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Reviews

Plants-herbal wealth as a potential source of ayurvedic drugs

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Abstract

Nearly 80 % of the global population still depends upon the herbal drugs for their health care. There has been an increase demand for the pharmaceutical products of Ayurveda in all over the world because of fact that the allopathic drugs have a side effect. In the present context the Ayurvedic system of medicine is widely accepted and practiced by peoples no only in India but also in the developed countries- such as Europe, USA, Japan, China, Canada etc. Plant based therapy are marked due to its low cost, easy availability based on generation to generation knowledge. However, over commercial exploitation of these plant products and frequent degradation of natural resources are reported to be major threats to medicinal plants in India. The aim of the present review is to understand the knowledge of plants used for Ayurvedic preparations in relation to their use as therapeutic agents, pharmacological properties, medicinal plants being imported; medicinal plant parts being exported, endangered medicinal plants and availability of medicinal plants in different bio-geographical zones of India so that the data and information of this review could be utilized in drawing strategies for rational and more scientific use of medicinal plants in a way that can be extended for future scientific investigation in different aspects. The development of this traditional Indian system of medicines with perspectives of safety, efficacy and quality will help not only to preserve this traditional heritage but also to rationalize the use of natural products in health care without side effects.

Key words: ayurvedic drugs; bioactive compounds; plant product; therapeutic use; safety

Introduction

Ayurvedic medicines mainly based on plants enjoy a respective position today, especially in the developing countries, where modern health services are limited. Safe effective and inexpensive indigenous remedies are gaining popularity among the people of both urban and rural areas especially in India and China. Information from ethnic groups or indigenous traditional medicines has played vital role in the discovery of novel products from plants as chemotherapeutic agents.

Herbal medicines have been main source of primary healthcare in all over the world. From ancient times, plants have been catering as rich source of effective and safe medicines. About 80 % of world populations are still dependent on traditional medicines. Herbal medicines are finished, labeled medicinal products that contain as active ingredients, aerial or under ground part of plants or other plant materials, or combination thereof, whether in the crude state or as plant preparations. Medicines containing plant materials combined with chemically defined active substances, including chemically defined

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isolated constituents of plants are not considered to be herbal medicines [1].

Herbal medicines continue to be a major market in US pharmaceuticals and constitute a multi-billion dollar business. Approximately 1500 botanicals are sold as dietary supplements; formulations are not subject to Food and Drug Administration (FDA) clinical toxicity testing to assure their safety and efficacy. The Indian herbal drug market size is about $1 billion and the export of plant based crude drug is around $100 million. The current market potential of herbal medicine is estimated about $ 80-250 billion in Europe and USA [2]. The current market size of the herbs and natural health products in China is about USD 650 million, of which imported herbal medicines account for USD 15 million. In response to the expected improvement in modern herbal medicine and reflective of their growing demand for natural medicines, 73 % of the respondents to a consumer survey indicated they would depend more on herbal medicine in the future. Imports of herbs into Hong Kong in 2003 amounted to USD 166.4 million, a 6.8 % decrease over the 2002's imports. This reflects less imports of licorice roots of USD 0.2 (−23.8 %) and ginseng root of USD 123.2 (−8.8 %) [3].

The aim of the present review is to understand the knowledge of plants used for Ayurvedic preparations in relation to their use as therapeutic agents, pharmacological properties, medicinal plants being imported; medicinal plant parts being exported, endangered medicinal plants and availability of medicinal plants in different bio-geographical zones of India. The authors have tried to put all these classes of plants at a common platform so that the data and information of this review could be utilized in drawing strategies for use of medicinal plants in a way that can be extended for future scientific investigation in different aspects.

Review

The Ayurvedic concept appeared and developed between 2500 and 500 BC in India. The literal meaning of Ayurveda is "science of life," because ancient Indian system of health care focused views of man and his illness. It is pointed out that the positive health means metabolically well-balanced human beings. The practice of Ayurveda therapeutics consisted of 8 sections divided into 180 chapters and listed 314 plants, which are used as medicines in India [4]. Four thousand years ago, the medical knowledge of the Indian subcontinent was termed as Ayurveda. Ayurveda remains an important system of medicine and drug therapy in India. Plant alkaloids are the primary active ingredients of Ayurvedic drugs. Today the pharmacologically active ingredients of many Ayurvedic medicines are being identified and their usefulness in drug therapy being determined. As mentioned in the introduction only a certain percentage of plants are used in traditional medicines. The Indian subcontinent is a vast repository of medicinal plants that are used in traditional medical treatments [5]. In India, around 15000 medicinal plants have been recorded [6] however traditional communities are using only 7,000 - 7,500 plants for curing different diseases [7-9]. The medicinal plants are listed in various indigenous systems such as Siddha (600), Ayurveda (700), Amchi (600), Unani (700) and Allopathy (30) plant species for different ailments [10]. According to another estimate 17,000 species of medicinal plants have been recorded out of which, nearly 3,000 species are used in medicinal field [11].

Chemical principles from natural sources have become much simpler and have contributed significantly to the development of new drugs from medicinal plants [12-13]. The valuable medicinal properties of different plants are due to presence of several constituents i.e. saponins, tannins, alkaloids, alkenyl phenols, glycol-alkaloids, flavonoids, sesquiterpenes lactones, terpenoids and phorbol esters [14]. Among them some are act as synergistic and enhance the bioactivity of other compounds.

Artemisinin produced by *Artemisia annua* plant is very effective against *Plasmodium falciparum*, *P. vivax* and also drug resistant parasite. The main active constituents of *Artemisia annua* are sesquiterpenoid lactone endoperonides named artemisinin and artemisinic acid. For more than century quinine, an alkaloid obtained from the bark of various species of cinchona trees has been used in the treatment of Malaria and interestingly was one of the first agents used for the treatment of amoebic dysentery. Reserpine isolated from raw plant extract of *Rauvolfia serpentina* is used as tranquilizer and in control of high blood pressure. From 2000 years the powdered root of Rauvolfia *serpentina* has been used in treatment of mental illness in India. Although synthetic drugs are often used in treatment of certain disease but a remarkable interest and confidence on plant medicine was found [15].

Indian Vedas describe the widespread use of herbal products and aqueous extract of different plant parts for curing different diseases. Maximum 30 % of root part of medicinal plant is used in different practices in comparison to other plant parts [16]. The therapeutic actions of important medicinal plants and its parts used, the Ayurvedic systems of medicine in India are reported in Table 1 [3, 4, 17, 19]. The pharmacological properties of some Ayurvedic crude drugs support for their therapeutic claims are listed in Table 2 [31-34, 48, 49, 78 - 81].

India has been identified as one of the top twelve mega bio-diversity center of the world. This is because India has a vast area with wide variation in climate, soil, altitude and latitude. India with its biggest repository of medicinal plants in the world may maintain an important position in the production of raw materials either directly for crude drugs or as the bioactive compounds in the formulation of pharmaceuticals and cosmetics etc. Medicinal plant based drug industries is progressing very fast in India but it is best with a number of problems. Most alarming problem the industry has started facing and will face in future is the demanding supply of plant material from natural resources. A national policy on medicinal plants with a view to pressure endangered species and promoting cultivation of plants which are being extensively used by industry will help in solving the major problem of the industry. Herbal plants which are being imported are listed in Table 3 [3, 18, 82], Herbal plants having export potential are listed in Table 4 [3, 18, 82] and the threatened herbal plants are listed in Table 5 [3, 18, 82]. In India nearly 15000 plant species are used as a source of medicine. Distribution of different plant species in India are listed in Table 6 [14, 17, 18].

Many of the ancestor plants are highly endangered and urgently need to be maintained in their native habitats. Unless we preserve genetic material for propagation from these species now, many will be extinct before we can protect and restore habitats for their long term recovery. Surveying, monitoring and collecting material for propagation from populations of these species are the primary activities of individual. The viable plant material, living plant collections and long term seed storage can be preserved in order to maximize their potential for future use in our restoration efforts. To ensure accurate accession records, especially necessary for future restoration work, collection of highly accurate GPS location data for individual plants and populations is essential, as is creation of high quality species distribution and survey maps. Land owners and government agencies that are willing to implement plant restoration programs on their properties may also benefit from government.

Conclusion

Even from early civilization, herbs have been considered to be a powerful tool in treating illnesses. In places where physicians cannot reach, people have invented their own concoction of herbs and plants to deal with the common afflictions of daily life. At times, these herbal treatments have proved more superior and effective than its chemical

Table 1. Therapeutic uses of medicinal and aromatic plants along with their parts used in Ayurvedic systems of Indian medicines [3, 4, 17, 19]

No.	Botanical names	Family	Local name	Parts used	Therapeutic actions
1	*Acorus calamus* Linn.	Araceae	Vacha	Root	Memory loss, anxiety, bronchitis, mental fatigue sinusitis, tension, headache and joint pains [17].
2	*Achillea millefolium* Linn.	Compositae	Biranjasipha	Whole plant	A simulative tonic and carminative that helps expel gas from the stomach and intestines. It has a very healing and soothing effect on the mucous membranes. Aqueous extracts are used for thinning hair [19, 4].
3	*Argyreia speciosa* Sweet	Convolvulaceae	Vridha daraka	Root & seed	The nervous system, geriatric tonic and mild aphrodisiac help maintain healthy joints [17]
4	*Adhatoda vasica* Nees	Acanthaceae	Vasaka	Root & leaf	Expectorant used in asthma, bronchitis, cough and dysmenorrhea [17, 19].
5	*Aegle marmelos* Corr.	Rutaceae	Bilwa	Fruit	Diarrhea, gastritis and adult onset diabetes [17]
6	*Andrographis paniculata* Wallich	Acanthaceae	Kirta	Leaf	Children's bowel complaints, gastric acidity, viral hepatitis, liver congestion and flatulence [17, 19].
7	*Asparagus racemosus* Willd	Liliaceae	Shatavari	Root	Increases muscle strength, stomach, lungs, and sexual organs, increases breast milk secretion during lactation and male impotence [19].
8	*Allium sativum*	Liliaceae	Lahasun	Bulb	Carminative, aphrodisiac, stimulant in fevers, coughs febrifuge, in intermittent fever, skin diseases, and collie earache [17, 64].
9	*Bacopa monnieri* (Linn.) Penn.	Scrophulariaceae	Brahmi	Leaf	Nervous exhaustion, generalized fatigue, epilepsy, improves memory, anti-ageing and bronchitis, coughs [17].
10	*Boerhaavia diffusa* Linn.	Nyctaginaceae	Punarnava	Root	Diuretic, laxative, expectorant used in asthma, bronchitis, anemia and anti-inflammatory [4, 17].
11	*Cedrus deodara* Roxb.	Coniferae	Devadaru	Wood	Flatulence, rjona, hemorrhoids, fever, reduces and promotes sweating [17, 19].
12	*Centella asiatica* Urbann	Umbelliferae	Mandukaparni	Whole plant	Anxiety, to promote memory power and also to reduce blood pressure [3, 17]
13	*Capparis spinosa* Linn.	Capparidaceae	Himsra	Root bark	Capers are a hepatic stimulant that has been used for improving the functional efficiency of the liver. histological architecture of the liver and its positive effect on liver glycogen and serum proteins [3, 4].
14	*Cinnamomum iners* Reinw	Lauraceae	Tejpatra	Leaf	Used for scorpion sting [17].
15	*Cichorium intybus* Linn	Compositae	Kasani,	Whole plant	Chicory is a powerful hepatic stimulant that increases bile-secretion, promotes digestion and enhances the action of capers, liver glycogen, free radical induced DNA damage [3, 4].
16	*Commiphora mukul* Engl.	Burseraceae	Guggul	Gum & resin	Guggul is a resin, the major ingredient in joint care and immuno care, increase white blood cell count and to possess strong immuno-modulating properties. Common cold, an adjuvant of other types of therapies. In addition, lower cholesterol and triglycerides, while maintaining the HDL to LDL ratio has long known Guggul [3].

Continuted table 1

17	*Crocus sativus* Linn.	Iridaceae	Kumkuma	Stigmas	Carotenoid pigments, antioxidant properties, natural source of two B vitamins, Riboflavin and Thiamine, promoter of the immune defenses in Ayurvedic therapies [4, 19].
18	*Cyperus scariosus* Br.	Cyperaceae	Nagarmusta,	Tuber	Rjona-urinary system, on hepatoprotective properties [17].
19	*Didymocarpus pedicellata*	Gesneriaceae	Shilapushpa	Leaf	Diuretic that has been shown to be effective in supporting a healthy urinary tract [19].
20	*Datura metel* Linn.	Solanaceae	Datura	Whole plant	Whooping cough, muscle spasm, sciatica, asthma and painful menstruation [19].
21	*Eclipa alba* Hassk.	Asteraceae	Bhringaraj	Whole plant	Liver disorders, skin and hair care, improves complexion, viral hepatitis, calms the mind, memory disorders, and strengthens spleen and general tonic [4, 19].
22	*Embelia* ribes	Myrsinaceae	Vidanga	Powdered berries	Intestinal worms, skin-fungal infections, obesity, sore throat and digestive strengthener. Keep the intestines free of toxins. It is reported as a reducing agent of sperm count [17].
23	*Emblica officinalis* Gaertn.	Euphorbiaceae	Amalaki	Fruit	Increases red blood cell counts and therefore improves anemia, asthma, bronchitis, stomach problems and hemorrhoids [19, 4].
24	*Evolvulus alsinoides* Linn.	Convolvulaceae	Shankhpushpi	Whole plant	General weakness, nervous exhaustion and memory loss [17].
25	*Gloriosa superba* Linn.	Liliaceae	Kalapaikilangu	Tuber & seed	Deadly toxic to human beings, used as server ulcer in an optimum dose and cure cancer [17].
26	*Garcinia cambogia* Desr	Guttiferae	Garcinia	Vilati, amli	Biologically active compounds (-) Hydroxy Citric Acid. HCA is known to inhibit the synthesis of lipids and fatty acids. HCA inhibits the enzyme ATP-Citrate lyaze that leads to reduce production of acetyl CoA, which is a key substance in fat and carbohydrate metabolism. Therefore, formation of LDL and triglycerides is very low. Garcinia contains significant amounts of vitamin C and used as a heart tonic [3]
27	*Glycyrrhiza glabra* Linn.	Leguminosae	Yashti-madhu	Root	For gastrointestinal health. It is a mild laxative, which soothes and tones the mucous membranes and relieves muscle spasms. It is rich in flavonoids and an antioxidant, cancer protecting, botanical boosting and an anti-mutagen, preventing damage to genetic material that can eventually result in cancer [3, 4].
28	*Gymnema sylvestre* R. Br.	Ascelepiadaceae	Meshashringi	Root	"Sugar destroyer", has been shown *in vitro* to have a glycolytic action and reduce the strength of a glucose solution. Regulate sugar metabolism for several centuries. It increases insulin production, regeneration of pancreas cells and the site of insulin production [4].

Continuted table 1

29	*Mucuna pruriens* Baker	Papilionaceae	Kapikachchha	Seed powder	Hypercholesterolemia, general weakness, Parkinson's disease and nervous disorders [17].
30	*Melia azadirachta* Linn.	Meliaaceae	Persian lilac	Stem bark	Used as a tonic and astringent that promotes healing, anti-spasmodic action. its detoxifying properties. Beneficial effects for the circulatory, digestive, respiratory and urinary systems [35, 73, 74].
31	*Momordica charantia* Linn.	Cucurbitaceae	Karela	Fruit & leaf	Contains Gurmarin, a polypeptide considered to be similar to bovine insulin and strong sugar regulating effect by suppressing the neural responses to sweet taste stimuli [36, 41-47].
32	*Moringa pterygosperma* Gaertn	Moringaceae	Shigru	Root	Shigru contains physiologically active principles that have been shown to be effective in a broad range of health needs. For example, it contains "Pterygospermin", an antibiotic-like substance [3].
33	*Mucuna pruriens* Baker	Leguminosae	Kapikachchhu	Seed	It is reported as a good natural source of *L. dopa*. That lends much credibility to the old claim from Ayurvedic physicians that *M. pruriens* is a very effective tonic for nervous system. Studies have demonstrated its usefulness maintaining optimum performance of the nervous system [4].
34	*Nardostachys jatamansi* DC.	Valerianaceae	Jatamansi	Root	Jatamansi is relaxing plant with established effectiveness for mental health. Ayurvedic practitioners include it in their formulations to address anxiety. It has been shown effective in maintain a restful sleep and with many menopausal symptoms [3 ,7].
35	*Ocimum sanctum* Linn.	Lamiaceae	Tulasi	Leaf	Tuberculosis,. ringworm, ear infections, common cold, cough, bronchitis, general stress syndrome, skin infections, indigestion, nausea and sinus infection [4, 17].
36	*Oroxylum indicum* Vent	Bignoniaceae	Shyonaka	Root bark	Digestive aid, arthritic conditions, anti-diarrhoea, and purgative [17].
37	*Operculina turpethum* S	Manso	Trivrit	Root	Constipation and colic obesity [19].
38	*Orchis mascula* Linn.	Orchidaceae	Salabmisri	Tuber	Nerve stimulant and revigorating tonic that has long been known for its value in cases of sexual weakness. It has also been tested recently for cases of nervous debility [4].
39	*Piper longum* Linn.	Piperaceae	Pippali,	Fruit	Pippali is a powerful stimulant for both the digestive and the respiratory systems and has showed a rejuvenating effect on lungs. It plays an important role in aiding the thermogenic response, i.e. the release of metabolic heat energy. This effect is the result of increased thyroid hormone level in the body. Pippali a typical Ayurvedic complementary component whose benefit is to increased the bioavailability and enhance absorption of the other active ingredients [3, 19].

Continuted table 1

40	*Piper nigrum* Linn.	Piperaceae	Maricha	Fruit	The black pepper is one of the most renowned culinary spices. It contains an alkaloid piperine that has been widely used to amplify the body's ability to absorb nutrients contained in the food and aid the digestive process [3, 4, 19].
41	*Phyllanthus amarus* Linn.	Euphorbiaceae	Bhumi amalaki	Whole plant	Chronic liver disorders, jaundice, viral hepatitis, dyspepsia, anorexia moderate constipation, chronic colitis, irritable bowel syndrome, urinary tract infection [40].
42	*Plumbago zeylanica* Linn.	Plumbaginaceae	Chitraka	Root	Skin conditions, arthritic pain, abortifacient, blood purifier, obesity and hemorrhoids [17].
43	*Ricinus communis* Linn.	Euphorbiaceae		Seed	Dysentery, coughs, constipation, piles, antivenom to scorpion stings, rheumatis and nerve disorder [19].
44	*Rauwolfia serpentina* Benth.	Apocynaceae	Sarpagandha	Root	High blood pressure, mental agitation, insomnia, sedative, hypnotic. Sarpagandha is the source of reserpine, an anti-hypertensive drug used since 1970 [17, 19].
45	*Rubia cordifolia* Linn.	Rubiaceae	Manjishta	Root & stem	Indian madder is considered the best Ayurvedic blood-purifying herb. In Ayurvedic medicine, it is used as an immune regulator. Its antioxidant properties are also being investigated. Its role in supporting heart health is evidenced by studies showed that it regulates the tendency of blood to form clots regulates blood pressure and blood vessel constriction [4, 17].
46	*Saraca indica* Linn.	Caesalpiniaceae	Asoka	Stem bark	Menorrhagia, depression, bleeding, hemorrhoids, uterine fibroids, considered as a uterine sedative and tonic [17].
47	*Saxifraga ligulata* Wall	Saxi fragaceae	Pasanavheda	Root	Diuretic action with the unique property of reaping optimum urinary tract health is reported. *S ligulata* supports bladder by acting on the crystalloid-colloid balance and keeping calcium salts in solution [3, 17].
48	*Solanum nigrum* Linn.	Solanaceae	Kakamachi	Whole plant	Kakamachi plant and berries contains various alkaloids that have been isolated and shown to have a dilatation action on the pupil. This is mainly used for healthy liver, skin, kidneys and bladder. Recent studies indicate that the hepatoprotective effects of the crude extract may be due to the suppression of the oxidative degradation of DNA [3, 4, 19].
49	*Terminalia arjuna* W. & A.	Combretaceae	Arjuna	Stem bark	Arjuna is a heart tonic that has been used to support the cardiovascular functions since ancient times with known cardio protective effects. Recent work has investigated the mechanism of this activity and has shown a dose-dependent regulation of blood pressure and heart rate. There was also a slight increase in the HDL-to-total cholesterol ratio and an overall improvement in the cardiovascular profile [24].

Continuted table 1

50	*Sida cordifolia* Linn.	Malvaceae	Bala	Root	Generalized weakness, post-partum weakness, mental exhaustion, nervousness, bronchospasm and cough [3, 25].
51	*Solanum surattense* Burm.f.	*Solanaceae*	Kantakari	Whole plant	Asthma, cough, bronchspasm, sore throat, constipation, an effective expectorant and diuretic [17].
52	*Terminalia bellerica* DC. (W & A)	Combretaceae	Bibhitaka	Fruit	General tonic and strengthener, cough, sore throat, fatigue, all types of gastrointestinal disorders and mild laxative [3, 19].
53	*Terminalia chebula* Retz.	Combretaceae	Haritaki,	Fruit	In Sanskrit, Haritaki means "carries away" (all diseases). Haritaki is a safe and effective purgative, expectorant and tonic. It is a component of the classic Ayurvedic combination called "Triphala" (three fruits). Tiphalpha is an important Ayurvedic medicine, which often promotes health through successive steps of purification and detoxification. It is known to have strong anti-mutagenic activity, because of its very rich content vitamin C [3, 27].
54	*Tylophora asthmatica* W & A	Asclepiadaceae	Nanjaruppan	Root	Dry leaf is used to given asthma, tuberculosis and dry cough [27].
55	*Tinospora cordifolia* Miers	Menispermaceae	Guduchi	Stem	Guduchi is a rich source of natural vitamin C that has now been proved to be effective in inhibiting the growth of bacteria and in building up the immune resistance. Research is now providing clues to Guduchi's immune-boosting ability. In a scientific investigation using human white blood cells, it increased the killing ability of macrophages, the immune cells responsible for fighting invaders [29, 62, 66-70].
56	*Tribulus terrestris* Linn.	Zygophyllaceae	Gokshura	Fruit	Gokshura is a mild diuretic widely used to promote the flow of urine, cools and soothes the membranes of the urinary tract and inhibits the production of oxalate, a substance that cause microcrystals. Gokshura's role in maintaining a healthy heart has also been proved. It contains saponins that may improve the heart function by dilating coronary arteries, thereby boosting circulation to the heart. In China, 406 patients were treated with these saponins and their EKG improved in 67 % of the cases [19, 28].
57	*Wedelia calendula* (Linn.) Less.	Vitaceae		Leaf & root	Used as hepatic disorders, stomach and lung cancer [17].
58	*Withania somnifera* Dunal.	Solanaceae	Ashwagandha	Tuber & root	Used for rheumatism and arthritis. Used to treat general debility, exhaustion, stress induced fatigue and insomnia, the muscles and bone marrow. As stimulants for the immune system [30, 63].
59	*Zingiber officinale* Rosc	Zinziberaceae	Ginger	Root	To improve digestion and to prevent nausea. Helping bowel movements and relaxing the muscles are controlling the digestive system. Absorption and prevents gastrointestinal side effects [65].

Continuted table 1

60	*Aloe barbadensis*	Liliaceae	Gwarpatha	Leaf	Stomachic, purgative anathematic in piles and rectal fissures, constipation, menstrual, suppression [65].
61	*Acacia nelotica* Linn.	Mimosaceae	Babool	Stem bark	Astringent, demulcent, diarrhea, dysentery, diabetes mellitus [19, 25].
62	*Abrus preacatorium* Linn.	Fabaceae	Ganja	Seed	Purgative, emetic, tonic, aphrodisiac, nervous disorder and cattle poisoning, abortion [17].
63	*Asteracantho longifolia* Nees.	Acanthaceae	Tal makhana	Whole plant	Diuretic, gonorrhea, in spermaterrhoea, jaundice, dropsy, rheumatism, anasarca, urinogenital tract [17].
64	*Acacia catechu* Linn.	Mimosaceae	Khadira	Heart wood	Astringent [19].
65	*Boswellia serrata*	Burseraceae	Salar	Gum & resin	Skin eruption, Diaphoretic, diuretic, astringent, emmenagegue in rheumatism, nervous and skin disorders [3].
66	*Berberies aristata* D.C.	Berberiedaceae	Daru Haldi	Stem	Deobstruent, in skin diseases, menorrhagia, jaundice and affection of eyes [19].
67	*Barleria prienitis* Linn	Acanthaceae	Sahacara	Whole plant	Catarrhal affection of children, fever and much phlegmatic in cough, in anasarca, toothache, glandular swellings, in dropsy [3, 4].
68	*Bergenia ciliates* Sternb	Saxifragaceae	Bheda	Rhizome	Tonic, used in fever, diarrhea, pulmonary, affections, anti scorbutic, bruised and applied to boils and ophthalmic [3, 24].
69	*Cajanus cajan* Linn.	Fabaceae	Arhara	Root	Snake bite and applied over the mamme to check secretion of milk [19, 24].
70	*Croton tiglium* Linn.	Euphorbiaceae	Jayapala	Seed	Drastic, purgative, irritant, rubefacient, cathartic, fish poison, in snake-bite [17].
71	*Curcuma longa* Linn.	Zingiberaceae	Haldi	Rhizome	Aromatic, stimulant, tonic, carminative, blood purifier, anti periodic, alterative, for sprains and wounds, purulent conjunctivitis [20-23].
72	*Cesalpenia bondne*	Cesalpeniaceae	Kantharanj	Seed	Piles and ulcer [17].
73	*Cynodon dactylen* Linn	Poaceae	Doob	Root	Diuretic, in dropsy, in secondary syphilis for stopping bleeding from piles, dysentery, ophthalmic [17].
74	*Citrullus colocynthis*	Cucurbitaceae	Indrayan	Fruit	Pregnancy, as cites, Jaundice, urinary diseases and rheumatism, snake poison [17].
75	*Carissa carandas* Linn.	Apocynaceae	Karonda	Root	Bitter, stomachic, anthelmintic, cooling, acidic [17].
76	*Cuminum cyminum* Linn.	Umbelliferae	Jira	Fruit	Stomachic, stimulant, astringent, dyspepsia and diarrhea, snake-bite [19].
77	*Desmodium gangeticum* D.C.	Fabaceae	Salaparni	Root	Astringent, in diarrhea, tonic, diuretic, fever, biliousness, cough, vomiting, asthma, snake-bite, scorpion- sting [17, 19].
78	*Brassica campestris* Linn.	Brassicaceae	Saraso	Seed	Antiscorbutic, embrocation, in muscular rheumatism, stiff neck, dengue, fever, use on chest in bronchitis [19].
79	*Mangifera indica* Linn.	Anacardiaceae	Aam	Seed & bark	In Scorpian-sting, asthma, astringent used in uterin haemorrhage, haemoptysis and melaena, diarshea and other discharges [19, 24].

Continuted table 1

80	*Achyranthes aspera* Linn.	Amaranthaceae	Latjera	Root	Astringent in hydrophobia, purgative ,diuretic, in dropsy, piles, boils, skin eruption, colic, snake bite [17].
81	*Calotropis procera* Linn.	Asclepiadaceae	Aak	Root, leaf, & stem bark	In dysentery, ipecacuanha, diaphoretic, emetic intermittent fevers, cold, coughs, asthma, and indigestion [17].
82	*Cissus quadrangularis* Linn.	Vitaceae	Hadjod	Stem	Stomachic, digestive troubles, irregular menstruation and scurvy given internally and applied topically for fracture of bones, asthma [17, 19].
83	*Clerodendrum serratum* Linn.	Verbenaceae	Bharangee	Root	In febrifuge and catar, affections, useful in malaria, fever, snakebite, cephalgia and ophthalmia [28].
84	*Cocos nucifera* Linn.	Arecaceae	Nariyal	Endosperm	Aphrodisiac, diuretic, alopecia, loss of hair after fevers and debilitating diseases, cooling, fever, urinary disorder [17, 28].
85	*Fagonia cretica*	Zygophyllaceae	Dhamaso	Leaf	Diarrhaea, Astringent, prophylactic against small pox, dropsy, any disorder, cooling [17].
86	*Ficus racemosa* Linn.	Moraceae	Udumbara	Stem Bark	Astringent, dysentery and stomachi [17].
87	*Hibiscus cannabinus*	Malvaceae	Bhang	Leaf	Constipation, Purgative [19].
88	*Ferula foetida* Rege.	Umbelliferae	Hing	Oleogum & resin	In scorpion-sting, intestinal antiseptic carminative, in hysteria and epilepsy [17].
89	*Jasminum officinale* Linn	Oleaceae	Chamelle	Leaf	Used in ring worm, chewed as a treatment for ulcerations or eruptions in the mouth, juice for corns, in ear for otorrhoea [19].
90	*Luffa acutangula* Linn.	Cucurbitaceae	Turai	Whole plant	Emotic, purgative, for granular conjunctivitis, splenetic, hemorrhoids, leprosy [17, 19].
91	*Lens culinaric* Medic	Fabaceae	Masur	Seed	Mucilaginous, constipation, intestinal affection in foul and indolent ulcers [19].
92	*Mimosa Pudica* Linn.	Leguminosae	Lajalu	Whole plant	Gravellish, complaints, in piles and fistula, hydrocele, scorpion-sting [3, 4].
93	*Phaseolus radiatus*	Fabaceae	Urid	Seed	Paralysis, rheumatism and affections of the nervous system, hot & tonic, in piles, liver, cough and in fever [17].
94	*Pterocarpus Santalinus* Linn.	Fabaceae	Lal chandan	Heart wood	Astringent, tonic, cooling, inflammatory, headache, in bilious affections, skin diseases, in fever, in scorpion- sting [17, 19].
95	*Pluchea lanceolata* Oliver & Hiern	Asteraceae	Rasna	Leaf	Substitute for senna, antipyretic [3, 4].
96	*Pista cialeanticus* Linn.	Anacardiaceae	Karkatasringi	Leaf	Used as in solution as a filling for carions teeth [19, 28].
97	*Phyllanthus fraternus* Webst.	Euphorbiaceae	Bhumi amalaki	Root, stem & leaf	Used as a diuretic, in dropsical affections, gonorrhoea and other troubles of the genitor-urinary tract stomachic [3, 17].
98	*Musa aradisiacal* Linn.	Musaceae	Kela	Rhizome	Anathematic, astringent inotalgia and haemoptysis, tonic, antiscorbutic, useful in blood and venereal diseases in nervous affection like hysteria and epilepsy, dysentery, diarrhea, in cholera [19].
99	*Myrica esculanta*	Myricaceae	Kayphal	Fruit & stem bark	Astringent, carminative, antiseptic, useful in fever, asthma, cough, headache, cholera [17, 19].

Continuted table 1

100	*Nelumbo nucifera* Gaertn.	Nymphaeaceae	Kamal kakadi	Rhizome	For piles as demulcent for demulcent for dysentery, skin affections, ringworm, burning [17, 19].
101	*Nymphaea stellata* Willd	Nymphaceae	Neel kamal	Flower	Palpitation of heart, diarrhea, piles, dyspepsia [19].
102	*Oxalis corniculata* Linn.	Oxalidaceae	Changeri	Whole plant	Cooling, refrigerant, stomach, antiscorbutic, cure for scurvy [17].
103	*Punica granatum* Linn.	Punicaceae	Birhatta	Seed	Carminative, expectorant, asthma, cough, catarrhal, parturition, tooth ache, fever, worm complaints, colic in dysuria and inchuria [3, 4, 27].
104	*Pongamia pinnata* Linn.	Leguminosae	Kronja	Seed	Skin diseases, cutaneous affection used as fish poison, bleeding, piles, ulcer, gonorrhoea [28].
105	*Rosa centifolia* Linn.	Rosaceae	Gulab	Flower	Astringent, laxative use as syrup to infants. Cooling in fever, and in palpitation of heart [17, 27].
106	*Raphanus sativus* Linn.	Cruciferae	Muli	Whole plant	Diuretic, laxative, expectorant, peptic, carminative, urinary complaints, piles and gastro dynic pains [17].
107	*Saccharum spontaneum* Linn.	Poaceae	Kasa	Root stock	Aphrodisiac, useful in burning, sensations, strangury, phthisis, vesical calculi, diseases of blood, biliousness, haemorrhagic [17].
108	*Santalum album* Linn.	Santalaceae	Chandan	Heart wood	Headache, fever, local inflam, skin diseases, to allay heat and pruritus, diaphoretic, dysuria, gonorrheal urethritis and cystitis [19, 17].
109	*Scindapsus officinalis Schtt.*	Araceae	Gajapipali	Fruit	Aphrodisiac, stimulant, diaphoretic, anthelmintic, for rheumatism [17].
110	*Syzygium cumini Linn.*	Myrtaceae	Jamun	Seed & stem bark	Astringent, decoctions, gargles and washes, diarrhea, dysentery, stomachic, carminative and diuretic [38].
111	*Swertia chirata Buchham*	Gentianaceae	Chireta	Whole plant	Bitter, tonic, stomachic, febrifuge laxative [82].
112	*Syzygium aromaticum* Linn.	Myrtaceae	Lavang	Flower bud	Stimulant, aromatic, carminative, used in flatulence and dyspepsia [19].
113	*Solanum indicum* Linn.	Solanaceae	Birhatta	Root	Carminative, expectorant, useful in asthma, cough, catarrhal affections, difficult parturition, toothache, fevers, warm complaints, colic, in dysuria and inchuria [19].
114	*Taxus baccata* Linn.	Taxaceae	Birmi	Leaf	Emmenagogue, sedative, antiseptic asthma, bronchitis, hiccough, indigestion, epilepsy aphrodisiac [17, 19].
115	*Trigonella Foenum-gracecum* Linn.	Leguminosae	Methi	Seed	Carminative, tonic, aphrodisiac, smallpox, cooling drink, dysentery [19].
116	*Vitis vinifera* Linn.	Vitaceae	Munkka	Fruit	Skin diseases, in diarrhea, astringent, throat affection, demulcent, cooling, sweet, stomachic, heat of body, in thirst, cough, hoarseness, consumption [17, 28].
117	*Vitex negundo* Linn.	Verbenaceae	Nirgundi	Leaf	Tonic, vermifuge, headache, catarrhal, discutient, in dispersing swellings of joints, rheumatism, fever, for removing foetid discharge and worms ulcers, sinuses [3, 17].
118	*Zizyphus mauritiana* Lam.	Rhamnaceae	Desiber	Fruit pulp & stem bark	Decoction in fever, wounds, ulcer, diarrhea, cooling, astringent, in bilious affections [3, 17].

Table 2. Active chemical constituents of some Ayurvedic crude drugs with pharmacological therapeutic claims [31-34, 48, 49, 78-81]

No.	Botanical name	Chemical composition	Therapeutic uses
1	*Adhatoda vasica* Nees [15,50]	1.0 % Vasicine 2.0 % Total alkaloids	Anti-asthmatic, Bronchodilator Cold remedy
2	*Andrographis paniculata* Wallich ex Nees [37, 50]	10 % Andrographolides	Hepatoprotectant
3	*Boswellia serrata* Roxb. [17, 54, 55, 58]	75 % Organic acids 40 % Boswellic acid 20 % Sennosides	Antiarthritic, Antiinflammatory and laxative action
4	*Bacopa monniera* (Linn.) Pennell. [14,15]	20 % Bacosides A&B	Memory enhancer
5	*Capsicum annum* Linn.[15, 50]	40 % Capsaicin 75 % Capsaicin 90 % Capsaicin	Pain reliever
6	*Centella asiatica* Urb. [50, 19]	8 % Total triterpenes	Skin, health weight management
7	*Coleus forskohlii* Briq. Syn [50, 61]	1 % Forskohlin	Antihypertensive, weight management
8	*Curcuma longa* Linn. [51-53, 56, 57]	Curcumin C3, 95 % Curcuminoids	Antioxidant, anti-viral, anti-inflammatory, anticarcinogenic
9	*Emblica officinalis* Gaertn. [19, 39]	30 %Tannins	Detoxification Rejuvenating agent
10	*Garcinia cambogia* Desr. [50, 17]	50 % (-) HCA (Ca)	Weight management
11	*Garcinia indica* Chois. [50]	CitrinÒ crystalline powder 10 % (-) HCA	Beverages, naturally Red in color
12	*Gymnema sylvestre* R. Br. [77]	Gymnema Sylvestre GS 425 % 75 % Gymnemic acids	Antidiabetic
13	*Glycyrrhiza glabra* Linn.[15, 59]	20 % Glycyrrhizinic acid 5 % Lutein	Eyesight-age related Macular degeneration
14	*Camellia sinensis* (Linn.) Kuntze [75]	40 % Catechins 75 % Catechins 2 % Caffeine	Antioxidant
15	*Commiphora mukul* Engl. [76]	Gugulipid 2.5 % Guggulsterones Z&E	Cholesterol Management
16	*Momordica charantia* Linn. [43-47]	7 % Bitter principles 0.5 % Charantin	Antidiabetic
17	*Morinda citrifolia* Linn. [15]	Fruit Powder	General tonic
18	*Mucuna pruriens* Baker [71,72]	10 % & 15 % *L*-Dopa Min. 20 % Catecholamines	Nerve tonic Energy
19	*Melia azadirachta* Linn. [35, 73, 74]	3 % Bitter Principles	Anti-bacterial
20	*Phyllanthus amarus* Linn [15].	0.02 % Phyllanthine & hypophyllanthine	Anti-hepatitis
21	*Picrorhiza kurroa* Royle ex Benth., [	4 % Kutkin	Hepatoprotectant

Continuted table 2

22	*Piper nigrum* Linn. [15, 50]	95 % Piperine	Nutrient bio-availability Enhancer
23	*Piper longum* Linn. [15, 50]	1.5 % Piperine	Biopotentiator, ant-asthmatic thermogenic
24	*Rubia cordifolia* Linn.	4:1 Concentration	Skin disorders
25	*Sida cordifolia* Linn. [60]	0.8 % Ephedrine 10 % Isoflavones	Bronchodilator anti-carcinogenic
26	*Terminalia arjuna* W. & A. [15]	1 % Arjunolic acid	Revitalizing, circulation
27	*Terminalia bellerica* Roxb. [15]	35 % Tannins	Rejuvenating agent
28	*Terminalia chebula* Retz. [15]	30 % Tannins	Rejuvenating agent
29	*Tinospora cordifolia* Miers [66-70]	2.5 % Bitter principles	Diuretic
30	*Tribulus terrestris* Linn. [15,50]	20 % Steroidal saponins 45 % Steroidal saponins	Muscle building, Anabolic alternative
31	*Ocimum sanctum* Linn [34]	2 % Ursolic acid	Antidiabetic Stress management
32	*Tylophora asthmatica* W &A.[15]	0.1 % Total alkaloids	Anti-asthmatic
33	*Withania somnifera* (Linn.) Dunal [30-63]	5 % Withanolides, 1.0 % alkaloids, 0.25 % withaferin	Herbal adaptogen
34	*Zingiber officinale* (Willd.)Rosc. [15,50]	5 % Gingerols	Digestive aid Ginger soft extract

Table 3. Main imported medicinal plants in India [3, 18, 82]

No.	Botanical name of plant	Common name
1	*Glycyrrhiza glabra*	Mulhathee
2	*Pimpinella anisum*	Anise fruit
3	*Thymus vulgaris*	Hasha
4	*Operculina turpethum*	Turbud
5	*Cuscuta epithmum*	Aftimum vilaiyti
6	*Smilax ornate*	Ushba
7	*Smilax china*	Chopchini
8	*Lavandula stoechas*	Vstukhudus

counterparts, not to mention even of its safety and economy. The knowledge of these valuable plant remedies have not been documented and was orally dissipated by the tribal populations. But these tribal possessed remarkably accurate knowledge about the medicinal use of the plants around them. Numerous drugs have entered the global market and international pharmacopoeia through the study of ethno-pharmacology and traditional medicine [83]. Major thrust by whole of the pharmaceutical industry is focused towards design and development of new innovative/indigenous plant based drugs through investigation of leads from traditional system of medicine [84].

Ayurvedic medicinal plant products are most convenient and have greater acceptance amongst the users due to their easy availability easy biodegradability, easy to handling, economic cost, mankind and environment friendly nature both and minimum side effect. Despite this the traditional

Table 4. Main exported medicinal plants in India [3, 18, 82]

No.	Botanical names	Family	Common name	Parts used
1	*Acorus calamus* Linn.	Araceae	Vacha	Rhizome
2	*Argemone mexicana* Linn.	Papaveraceae	Datura.	Fruit
3	*Adhatodo vasica*	Acanthaceae	Vasa	Whole plant
4	*Aconitum species*	Ranunclulaceae	-	Root
5	*Berberis aristata*	Berberidaceae	Daru haridra	Root
6	*Curcuma amada* Linn.	(Scitaminaceae	Amba haldi	Rhizome
7	*Curcuma longa* Linn.	Scitaminaceae	Haldi	Rhizome
8	*Curcuma aromatica* Salish	Scitaminaceae	Jangali haldi	Wild turmeric
9	*Cassia lanceolata* Linn. (Forsk)	Caceslpiniaceae	Thalispathri	Leaf
10	*Cassia angustifolia*	Leguminosae	Hindisana	Leaf & pod
11	*Colchicum luteum*	Liliaceae	Hirantutiya	Rhizome, Seed
12	*Hedychium spicatum*	Zingiberaceae	Sitruti	Rhizome
13	*Ipomaea hederacea* Jacq.	Convolvulaceae	Kala dana	Pharbitis
14	*Inula racemosa*	Compositae	Rasan	Rhizome
15	*Juglans regia*	Juglandaceae	Akhrot	Bark
16	*Juniperus communis*	Cupressaceae	Aaraar	Fruit
17	*Juniperus macropoda*	Cupressaceae	Dhup	Fruit
18	*Withania somnifera* Dunal.	Solanaceae	Aswagandha	Vegetable rennet
19	*Myrica nagi* Thunb.	Myricaceae	Kaifal	Leaf
20	*Nardostachys jatamansi* DC.	Valerianaceae	Jadamanshi	Whole plant
21	*Nigella sativa* Linn..	Ranunculaceae	Kalajeera	Seed
22	*Ptychotis ajowan* DC.	Umbelliferae	Ajwain	Leaf
23	*Piper longum* Linn.	Piperaceae	Adamkath	Fruit
24	*Punica granatum*	Punicaceae	Dadima	Flower, Root, Bark
25	*Podophyllum emodii*	Berberidaceae	Papra	Rhizome
26	*Rubia cordifolia* Linn..	Rubiaceae	Medhamahmeda	Madder root
27	*Rauwolfia secrpantina*	Apocynaceae	Chota chand	Root
28	*Sapindus trifoliatus* Linn.	Sapindaceae	Sonth (dried)	Indian fiber
29	*Symplocos racemosa* Roxb.	Styraceae	Majithlall	Bark
30	*Swertia chirata* Ham.	Gentianaceae	Chiraita	Whole plant
31	*Terminalia chebula* Retz.	(Combretaceae	Harda chota	Bark and seed
32	*Zingiber officinale Roseoe.*	Gingiferaceae	Adrak (fresh)	Rhizome

knowledge system in India is facing a major set back due lack of documentation. There is an urgent need to record all Ayurvedic and ethno botanical information among the diverse ethnic communities before some of very important aspects of the traditional culture are completely lost. So in this review a number of aspects related to plant products have been put at a single platform so that the in built potential of these

Table 5. Threatened/Endangered medicinal plants in India [3, 18, 82]

No.	Plants Name	Present status
1	*Aconitum deinorrhizum*	Almost extinct
2	*Aconitum heterophyllum*	Greatly threatened
3	*Angelica glauca*	Threatened
4	*Arnebia benthemii*	Threatened
5	*Artemisia brevifolia*	Likely to be threatened
6	*Artemisia maritima*	Likely to be threatened
7	*Atropa acuminata*	Threatened
8	*Berberis aristata*	Threatened
9	*Bunium persicum*	Greatly threatened
10	*Colchicum Iuteum*	Threatened
11	*Corydalis govaniana*	Likely to be threatened
12	*Dactylorhiza hatagirea*	Threatened
13	*Dioscorea deltoidea*	Threatened
14	*Ephedra gerardiana*	Likely to be threatened
15	*Ferula jaeschkeana*	Threatened
16	*Gentiana kurroa*	Threatened
17	*Hedychium spicatum*	Likely to be threatened
18	*Jurinea dolomiaea*	Likely to be threatened
19	*Nardostacys jatamansi*	Threatened
20	*Orchis latifolia*	Threatened
21	*Picrorhiza kurroa*	Likely to be threatened
22	*Posophyllum emodi*	Threatened
23	*Rheum emodi*	Threatened
24	*Swertia chirata*	Threatened
25	*Valeriana wallichii*	Likely to be threatened
26	*Zanthoxylum alatum*	Likely to be threatened
27	*Savssurea costus*	Likely to be threatened
28	*Cinnamomumtamala*	Likely to be threatened
29	*Gloriosasuperba*	Likely to be threatened
30	*Rauwolfia serpentina*	Likely to be threatened

herbs can be explored at international scientific level in a more systematic form. The information available in this review could be helpful to scientists, drug designers, medicinal plant boards and other scientific bodies related to ayurvedic research. The traditional knowledge with its holistic and systems approach supported by experimental base can serve as an innovative and powerful discovery engine for newer, safer and affordable medicines. These plant species mentioned in the ancient texts of Ayurvedic and other

Table 6. Availability of medicinal plants in different bio-geographical zones of India [14, 17, 18]

No.	Bio-geographical zones	No. of known medicinal plants	Occurrence of some important medicinal plants
1	Trans Himalayan zone	700	Ephedra gerardiana, Hippophae rhamnoides, Arnebia euchroma
2	Himalayan zone (i) North West Himalaya (ii) Western Himalaya	1,700	Aconitum spp., Berberis spp., Ferula jaeschkeana, Saussurea costus, Dactylorhiza hatagirea, Picrorhiza kurroa, Podophyllum hexandrum, Rheum australe, Swertia chirayita, Taxus wallichiana, Gentiana kurroo, Inula racemosa.
	(iii) Central Himalaya (iv) Eastern Himalaya	1,200	Nardostachys grandiflora, taxus wallichiana, coptis teeta, panax pseudo-ginseng, Swertia chirayita, Rheum australe,picrorhiza kurroa, podophyllum hexandrum, gaultheria fragantissima, entada pursaetha.
3	Desert zones Kutch and Thar	500	Convolvulus microphyllus, Tecomella undulata, Citrullus colocynthis, Cressa cretica.
4	Semi-arid zone	1,000	Commiphora wightii, Alhagi pseudalhagi, Salvadora spp.
5	Western Ghats (i) Western Ghats mountains (ii) Malabar coasts	2,000	Myristica malabarica, Coscinium fenestratum, Garcinia indica, Vateria indica, Utleria salicifolia,
6	Deccan Peninsula (i) Deccan Plateau south (ii) Central Plateau (iii) Eastern Plateau (iv) Chhota Nagpur (v) central Highlands	3,000	Pterocarpus santalinus, Mesua ferrea, Decalepis hamiltonii, Aristolochia spp., Terminalia paliida
7	Gangetic Plains (i) Upper Gangetic Plains (ii) Lower Gangetic Plains	1,000	Holarrhena pubscens, Mallotus phillipinensis, Pluchea lanceolata, Peganum harmala, Chlorophytum spp., Rauvolfia serpentine, Saraca asoca
8	North East India (i) Brahmaputra valley (ii) Assam hills	2000	Aquilaria malaccensis, Smilax glabra, Abroma augusta, Hydnocarpus kurzii.
9	Islands (i) Andaman islands (ii) Nicobar islands (iii) Lakshdeep islands	1,000	Calophyllum inophyllum, Adenanthera pavonina, Barringtonia asiatica, Aisandra butyracea
10	Coasts. (i) West coasts (ii) East coasts	500	Rhizophora mucronata, Acanthus ilicifoloius, Avicennia marina, Sonneratia caseolaris.

Indian systems of medicines may be explored with the modern and most sophisticated scientific approaches for better leads in the health care. The development of these traditional systems of medicines with the perspectives of safety, efficacy and quality will help not only to preserve this traditional heritage but also to rationalize the use of natural products in the health care.

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References

[1] World Health Organization,: Quality control methods for medicinal plant materials. Published by WHO, Geneva, 1998.

[2] El SN and Karakava S. Radical scavenging and iron-chelating activities of some greens used as traditional dishes in Mediterranean diet. Int J Food Sci Nutr, 2004, 55: 67.

[3] Samy PR, Iushparaj PN, Gopalakrishnakone PA. Compilation of bioactive compounds from Ayurveda, Bioinformation, 2008.

[4] Subhose V, Narian A. Basic principles of pharmaceutical science in Ayurvĕda. Bull Indian Inst Hist Med Hyderbad, 2005, 35: 83.

[5] Ballabh B and Chaurasia OP. Traditional medicinal plants of cold desert Ladakh--used in treatment of cold, cough and fever. J Ethnopharmacol, 2007, 112: 341.

[6] Dev S Ethnotherapeutic and modern drug development: The potential of Ayurveda. Current Sci, 1997, 73: 909.

[7] Perumal Samy R and Ignacimuthu S. Screening of 34 Indian medicinal plants for antibacterial properties. J Ethnopharmacol, 1998, 62: 173.

[8] Perumal Samy R and Gnacimuthu SI. Antibacterial activity of some folklore medicinal plants used by tribals in Western Ghats of India. J Ethnopharmacol, 2000, 69: 63.

[9] Kamboj V P. Herbal medicine – Some comments. Current Sci, 2000, 78: 35.

[10] Rabe and Staden J V. Antibacterial activity of South African plants used for medicinal purposes. J Ethnopharmacol, 1997, 56: 81.

[11] Nayar M P. The *ecological biogeography* of the lowland endemic tree flora. Bull Bot Surv Ind, 1987, 29: 319.

[12] Cox PA, Ethnopharmacology and the search for new drugs Bioactive Compounds from PlantsCiba Foundation Symposium 154, Chichester, John Wiley & Sons, 1990, 40.

[13] Cox P, Balick M. The ethnobotanical approach to drug discovery. Sci American, 1994, 82.

[14] Tiwari S, Singh A. Toxic and sub-lethal effects of oleadrin on biochemical parameters of freshwater air breathing murrel, Chant punctatus (Bloch). Indian J Exp Biolo, 2004, 42: 413-18.

[15] Tiwari S. Plants: A Rich Source of Herbal Medicine. Journal of Natural Products, Vol 1, 2008, 27-35.

[16] Ved DK, Mudappa A, Shankar D. Regulating export of endangered medicinal plant species-need for scientific vigour. Curr Sci, 1998, 75: 341-4.

[17] Chopra RN, Nayar SL, Chopra IC. Glossary of Indian medicinal plants. NISCIR, CSIR, Delhi 2002.

[18] Singh J, Singh AK, Pravesh R. Product ion and trade potential of some important medicinal plants: an overview. In: Proceeding of first national interactive meet on medicinal and aromatic plants, CIMAP, Lucknow, India, 2003, 50-8.

[19] Ayurvedic Pharmacopoeia of India, Part-1, Govt. of India, Deptt. of ISM&H, published by the controller of publications, Delhi.

[20] Pan R, Qiu S, Lu D, Dong J. Curcumin improves learning and memory ability and its neuroprotective mechanism in mice. Chinese Med J, 2008, 121(9): 832-39.

[21] Gul N, Mujahid TY, Jehan N, Ahmed S. Studies on the antibacterial effect of different fractions of Curcuma longa against various urinary tract infection isolates Pakistan J Biol Sci, 2004, 7(12): 2055-60.

[22] Araujo CAC, Leon L L. Biological activities of Curcuma longa L Mem Inst Oswaldo Cruz, 2001, 96: 723-8.

[23] Rafatullah S, Tariq M, Alahyah MA. Evaluation of turmeric (*Curcuma longa*) for gastric and duodenal antiulcer actuivity in rats. J Ethnopharmacol, 1990, 29(1): 25-34.

[24] Srimal RC. Turmeric: A brief review of medicinal properties Fitoterapia, 1997, 68(6): 483-93.

[25] Garg SK, Mathur VS, Chaudhury RR. Screening of Indian plants for antifertility activity Indian J Exp Biol, 1978, 16: 1077-9.

[26] Chopra, HK. Almonds a panacea Longevity and Health, 2004, 17.

[27] Dahanukar SA and Thatte UM. Therapeutic approaches in Ayurveda Revisited, Popular Prakashan, Mumbai, 1989a, 74-130.

[28] Dahanukar SA and Thatte UM. Therapeutic approaches in Ayurveda Revisited, Poppular Prakashan, Mumbai, 1989b, 109-10.

[29] Deshmukh A and Usha D. *In vitro* effect of Tinospora cordifolia on PMN function Update Ayurveda-94, Bombay, India 24th-26th Feb, 1994, 63.

[30] Parbhakar C, Koshy V, Menon S and Viadyanathan V. Effect of withania somnifera, asparagus racemosus and lakshadi thalim in improving the physical and mental health of school children Medicinal and Nutritional Research Communications 1994, 2, 15-8.

[31] Uniyal MR. Effective ayurvedic medicinal plants used in Rasayana therapy In proceedings of Ayurvedic conference

on Rasayana 25-26 March, RAV, Delhi, 2002, 180-7.
[32] Wagner H, Norr H and Winterhoff H. Plant adaptogens Phytomedicine, 1994(1), 63-76.
[33] Achrekar S, Kaklij GS, Pote MS, Kelkar SM. Hypoglycemic activity of *Eugenia jambolana* and *Ficus bengalensis*: mechanism of action. *In Vivo.* 1991, 5(2): 143-7.
[34] Bailey CJ, Day C. Traditional plant medicines as treatments for Diabetes, Diabetes Care, 1989, 12: 553-64.
[35] Chattopadhyay, RR. Effect of Azadirachta indica on leaf extract on hepatic glycogen in rats. Ind J Pharm, 1993, 25: 174-5.
[36] Leatherdale BA, Panesar RK, Singh G, Atkins TW, Bailey CJ, Bignell AH. Improvement in glucose tolerance due to Momordica charantia (Karela). Br Med J (Clin Res Ed) , 1981, 282: 1823-4.
[37] Maiti R, Jana D, Das UK, Ghosh D. Antidiabetic effect of aqueous extract of seed of Tamarindus indica in streptozotocininduced diabetic rats. J Ethnopharmacol, 2004, 92 (1), 85-91.
[38] Mahapatra PK, Pal M, Chaudhari AKN, Chakraborty D, Basu A, Preliminary studies on glycemic effect of Syzyginium Cumini seeds. IRCS Medical Science Biochemistry, 1985, 13 (7): 129-33.
[39] Nammi et al. Fresh leaves juice of Catharanthus roseus reduces blood glucoseBio Med central Compl Altern Med, 2003, 3(1), 4-6.
[40] Nadig PD, Laxmi S, Agarwala A. Antidiabetic activity of phyllanthus amarus and its probable mode of action Ind J Pharmacol, 2004, 36, S21.
[41] Shapiro K, Gong WC. Natural products used for Diabetes, J Am Pharm Assoc, 2002, 42: 217-26.
[42] Shane-McWhorter L. Biological complementary therapies: a focus on botanical products in Diabetes, Diabetes Spectrum 2001, 14: 199-208.
[43] Srivastava Y, Venkatakrishna , Bhatt H, Verma Y, Venkaiah K, Raval BH. Antidiabetic and adaptogenic properties of Momordica charantia extract: An experimental and clinical evaluation. Phytother Res 1993, 7: 285-9.
[44] Welhinda J, Karunanayake EH, Sherif MHR, Jayasinghe KSA. Effect of Momordica charantia on the glucose tolerance in maturity onset diabetes, J Ethnopharm 1986, 17: 277-82.
[45] Karnic CR. A clinical trial of a composite herbal drug in treatment of diabetes mellitus (madhumeha) Aryavaidyan, 1991, 5(1): 36-46.
[46] Grover JK, Vats V, Rathi SS, Dawar R. Traditional Indian Antidiabetic plants attenuate progression of renal damage in streptozotocin induced diabetic mice Journal of ethnopharmacology, 2001 76: 233-8.
[47] Mokdad AH, Ford ES, Bowman BA, Dietz WH, Vinicor F, Bales VS & Marks V S. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001, JAMA 289, 76-9.
[48] Sharma RD. Effect of fenugreek seeds and leaves on blood glucose and serum insulin responses in human subjects, Nutrition Research, 1986, 6(12): 1353-64.
[49] Patwardhan B, Ashok DBV, Chorghade M. Ayurveda and natural products drug discovery. Current Science, 2004, 80(6), 789-99.
[50] Krishna CM, Subhose V, Sannd R, Meena A K, Mangal AK, Kumar Sanjiv & Bansal Parveen. Indicative Substance for Quality Assurance of Ayurvedic Drugs. National workshop on quality control of ASU Drugs with pharma industry as a partner, held on 24th January 2009 at NIAPR Patiala, 2009, 139-44.
[51] Mishra S, Palanivelu K. The effect of curcumin (turmeric) on Alzheimer's disease: An overview, Annals Indian Acad Neurol, 2008, 11: 13-9.
[52] Bernard GT, Esteban P, Christopher JS. Turmerones: Isolation from Turmeric and their Structure Determination. Chem Commun, 1982, 6: 363.
[53] Scientific Correspondence, Major constituents in leaf essential oils of *Curcuma longa* L. and *Curcuma aromatica* Salisb. Current Science, 2002, 83 (11): 1312-3.
[54] Abraham Z, Bhakuni DS, Garg HS, God AK, Mehrotra BN, Patnaik GK. Screening Indian plants for biological activity: Part XII. Indian Journal of Experimental Biology, 1986, 24: 48-68.
[55] Yegnarayan R, Saraf AP, Balwani JH. Comparison of anti-inflammatory activity of various extracts of Curcuma longa (Linn). Ind J Med Res, 1976, 64: 601-8.
[56] Rao TS, Basu N, Siddiqui HH. Anti-inflammatory activity of *Curcumin analogues*. Ind J Med Res, 1982,75: 574-8.
[57] Aggarwal BB, Harikumar KB. Potential therapeutic effects of curcumin, the anti-inflammatory agent, against neurodegenerative, cardiovascular, pulmonary, metabolic, autoimmune and neoplastic diseases. Int J Biochem Cell Biol, 2009, 41(1): 40-59.
[58] Sandur K, Pandey MK, Sung B, Ahn KS, Murakami A, Sethi G, Limtrakul P, Badmaev V, Aggarwal BB. Curcumin demethoxycurcumin, bisdemethoxycurcumin, tetrahydrocurcumin, and turmerones differentially regulate anti-inflammatory and anti-proliferative responses through a ROS-independent mechanism. Carcinogen, 2007, 28(8): 1765-73.
[59] Faizal P, Suresh S, Satheesh Kumar R, Augusti KT. A study on the Hypoglycaemic and hypolipidemic effects of an Ayurvedic Drug Rajanyamalakadi in diabetic patients. Indian J Clin Biochem, 2009, 24(1): 82-7.
[60] Mehta K, Pantazis P, McQueen T, Aggarwal BB. Antiproliferative effect of curcumin (diferuloylmethane)

against human breast tumor cell lines. Anticancer Drugs, 1997, 8(5): 470-81.

[61] De Clercq E. Current lead natural products for the chemotherapy of human immunodeficiency virus (HIV) infection. Med Res Rev, 2000, 20: 323–49.

[62] Kapil A and Sharma S. Immunopotentiating compound from Tinospora cordifolia. J Ethnopharmacol, 1997, 58, 89

[63] Salil KB. Antioxidant activity of glycowithanolides from withania somnifera. Ind J Experimental Biol, 1997, 35(3), 236-9.

[64] Maries RJ, Farnsworth, NR. Antidiabetic plants and their active constituents.Phytomedicine, 1995, 2: 137-89.

[65] Yongchaiyudha S, Rungpitarangsi V, Bunyaprahatsara N, Chokechaijaroenporn O, Yongchaiyudha S. Antidiabetic activity of Aloe vera L juice I Clinical trial in new cases of diabetes mellitus, Phytomedicine 1996, 3: 241-43.

[66] Mathew S, Kuttan G. Antioxidant activity of Tinospora cordifolia and its usefulness in the amelioration of cyclophosphamide toxicity. J Ext Clin Cancer Res1,16: 407-11.

[67] Mahajan VR, Jolly Cl. A new hypoglyceamic agent from Tinospora cordifolia Miers Indian Drugs, 1985, 23: 119-20.

[68] Grover JK, Vats V, Rathi SS. Antihyperglycemic effect of Eugenia jambolana and Tinospora cardifolia in experimental diabetes and their effects on key metabolic enzymes involved in carbohydrate metabolism. Journal of ethanopharmacology, 2000,73: 461-70.

[69] Prince PS, Menon VP. Antioxidant activity of Tinospora cordifolia roots in experimental diabetes. J Ethnopharmacol, 1999, 65: 277-81.

[70] Sinha K, Mishra NP, Singh J, Khanuja SPS. Tinospora cordifolia (Guduchi), a reservoir plant for therapeutic applications: A Review. Ind J TradKnowledge, 2004, (3) 257-70.

[71] Welihinda J, Karunanayake EH, Sheriff MH, Jayasinghe KS. Effect of Momordica Charantia on the Glucose Tolerance in Maturity Onset Diabetes. J Ethnopharmacol, 1986, 17(3): 277-82.

[72] Leatherdale BA, Panesar RK, Singh G. Hypoglycemic Activity of Polypeptide-P From a Plant Source. J Nat Prod, 1981, 44(6): 648-55.

[73] Sonia B and BP Srinivasan. Investigation into the Anti-diabetic Activity of Azadirachta indica. Ind J Pharm, 1999, 31: 138-41.

[74] Ebong PE, Atangwho IJ, Eyong EU and Egbung GE. The Antidiabetic Efficacy of Combined Extracts from Two Continental Plants: Azadirachta indica (A Juss) (Neem) and Vernonia amygdalina (Del) African Bitter Leaf). American Journal of Biochemistry and Biotechnology, 2008, 4 (3): 239-44.

[75] Venkateswaran S and Pari L. Effect of Coccinia indica leaves on antioxidant status in streptozotocin-induced diabetic rats Journal of Ethnopharmacology, 2003, 84, (2-3), 163-8.

[76] Rizvi SI, Zaid MA, Suhail M Insulin-mimetic effect of (-) epicatechin on osmotic fragility of human erythrocytes. Indian JExp Biol 1995, 33: 791-2.

[77] Gray AM and Flatt PR. Insulin-secreting activity of the traditional antidiabetic plant Viscum album (mistletoe). Journal of Endocrinology, 1999,160: 409–14.

[78] The Wealth of India, Volume I – VI, CSIR, National Institute of Science Communication, New Delhi, 1999.

[79] Isbrucker R A, and Burdock G A. Risk and safety assessment on the consumption of Licorice root (Glycyrrhiza sp.), its extract and powder as a food ingredient, with emphasis on the pharmacology and toxicology of glycyrrhizin. Regulatory Toxicological Pharmacology, 2006, 46(3): 167-92.

[80] Narayana A and Subhose V. Standardization of Ayurvĕdic formulations: a scientific review. Bulletin Indian Institute History Medical, Hyderabad, 2005, 35: 21.

[81] Chatterjee I, Chakravarty AK, Gomesa A, Daboia russellii and Naja kaouthia venom neutralization by lupeol acetate isolated from the root extract of Indian sarsaparilla Hemidesmus indicus R.Br . Journal of Ethnopharmacology, 2006, 106(1): 38-43.

[82] Handa S S. Medicinal plants based drug industry and emerging plant drugs – Review, Indian Journal Med Res, 233-63.

[83] Waxler NE. Morrison plural medicine in India and Srilanka: do ayurvedic and Western medical practice offer? Soc Sci Med, 1988, 27: 531-44.

[84] Patwardhan B, Ashok DBV, Chorghade M. Ayurveda and natural products drug discovery. Current Science, 2004, 80(6): 789-99.