longa* L., named as *Jianghuang* in Chinese, can break up blood stasis, promote the flow of *qi*, stimulate menstruation, and relieve pain as per TCM. In Ayurveda, the whole plant of *Curcuma longa* L. (commonly known as *Haldi*, and *Haridra* in Sanskrit) is valued as a very useful herb. Its rhizomes are used for treating many conditions including respiratory diseases, rheumatism, inflammation, and menstrual problems, cold, cough and skin allergies (Araujo and Leon, 2001). The leaves of *Haridra* are used traditionally to improve digestion, reduce gas and bloating and as a flavouring agent for culinary purposes. The leaves have also been reported to have antimicrobial properties (Arutselvi, et al., 2012).

Also, the roots of various species of *Asparagus* are used in both TCM and Ayurveda for different treatments. Ayurveda utilises the *Asparagus racemosus* Willd. species while TCM uses *Asparagus cochinchinensis* (Lour.) Merr. (**Fig. 1H and 1E**). TCM prescribes *Asparagi Radix* to remove excess heat and improve *yin* and Ayurveda considers it to have cooling properties as it is prescribed for excess pitta dosha (to remove heat) and deficient kapha (to increase moisture, which cools). These two *Asparagus* species are from the same genus, and are considered to have similar properties. While the theoretical basis of their uses is similar, they are used in treating different diseases in both, Ayurveda and TCM. TCM describes the use of *Asparagus* species in treating cough, renal disorders, ulcers and benign breast carcinomas, whereas in Ayurveda, *Asparagus* is used as an aphrodisiac, diuretic, lactogenic and revitalizer for *Vata* dosha. The common use of it, between these two systems is its use in gastric ulcer treatment (Sharma et al., 2011; Shashi et al., 2013).

In Ayurveda, *Chlorophytum borivillianum* (Fam. Liliaceae) and *Curculigo orchioides* Gaertn. (Fam. Hypoxidaceae) have been used as aphrodisiac drugs and as herbal sex tonics (Jadhav and

Bhutani, 2005; Rath, 2013; Thakur, et al., 2009). *Curculigo orchioides* has also been suggested to have cooling properties. In TCM, the rhizomes of *Curculigo orchioides* are reported to reinforce *yang*, release cold and have aphrodisiac properties (Thakur, et al., 2009; Yang, 2003). Thus, literature reveals the common use of *Curculigo orchioides* as an aphrodisiac traditional medicine in both TCM and Ayurveda.

5. Experimental evidences to explore common plant species in Ayurveda and TCM

The authors have carried out tissue-specific metabolite analysis based comparative studies of plant species found in common between Ayurveda and TCM. Metabolite profiles of laser-dissected specific tissues of *Aconitum heterophyllum*, *A. carmichaelii* and *A. kusnezoffii* were studied (Jaiswal et al., 2014a). The presence of the “high acute toxic” class of Diester Diterpene Alkaloids (DDA) was ascertained through quadrupole time-of-flight mass spectrometry (UHPLC–QTOF MS) based analysis. The results from the study indicate that the toxic alkaloids; aconitine, mesaconitine and hyaconitine were exclusively present in the *A. carmichaelii* and *A. kusnezoffii* which are used extensively in TCM. Whereas, *A. heterophyllum* which is one of the *Aconitum* species used in Ayurveda did not exhibit the presence of the target toxic alkaloids. The metabolite profiles of tissues reveal that the selected three toxic alkaloids are found only in *A. carmichaelii* and *A. kusnezoffii*. The most toxic alkaloid constituents were found in the lateral projections of *A. carmichaelii* and specifically in the metaderm, the cork and vascular bundles. This study suggests that *A. heterophyllum* can be used as a less toxic substitute to *A. carmichaelii* and *A. kusnezoffii* used in TCM.

The protodioscin contents were estimated and metabolite profiles were compared in *Asparagus racemosus* Willd. and *Asparagus cochinchinensis* (Lour.) Merr. used in Ayurveda and TCM respectively. It was found that the content of protodioscin, which is a bioactive furostanol saponin, was higher in *A. cochinchinensis* (Lour.) Merr. than *Asparagus racemosus* Willd. Also in the tissue specific metabolite profiling we found that velamen tissue had higher abundance of saponin constituents compared to the other tissues like cortex, vascular bundles and pith investigated in our study (Jaiswal et al., 2014b). *Asparagus* is a commercially and therapeutically valued drug for TSM's. The drug has been extensively exploited by herbal drug industries and food supplement manufacturers, leading to its inclusion into the endangered category. Our study suggests that these two species can be “qualitatively” substituted for each other in therapeutic

treatments in Ayurveda and TCM and herbal drug manufacturers can have alternate sources of bioresources for raw drug material.

In an earlier study performed by the authors, the species of *Cyperus* (nut grass) common between Ayurveda and TCM were compared (Jaiswal et al., 2014c). *Cyperus rotundus* rhizomes are a good source of a sesquiterpenoid compounds like (+) nootkatone. The content of (+) nootkatone was found to be higher in samples collected from India, than the samples collected from China. The whole drug and the amphivasal type vascular bundles, cortex, hypodermal fibre bundles and endodermis were studied for their metabolite profiles. No significant differences were found in the secondary metabolite profile which suggests the validity of the use of samples from both these countries as representative substitute for each other. In a recent study, the authors have studied *Curcuma longa* rhizomes from India and China for differences in their secondary metabolite profiles (Jaiswal et al., 2014d). The rhizomes belong to the same species. However, considerable differences were found in the morphological characteristics. The contents of active constituents and microscopic features were found to be similar although there was a difference in macroscopic features. Thus, from the results we infer that the *Curcuma longa* samples found in both these countries can be qualitatively substituted for each other.

The implications of these comparative studies suggest that the plant species used in common between Ayurveda and TCM have similar phytoconstituents. These common species are sometimes used for similar or dissimilar therapeutic treatments. If the contents of bioactive constituents are known, these plant species can be used alternatively in both the TSM's as the therapeutic activity depends on the type of phytoconstituents present.

6. Processing methods

Some plants, animal-based products and minerals in their natural form are not suitable to be used directly as drugs and should be subjected to processes like pretreatment, detoxification and formulation, as necessary prior to administration. The processing methods include cleaning, cutting, stir-frying, charring, steaming, boiling, calcining, etc. In TCM, the aims of processing are to enhance the efficacy and/or reduce the toxicity and to change the actions or properties of crude drugs. After processing, the chemical constituents of crude drugs may change dramatically (Zhao et al., 2010).

The branch of study that deals with formulation and processing of Ayurvedic drugs is called as “*Bhaisyajja Kalpana*”. *Bhaisyajja* means a drug and *Kalpana* means forms, thus it is knowledge of dosage forms of drugs. In Ayurveda, the essential attributes required for a product to be used as a drug are its safety, palatability for better patient acceptance, efficacy in stipulated time periods, and stability. For substances with toxic nature, a special detoxification/purification process is employed. The five classic forms of preparations are the juices (*Swarasa*) of medicinal material, cold infusions (*Sheeta*), pastes (*Kalka*), decoctions (*Kwaatah*), and hot water decoctions (*Faanta*). Ayurveda employs use of solvents like water, cow milk, oils, clarified butter (*ghee*) etc. in various formulations, and the type of solvent used affects the shelf life of the formulation.

In TCM, detoxification is one of the aims of processing herbal material, before administration to patients. Ayurveda also employs a detoxification process for processing of drugs before formulation into a dosage form. The *Shodhana*, i.e., the detoxification strategy in Ayurveda can be classified into ten types. We have described each one of them briefly. *Nirvapana*, is a *Shodhana* treatment where the mineral, metal or gem is heated until red hot and dipped immediately into a solvent like buttermilk, oil or cow urine and this facilitates disintegration of the heated material into fine particles. *Dhalana* treatment involves melting of metals like zinc, lead, sulphur or tin by application of heat and immediately subjecting to cold by dipping into a solvent like clarified butter (*ghee*) or milk. *Urdhvatapana* involves the sublimation and distillation of the material with the help of an earthen pot-like apparatus and further mixing the substance with an acidic solvent (e.g., citrus juice). *Bharjana* involves frying of a substance (e.g., alum) in *ghee* in order to make the substance crystalline and free from moisture. *Bhavana* involves trituration of a mineral substance with lemon and ginger juice to facilitate transfer of organic substances to the minerals. *Virecana* procedure involves simple mechanical methods like sifting for removal of adulterants in substances like cumin seeds etc. *Shoshana* involves shade-drying of seeds. *Sthapana* is a procedure of soaking a drug (e.g., nutmeg) in a solvent like cow urine, and then discarding the outer shell which is supposed to contain the toxic materials. *Svedana* involves steaming of a drug with cow’s milk or boiling it in an acidic solvent like lemon juice (Belge and Belge, 2012; Sharma, 2005). Distinctly, the processing methods of Ayurvedic medicinal materials also include frying, soaking and steaming, which is similar to the TCM processing methods. An example of a medicinal material (*Phyllanthus emblica*, commonly

known as Amla in India) used with different processing methods in different systems of Indian medicine is indicated in **Table 5** (Srivasuki, 2012; Anonymous, 2007; Sherwani et al., 2012).

Although detoxification is one of the common aims of Ayurvedic and TCM processing of medicinal materials, the processing methods are different. For example, for Aconite roots, a brief overview of different processing methods used in TCM and Ayurveda is presented in **Table 6**. Aconite roots from *Aconitum carmichaelii* Debx., *A. kusnezoffii* Reichb. (used in TCM) and *A. heterophyllum* Wall (used in Ayurveda), are very famous drugs used in different parts of the globe. The genus *Aconitum* is well-known for its significant beneficial effects and its fatal toxicities. The crucial factor that is responsible for such drastic differences in its activity is the method of processing. We have compared the processing methods of Aconite used in both TCM and Ayurveda (Sarkar et al., 2012). In one of the previous studies of the authors, the processing methods of aconite roots as per Ayurveda and TCM were compared (Jaiswal et al., 2013). It was found that the aqueous decoction procedure used in TCM and cow milk decoctions used in Ayurveda were the most effective detoxification strategies followed by efficacy of cow urine, for Aconite decoction. Our results are consistent with the observation from the studies carried out by Tong et al (Tong et al., 2013). It is observed that pH and heat affect the conversion of diester diterpenoid alkaloids to monoester diterpenoid compounds, thereby leading to the detoxification effect. There is a marked reduction in the content of aconitine, mesaconitine and hypaconitine in the roots, and these toxic compounds are effectively extracted into water and cow milk used as solvents for extraction. Thus, one can appreciate the age-old alchemies known to the traditional medicine practitioners in the years when advanced techniques for evaluation of such strategies did not prevail. Thus, by scientific validation of the ancient alchemies one can obtain a deeper understanding of the concept of detoxification of drugs used in TSM's (Zhao, 2010).

7. Current status

Worldwide, pharmaceutical research is increasingly focusing on the traditional medicinal materials of TCM and Ayurveda as these are two of the oldest and comprehensive medical systems known. In the past twenty years, modernization of these systems has made huge leaps, partly due to the increasing worldwide interest in their uses and properties, and partly due to the advances in related technological fields.

7.1 Medicinal materials of TCM

The Chinese Government attaches great importance to the modernization of Chinese medicinal materials. In 2002, “The Development Outline of the Modernization of Chinese Medicinal (2002-2010)” was proclaimed by Chinese government. In this outline, four strategic goals were proposed: constructing national innovation system, developing and perfecting the standards and practices, developing TCM new products with definite effects and forming modern industry with competitive advantages in the market.

The book, *Chemical Components of Source Plants in Traditional Chinese Medicine* published in 2009, states that 23,033 chemical components isolated from 6700 medicinal plants, collected from 5507 papers were published before 2005 in both Chinese and international journals (Zhou et al., 2009). It introduces and integrates a great number of recent worldwide research achievements on isolating and identifying the chemical components of medicinal plants. For example, from the root of *Panax ginseng* C.A. Mey, twenty-five triterpenoid saponins have been isolated (Qi et al., 2011). Also, the root of *Panax ginseng* C.A. Mey, is said to powerfully tonify vital *qi* (vital energy), restore the pulse, improve debility conditions, invigorate the spleen, benefit the lung, promote the production of body fluid, and calm the mind. Researchers have explored Ginseng’s therapeutic effects including central nervous system effects, anti-aging properties, adaptogenic effects, immunomodulatory and anti-tumor activity, and effects on metabolism and the circulation system (Zhao and Xiao, 2009; Yang and Li, 2003; Liu et al., 2000; Wong et al., 2010). In the book *Chemical Components of Source Plants in Traditional Chinese Medicine*, the pharmacological data for 7819 chemical components, which represents about 34% of total phytochemical components, is reported.

New drugs like Qinghaosu (artemisinin), from *Artemisia annua* L. with anti-malarial properties have been developed. The discovery of artemisinin and its derivatives is a second milestone in the history of antimalarial drug research after quinine (Wu, 2009). Many other new drugs like puerarin from *Puerarialobata* (Willd.) Ohwi (vasodilator), racanisodamine from *Scopoliatangutica* Maxim. (anticholinergic) and huperzine A from *Huperziaserrate* (cholinesterase inhibitor) have been developed from Chinese medicinal materials (Chinese Pharmacopoeia Commission, 2010). For example, Beidougen Pian (a tablet prepared from

extract of the rhizome of *Menispermum dauricum* DC), is used for the treatment of sore throat, tonsillitis and chronic bronchitis. Additionally, new proprietary TCM products, which are dosage forms processed from crude medicinal materials, have also been developed from medicinal plants. Shuanghuanglian Koufuye, an extract of the flower bud of *Lonicera japonica* Thunb., the root of *Scutellaria baicalensis* Georgi and the ripe fruit of *Forsythia suspensa* (Thunb.) Vahl are used for the treatment of cold induced by exogenous wind-heat. In China, the China Food and Drug Administration (CFDA) is responsible for the regulation of Chinese medicinal materials. The Certification Committee for Drugs enforces the Good Laboratory Practice for Non-clinical Laboratory Studies (GLP), Good Clinical Practice (GCP), Good Manufacturing Practice for Pharmaceutical Products (GMP), Good Agricultural and collection Practice (GACP), Good Supply Practice for Pharmaceutical Products (GSP) and Good Pharmacy Practice (GPP) for TCM materials. The Center for Drug Reevaluation is responsible for the affairs of national essential drugs, over the counter drugs, clinical evaluation of drugs and adverse drug reaction monitoring. Under CFDA, National Committee on the Assessment of the Protected Traditional Chinese Medicinal Products (NPTMP) was established for carrying out professional and technical review and advisory service on the Protected Traditional Chinese Medicinal Products. The Certification of licensed Chinese pharmacist and The Pharmacopoeia Commission is also carried out by CFDA.

7.2 Scenario for drugs in Indian systems of medicine

In India, over 4,000 terrestrial plants have been studied for their biological activities, and 20% have been found to have promising pharmacological activities (Singh, 2011). With an ancient lineage and rational approach, Ayurveda has continued to grow, and today is accepted as one of the official systems of medicine in India. The growth of Ayurveda is supported by the the Indian government through establishment of Institutes, Councils, and Research and Development centres. With the growing international demand for herbal drugs, it has become necessary for the regulatory authorities of Traditional and Complementary medicine to take resilient steps towards improvisation of the research, clinical practise, education and compendial standards of botanical drugs. The regulatory conditions for natural products and medicines are described in the Drugs and Cosmetic (D &C) Act, 1940 and the Drug and Cosmetic Rules, 1945. In the year 1964, the Ayurveda, Siddha and Unani (ASU) drugs received their inclusion in the Drugs and Cosmetics

Act. In 1982, through publication of a schedule, authorized acknowledgement for the compendial publications and Patent and Proprietary (P&P) medicines of ASU was provided. The Ayurveda, Siddha and Unani Drugs Technical Advisory Board (ASUDTAB) was founded in 1983, and its functions deal with providing guidelines to the licensing authorities of State and Central government for regulating the sale and manufacturing of ASU and P&P products. Various amendments to several rules for manufacturing and quality control of natural products have been incorporated in the D&C Act and published by AYUSH in the Gazette of India. In 2010, some new categories of ASU were included in the amendments made to D&C Act. Herbal extracts, toiletry preparations, cosmetics and health enhancing products were classified separately in this inclusion. An autonomous authoritative body named “National Medicinal Plants board - NMPB” has been formed by the Ministry of Health and Family Welfare, India. The functions of NMPB comprise of implementing policies for regulating cultivation, import and export, research, intellectual property rights, marketing and conservation of medicinally important plants. Apart from the national level authority, 27 state level medicinal plant boards have been recognized. The Department of AYUSH has worked upon its objectives of strengthening Ayurveda’s existence by improvising pharmacopeial standards, promoting agricultural and conservation aspects, and strengthening educational and research standards of Ayurvedic drugs (Chandra, 2011). The accomplishments of the Department of AYUSH are very well evident from the infrastructural growth in the clinical, educational and research institute numbers (as indicated in **Table S1 of supplementary file**). The study of traditional medicinal systems is incorporated into the curriculum of graduate level medical education. In November 2003, the Department of Indian Systems of Medicine and Homoeopathy (ISM and H) was renamed as Department of Ayurveda, Yoga and Naturopathy, Unani, Siddha and Homoeopathy (AYUSH) encouraging the inclusion of other traditional systems of medicines along with Ayurveda and Homeopathy. Apart from the commercial aspects, AYUSH strives to provide international co-operation for systems by establishing several research schemes, scholarships, exchange programmes and institutes to facilitate study of these systems by foreign students. The central councils under AYUSH for each of the systems are Central Council for Research in Ayurveda and Siddha (CCRAS), Central Council for Research in Unani Medicine (CCRUM), Central Council for Research in Homoeopathy (CCRH), Central Council for Research in Yoga and Naturopathy (CCRYN) ([http: www.indianmedicine.nic.in](http://www.indianmedicine.nic.in)). The research institutes

and councils promote drug discovery process from botanicals through preclinical and controlled clinical trials thus enhancing evidence based research for substantiation of traditional claims. The GLP, GMP and other statutory guidelines are followed by the research centres and manufacturing units in order to meet the global standards and enhance commercial and clinical acceptability of Ayurvedic products (WHO guidelines,1998; WHO, 2011; CDER Guidelines, 2000; EMEA, 2001).

TCM has already gained a considerable share of the global herbal drug market. In order to increase the share of global market for ASU and Homeopathy products, the regulatory bodies in India require strict enforcement of the rules and regulations laid down for manufacturing, quality control and clinical trials of traditional herbal medicines. This would further improve the standards of Indian herbal products and result into an increased global market. With the recent ammendments in the Schedules of D and C Act, and the measures taken for their enforcement by the regulatory bodies working along with AYUSH, the Indian system of medicine will certainly gain a remarkable position in the global herbal market.

8. Conclusion

In the present review, the histories of Ayurveda and TCM, and the common plants species used in their practise have been discussed. The perspective of recognizing common plant species between these two TSMs, the commonalities and differences in their processing methods and their therapeutic applications can help herbal drug researchers and traditional medicine practioners to explore further avenues in plant based medicines. This information can help in designing strategies for identification and utilization of “qualitative” and “quantitative” substitutes to botanical drugs which are in high demand in herbal drug market due to their therapeutic benefits, but are on the verge of extinction due to exploitation of their natural habitats. In a broader viewpoint, insights gained from such a study of literature can serve in expanding and improving the utilization of important medicinal plants from Ayurveda and TCM.

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Table 1. The same species used in Tibetan, Mongol, Uygur and Dai ethnic medicines

(EM)

Botanical name	Medicinal part/s	Application			
		Tibetan EM	Mongol EM	Uygur EM	Dai EM
<i>Acacia catechu</i>	Water extract	Leprosies, eczema, canker sore,	Dermatologic disease, external	Worm of intestinal tract, diarrhea,	Itching of skin,

(L.) Willd.*	of trunk	hemorrhoids, bleeding wound	injury	periodontitis, leprosis, choloplania, syphilis	exanthema maculosum , eczema, abdominal pain, diarrhea, bleeding wound, lung tuberculosis
<i>Aucklandia lappa</i> Decne. *	Root	Gastric distention, diphtheria, pneumonopathy	Lung abscess, expectoration, breathlessness, gastropathy, vomiting	Gastralgia, ischiodynia, liver pain, hysteralgia, low libido	Gas pains in abdomen, constipation, headache, dizziness, anorexia, injury from fall
<i>Cassia fistula</i> L.	Fruit	Hepatopathy, poisoning induced by tree	hepatopathy, dropsy, swelling of arthrosis, dyspepsia	Swelling of throat, arthritis	Constipation, urinary lithiasis, swelling of throat, canker sore
<i>Cyperus rotundus</i> L. *	Tuber	Laryngitis, tracheitis, pneumonopathy	Cough, swelling of throat, dysentery induced by heat	Gastrelcoma, nerves weak, concrement	Menstrual disorder, menalgia, headache, dizzy, sore and sarcoptidosis
<i>Luffacyl indrica</i> (L.) Roem. *	Stem, leaf and flower (Dai EM), seed (Tibetan , Mongol EM) fibro- vascular bundle	Desintoxication, emetic	Desintoxication, emetic	Constipation, amenorrhea, dropsy, choloplania, rheumathritis, syphilis, leprosis	Choloplania , scald, sore and sarcoptidosis, bleeding wound, whooping cough

<i>Nigella glandulifera</i> Freyn et Sint*	(Uyгур EM) Seed	Hepatomegalia, gastropathy	Dyspepsia, hepatalgia, deterioration of liver function	Alopecie, leukotrichia, leucoderma, itch of skin, headache, facial palsy, concrement	Concrement, heatstroke, stomachache, hemafecia
<i>Phyllanthus emblica</i> L. *	Leaf, root, fruit and stem bark (Dai EM), fruit (Tibetan, Mongol, Uyгур EM)	Hepatopathy, cholic disease, dyspepsia, ophthalmocace	Heat in blood, liver and gall, kidney and bladder; frequent micturition	General debility, weak vision, alopecie, leukotrichia, hydrodipsia induced by diarrhea	Swelling of throat, cough, canker sore, diarrhea, itch of skin
<i>Piper longum</i> L. *	Unripe ear	Gastric cold, impotentia	Dyspepsia, nausea, tracheitis, tuberculosis	Gastropathy, abdominal distention, abdominal pain, low libido, menstrual disorder, cough and excessive phlegm, arthralgia	cardiopalmus, aching pain of arthrosis, menstrual disorder
<i>Rubia cordifolia</i> L. *	Root and rhizome	Haematemesis, hemafecia, non-traumatic hemorrhage, non-traumatic hemorrhage, menoxenia, blood clot, injury from fall	Heat in blood, haematemesis, hemorrhinia, haemorrhagiauterina, measles	Puffiness, amenorrhea, abdominal dropsy induced by hepatic cirrhosis, ringworm, injury from fall	Dropsy, menorrhagia, impotency
<i>Syzygium aromaticum</i> (L.) Merr. et Perry (Syn. <i>Eugenia caryophyllata</i> Thunb.)*	Flower bud	Cardiodynia, gastrosia, anepithymia, dyspnea	Vesania, exanthema variolosum, swelling of throat	Gastrosia, dyspepsia, arthritis, low libido	Chest pain, abdominal distention, vomiting
<i>Zingiber</i>	Rhizom	Nemofrigid cold,	Dyspepsia, lung	Impotency,	Impotency,

<i>officinale</i> Rosc. *	e	cold-phlegm and cough, gastric cold	abscess, impotency	anemofrigid cold, impotency	pain in gastric cavity, vomiting, menorrhagia, aching pain of arthrosis
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*Recorded by Chinese Pharmacopoeia (2010 edition) and also used in TCM.

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Table 2. Plants used in common among Ayurveda and other allied traditional systems of medicine in India

Traditional medicinal system (TMS)	Plant used	Traditional uses of plants in various systems of Indian traditional medicine				References
		Ayurveda	Unani	Siddha	Homeopathy	
Plant part used	<i>Phyllanthus emblica</i> (syn. <i>Embllica officinalis</i>) (Fam. Phyllanthaceae)	Fruits	Fruits	Fruits	Fruit	Baliga et al. (2012), Adil et al. (2010), Achliya et al. (2004),
Therapeutic effects		Hepatoprotective, memory enhancing, anti-inflammatory, anti-viral, stomachic, anti-caries, diuretic, laxative, restorative, anti-pyretic, anti-inflammatory, hair tonic; appetizer, for improving vision	Vitaliser, tonic for heart and brain, anti-dysentric, anti-diarroheal	Antioxidant, anti-arthritis, anti-diabetic, cardioprotective, skin diseases	In treatment of gastric ailments, anthelmintic, for improvement of vision, and treating tonsillitis	Vasudevan et al. (2007), Krishnamurthy et al. (2007), Manjunath and Telles (2005), Rehaily et al. (2002), Rajendran et al. (2007), Baliga et al. (2013), Thas (2008), Singh et al. 2011), Kumar et al. (2012)
Method of administration		Oral administration and external application	Oral administration	Oral administration	Oral administration	
Dosage forms/preparations		Powder formulations like churna, dried and fresh fruits taken orally, Ghrita, oils, pastes, eye drops	Tonic	Kalpaamrutha is a preparation of several herbs along with honey	Used as infusion or powder along with other drugs in combination with Epsom salt	
Plant part used	<i>Terminalia chebula</i> Retz. (Fam. Combretaceae)	Fruits	Fruits	Fruits	Extract of dried ripe fruit	Ponnusankar et al. (2011), Anwesa et al. (2013),
Therapeutic effects		asthma, sore throat, vomiting, diarrhoea, dysentery,	Laxative, in treatment of various abdominal	Dermatological ailments, anti-diabetic effect	Anti-caries agent	Shailajan(2011), Ajazuddin and Saraf (2010),

		bleeding piles, ulcers, gout, heart and bladder diseases	disorders, anti-carries agent			Jagtap and Karkera (1999), Mutheeswaran et al. (2011)
Method of administration		Oral route of administration of the powder with ghee (clarified butter) or honey	Used as a powder with other herbs in the form of a powder	Oral administration	Oral route of application	
Dosage forms/preparations		Arishtha, churna, taila, eye washes prepared from decoction of powdered drug	Powder formulations called Tibb-e-Unani, Safoof-E-Sana	Powder form of drug, like chooranam	Concentrated aqueous extract of dried fruit	
Plant part used	<i>Terminalia bellerica</i> (Gaetrn.)Roxb.	Fruits	Fruits	Fruits	Fruits	Ramar et al. (2008), Saraswathi et al. (2012), Shaila (1998), Shiva (2001)
Therapeutic effects	(Fam. Combretaceae)	As anti-carries agent, also for in improving blood circulation. In treating chronic constipation, chronic fever, cancer, diarrhoea, cysts, fistula, gastritis, heart and hair problems. It can be also used in treatment of male sterility, migraine, obesity, piles.	common cold, pharyngitis constipation, and as a carminative	Anthelmintic, antiseptic, astringent, expectorant, laxative, lithotriptic, rejuvenative, tonic, good for vision and hair growth, and for vaginitis treatment	Cleansing of toxic products in kidneys and liver, anti-carries, in sinusitis, analgesic, antacid, in reducing post-menopausal pains and bloating	
Method of administration		Oral administration	Oral administration	Internal and external preparations	Internal and external preparations	
Dosage forms/preparations		Powder formulation	Powder formulation	Internal use powders, lotions, pastes,	Powders, syrups, tablets, eye drops, suppositories,	

				Intravaginal douches	toothpastes, ointments	
Plant part used	<i>Curcuma longa</i> L. (Fam. Zingiberaceae)	Roots	Roots	Roots	Peeled and dried root stocks	Saroya (2011), Ravindran et al.(2007), Ramawat (2009), Prasad and Aggarwal (2011), Debjit et al. (2009), Jain (1990)
Therapeutic effects		Anti-inflammatory, anti-diabetic, improving blood circulation. To treat migraine, paralysis and skin diseases	Improve blood circulates, digestion, reduce gas and bloating, as a cholagogue, in treatment of scabies, cold and sore throat	To treat ulcers and scabies, skin beautification, vitiligo and leukoderma treatment	Rheumatoid arthritis, Psoriasis, fevers and inflammation,	
Method of administration		External application of paste and internally through oral route	External application on skin and oral ingestion	Externally as a paste	Oral	
Dosage forms/preparations		Paste, powders, decoctions	ointment, Lotion, paste applied externally for skin ailments	paste	Pills, globuli, tinctures and liquids	
Plant part used	<i>Ocimum sanctum</i> Linn. (Fam. Lamiaceae)	Whole plant, Leaves	Leaves, whole plant,	Fresh leaves	Leaves	Sethi et al. (2003),Kelm (2000), Agrawal and Singh (1996),Sharma et al. (2012), Sethi et al. (2003), Kelm et al. (2000), Gupta (1994), Ram et al. (2009), Julian (1997)
Therapeutic effects		bronchitis, malaria, diarrhea, dysentery, skin disease, arthritis, eye diseases, anti-diabetic, antipyretic, insect bites, anti-	Cardiovascular disorders, diabetes and asthma	bronchitis, asthma, eosinophilia and chronic cough and detoxifying properties	Lung disorders, Tuberculosis, asthma	

	fertility, anticancer, antidiabetic, antifungal, antimicrobial, cardioprotective, analgesic, antispasmodic and adaptogenic actions				
Method of administration	Oral, intraocular preparations	Oral	Oral	Oral	
Dosage forms/preparations	Paste of fresh leaves, whole leaves, decoction of leaves, fixed oil preparations	Fresh leaves, decoction	Fresh leaves, and oils	It is chewed with pepper, as a tea with cloves for anti-nauseating effect and as sedative and also taken with honey or curd	

Table 3. Ancient books of medicinal materials published in China and India in different historical periods

Name of the traditional book	Author	Period	Description
Major classics in TCM			
<i>The Divine Husbandman's Classic of Materia Medica (ShenNong Ben Cao Jing)</i>	Not known	Late Eastern Han Dynasty (c. AD 200)	<ul style="list-style-type: none"> This book records 365 medicinals including 237 herbal substances, and summarizes medicinal experiences as of the Han Dynasty. Medicinals are classified into three categories: high-grade, medium-grade and low-grade. Entries for each substance include definition, compatibilities, properties, harvesting details, processing methods, and medical applications.
<i>Collection of Commentaries on the Classic of the Materia Medica (Ben Cao Jing Ji Zhu)</i>	Tao Hongjing	Liang Dynasty	<ul style="list-style-type: none"> This book records 730 medicinals. The materials are classified into seven categories: herbs, trees, crops, insects or beasts, jades or stones, fruits or vegetables, and medicinals with names but without actual applications. Each entry includes morphological description, production area, harvesting time, processing, dosage, usage, and authentication.
<i>Newly Revised Materia Medica (XinXiu Ben Cao)</i>	Commissioned by the government	Tang Dynasty in AD 659	<ul style="list-style-type: none"> It records 850 medicinals with excellent drawings and written descriptions.
<i>Materia Medica Arranged According to Pattern (Zheng Lei Ben Cao)</i>	Tang Shenwei	AD 1082	<ul style="list-style-type: none"> It records 1746 medicinals including their synonyms, medicinal properties, indications, production areas, harvesting times, processing methods, differentiations, and prescriptions. Medicinal materials are divided into 13 categories: jades and stones, herbs, trees, human beings, beasts, birds, insects and fishes, fruits, crops, vegetables, medicinals with names but without actual applications, herbs without illustrations, and trees and vines without illustrations.
<i>Compendium of Materia Medica (Ben Cao Gang Mu)</i>	Li Shizhen	1593	<ul style="list-style-type: none"> It records 1,892 medicinal materials including 1,095 herbal substances. Herbal substances are further classified into five categories: herbs, crops, vegetables, fruits, and trees, according to their properties, morphological characteristics, and growth environments. Under each entry, the name, production area, nature, taste, morphological characteristics, and processing method is documented.
Major classics in Ayurveda			
<i>Charaka Samhita</i>	Written by Agnivesha and revised by Charaka. Charaka's	Written between 400 BC to 500 BC in various stages	<ul style="list-style-type: none"> The compilation is considered as a milestone in Ayurveda. It is based upon a rational outlook towards etiology of various diseases, the treatment methods and anatomy and physiology of the human body. It comprises of about 340 plants listed in 120 chapters.

	writing were again revised by Dridhbala The revised compilation is named as <i>CharakaSamhita</i>		<ul style="list-style-type: none"> The English translation of Dridhbala's writings is available which comprise of 1000 pages.
<i>Sushruta Samhita</i>	Sushruta	It is believed to be written in parallel to <i>CharakaSamhita</i> around 600 B.C.	<ul style="list-style-type: none"> This was the second significant contribution in Ayurvedic ancient literature. It emphasizes on the science of surgery and Sushruta is named as the "<i>Father of surgery</i>". The book describes 395 plants, 57 substances of animal origin, and 64 agents from mineral or metallic sources with medicinal effects.
<i>Ashtanga Hridaya</i>	Vagabhatta	Around 700 B.C.	<ul style="list-style-type: none"> This compilation is considered to be an unmatched legendary contribution to the practice of Ayurvedic medicine. It is written in the form of poetry and it defines the importance of five sub-doshas of Kapha. Its English translated versions are also available.

Table 4. List of some representative medicinal plants from the same species or genus with different medicinal parts or efficacies recorded in Chinese pharmacopoeia and Indian Ayurvedic pharmacopoeia

No	China			India		
	Species	Medicinal part	TCM Therapeutic conditions	Species	Medicinal part	Therapeutic conditions
1	<i>Citrus medica</i> Linn.(Fam. Rutaceae)	Dried ripe fruit	Stagnation of qi in the liver and stomach manifested by distending pain in the chest and hypochondria , fullness and stuffiness sensation in the epigastrium, vomiting and belching; cough with copious expectoration	<i>Citrus medica</i> Linn. (Fam. Rutaceae)	Fresh fruit	Bleeding disorders, dyspnea, cough, thirst, gastro intestinal disorders, constipation , alcoholism ,hiccups digestive impairment
2	<i>Crocus sativus</i> Linn. (Fam. Iridaceae)	Dried stigma	Promotes blood circulation, unblocks menstruation, eliminates blood stasis, and relieves pain	<i>Crocus sativus</i> Linn. (fam. Iridaceae)	Style and stigma	Sinus, headache, nausea, cough, throat infection, pytiriasis versicolor, belching, Dysuria , Migraine
3	<i>Curculigo orchioides</i> Gaertn. (Fam. Amaryllidaceae)	Dried rhizome	Tonify kidney yang, strengthen tendons and bones, and eliminate cold and dampness	<i>Curculigo orchioides</i> (Fam. Amaryllidaceae)	Dried rhizome	Haemorrhoids, nervous system disorders, emaciation
4	<i>Curcuma longa</i>	Dried	Breaks up	<i>Curcuma longa</i>	Rhizome	Leprosy/skin diseases,

	L.(Fam. Zingiberaceae)	rhizome	blood stasis, promotes the flow of <i>qi</i> , stimulates menstruation and relieve pain	L.(Fam. Zingiberaceae)		disorders due to poison, ulcer, skin disease, increased frequency and turbidity of urine, anemia, urticaria, chronic rhinitis/sinusitis
5	<i>Cyperus rotundus</i> Linn. (Fam. Cyperaceae)	Dried rhizome	Remove stagnation of <i>qi</i> , regulate menstruation and relieve pain	<i>Cyperus rotundus</i> Linn. (Fam. Cyperaceae)	Root tubers	Digestive impairment, indigestion, thirst, fever, asthma, cough, dysuria, vomiting, puerperal disorders, diarrhea, rheumatoid arthritis, infestation of worms
6	<i>Datura metel</i> Linn. (Fam. Solanaceae)	Dried flower	Relieve asthma and cough, alleviate pain, and arrest spasm	<i>Datura metel</i> Linn. (Fam. Solanaceae)	Whole plant	Cough, dyspnea, fever, leprosy, dysuria, wounds, skin disorders, worm infestations, poisoning treatment, piercing pain, hair loss, nausea
7	<i>Eclipta prostrata</i> L. (Fam. Asteraceae)	Dried aerial part	Cool the blood, arrest bleeding, and replenishes the liver and the kidney	<i>Eclipta alba</i> Hassk. (Fam. Asteraceae)	Dried whole plant	Liver disease, worm infestations, oedema, piercing pain, dyspnea, cough, headache, heart diseases
8	<i>Eucalyptus globulus</i> Labill. and other species of Eucalyptus (Fam. Myrtaceae)	Dried leaf of the older branch	Dispel wind, release the exterior, clear heat resolve toxicity, transform phlegm, regulate <i>qi</i> , kill parasites, and relieve itching	<i>Eucalyptus globulus</i> Labill. and other species of Eucalyptus (Fam. Myrtaceae)	Leaf	Digestive impairment, rheumatism, sinusitis in children, cystitis, non-healing ulcer, chronic pyaemia, fever, cough, helminthiasis, chronic rhinitis/sinusitis, coryza, osteoarthritis, headache, puerperal fever, asthma, skin disease, tuberculosis
9	<i>Foeniculum vulgare</i> Mill. (Fam. Umbelliferae)	Dried ripe fruit	Dissipate cold, relieve pain, regulate <i>qi</i> , and harmonize the stomach	<i>Foeniculum vulgare</i> Mill. (Fam. Umbelliferae)	Fruit	Digestive impairment, colic pain, cough, blood disorders, dysentery, hemorrhoids
10	<i>Glycyrrhiza glabra</i> Linn. (Fam. Fabaceae)	Dried root and rhizome	Tonify the spleen and stomach, benefit <i>qi</i> , relieve spasm, alleviate pain, moisten	<i>Glycyrrhiza glabra</i> Linn. (Fam. Fabaceae)	Stem and root	Cough, hoarseness of voice, weakness, sinus, gout

the lung, stop
coughing,
clear heat,
resolve
toxicity,
moderate and
harmonize
the
characteristic
s of other
herbs

Accepted manuscript

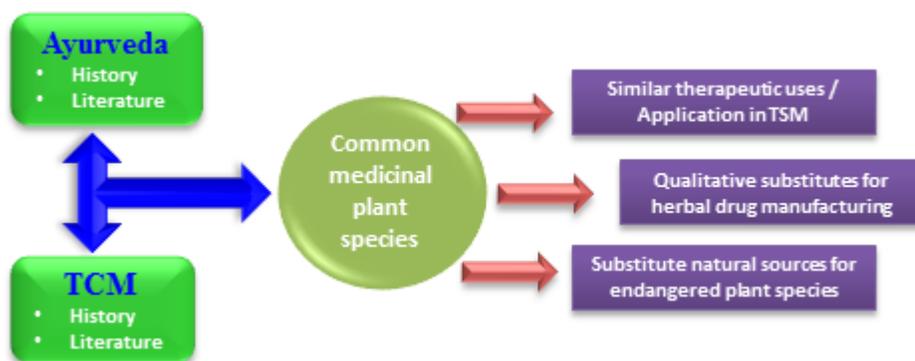
Table 5: Different processing methods for *Phyllanthus emblica* used commonly in all traditional systems of Indian medicine

Plant	Processing methods used				
	Ayurveda	Unani	Siddha	Homeopathy	Yoga
<i>Phyllanthus emblica</i> (Amla)	<ul style="list-style-type: none"> • Fruit Grounded and dried into a fine powder and mixed it with sugar • A mixture of equal quantity of fruit, <i>Syzygium cumini</i> and <i>Momordica charantia</i> powder • Dry fruit powder with a little sugar in milk, water, clarified butter or sugar cane juice • Leaves are mixed with honey and taken orally • The whole fruit is also soaked in various syrups, honey and salt solutions to enhance its taste and effects. • Oil of amla for external application to prevent hair loss. Singh et al.(2011),Kapoor (1990), Treadway(1994) 	<ul style="list-style-type: none"> • Boiled in cow milk and sugar. • Amla extracted in sesame oil for application on hair and scalp.Sherwani et al. (2012) 	<ul style="list-style-type: none"> • Prepared in the form of paste with cow ghee, and <i>Terminalia bellirica</i> and <i>Glycyrrhiza glabra</i>. Kartikeyan(2007) 	<ul style="list-style-type: none"> • Infusions of the fruit powder are prepared in water • Powder is also taken in the dry form • Also used with psyllium and liquorice in older patients. • It is also used in combination with Epsom salt, ginger and fennel mixtures. • Pills prepared from powder are also used in treatment (Srivasuki, 2012) 	<ul style="list-style-type: none"> • Fresh fruit juice or in the form of powder as an ingredient of a polyherbal powder formulation called juice (Mamtani, 2005).

Table 6: Different methods of aconite processing used in Ayurveda and TCM

Processing methods	
Ayurveda	TCM
<p>“Samanyashudhi” – General detoxification</p> <p><i>Processing with Cow urine</i></p> <p>The aconite roots are placed in a tray containing cow urine and exposed to sunlight. After 3 days the cow urine is discarded, and the root is peeled off, washed to remove traces of urine and then administered to the patient.</p> <p><i>Processing with Cow milk</i></p> <p>The roots are hung in a cloth bag, immersed in a pot containing cow’s milk in boiling condition. The milk is regularly changed with fresh milk at suitable intervals, until a total period of 8-12 hours of boiling. The roots are then peeled off to discard the cortex region, washed with water and administered to the patient (Sarkar et al., 2012; Singh et al, 1981; Shah, 2010).</p>	<p>Preparation of various decoction pieces</p> <p><i>Danfupian</i></p> <p>The aconite roots after being subjected to boiling with mineral salt water and drying are again boiled with Radix Glycyrrhizae, black beans and water until the cut slices have a numbness causing effect when tasted after processing.</p> <p><i>Baifupian</i></p> <p>The aconite roots are cleansed, soaked in edible mineral salt preparation, and boiled. After boiling the roots are peeled, cut longitudinally, steamed and dried.</p> <p><i>Heishunpian</i></p> <p>The raw aconite roots are soaked in mineral edible salt preparation after cleaning and boiled thoroughly. The pieces are then rinsed in water, cut longitudinally, repeatedly rinsed in water and steamed. Later, the pieces are either fried until completely dried or partly fried and then sun dried.</p> <p><i>Paofupian</i></p> <p>The slices of aconite roots are added in a pot containing hot sand, and stirred until the slices are swollen and become slightly discolored. The sand is then sifted out and the pieces are cooled for further use. Zhao et al. (2010).</p>
<p>“Visheshshudhi” – Special detoxification</p> <p>The aconite is boiled in water containing Borax for 6 hours and then used for patient administration (Sarkar et al., 2012; Shah, 2010)</p>	

Note: Figures : * Intended for color reproduction on the Web (free of charge)



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