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Some Plants used in Ayurvedic and Homoeopathic Medicine

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Traditional medicines are used by about 60% of the world's population. These are used for primary health care, not only in rural areas of developing nations but they are also used in the developed countries where modern medicine are pre dominantly used. In the western world the use of medicinal herbs is continuously growing, approximately 40% of the population is using herbs for medical illness due to increased incidences of adverse effects of allopathic medicine. There are about 45000 plant species in India, Eastern Himalayas, Western Ghats and Andman and Nicobar Islands are the hot spot for medicinal plants. Officially documented plants with medicinal potential are 3000 but traditional practitioner use more than 6000. Seventy percent of the population in the rural India is dependent on the ayurvedic system of medicine. Most of the drugs used in modern medicine and ancient Indian medicinal system are of plant origin. Beside plants many minerals, salts and animal products are used in Ayurvedic medicines. Homoeopathy originated in west, German physician Samuel Hanemann was the father of homoeopathy (1796), the homeopathic remedies are prepared by successive dilution followed by shaking forcefully. Homoeopathy uses animal, plant, mineral, and synthetic substances in its remedies. Arsenicum album (arsenic oxide), Natrum muriaticum (sodium chloride), opium (plant), and thyroindinum (thyroid hormone) are some of the homoeopathic medicines extracted from different sources.

Keyword: Tinospora Cordifolia, Calotropis giopium, gantica, Natrum muriaticum.

1. Introduction

Ayurvedic medicine is a system of traditional medicine, native to India. In Sanskrit word ayush means longevity and veda means related to knowledge^[1]. The earliest literature on Indian medical practice appeared during the vedic period in India. All the Vedas-Rig, Yajur, Sam, and Atharv have contributed to the development of Ayurveda. The *Shushrut samhita* and the *charaka samhita* are great encyclopedias of medicine compiled from various sources from the 600-BC to about 500. *Charaka samhita* has mentioned about 341 plants while *Shushrut samhita* have listed 760 medicinal plants^[2,3]. They are among the foundational works of Ayurveda. A number

of drugs and surgical methods are developed by ayurvedic practitioners for various ailments. Ayurveda stresses on a balance of three elemental energies or humors vata (air & space - "wind"), pitta (fire & water -"bile") and kapha (water & earth "phlegm"). According to ayurvedic medical theory, these three dosas are important for health, because when they exist in equal quantities, the body will be healthy, and when they are not in equal amounts, the body will be unhealthy. Ayurveda stresses on the use of plant-based medicines and treatments. Hundreds of plant-based medicines are employed by ayurvedic practioners. Some animal products may also be used, like milk, bones and minerals

including sulphur, arsenic, lead, copper sulphate. Some metals like gold, silver and mercury are also consumed as prescribed. Many ayurvedic herbs used for therapy have shown very promising results like turmeric and its derivative curcumin^[4] are very good antioxidants. *Tinospora cordifolia* has been tested for its hepatoprotective nature, *Salvia officinalis* (Common sage) may improve Alzheimer's patients^[5]. Many plants used as rasayana (rejuvenation) medications are found potent antioxidants. Homeopathy is a form of alternative medicine in which patients are treated with highly diluted preparations that are supposed to show similar symptoms in healthy persons as the patients. The basic principle of homeopathy, known as the "law of similars", is "let like be cured by like"^[6]. It was first stated by German physician Samuel Hahnemann in 1796. Homeopathy is a vitalist philosophy that interprets diseases and sickness as caused by disturbances in a hypothetical life-force (vital force). Homeopathy states that the vital force has the ability to react and adapt to internal and external causes, which homeopaths refer to as the law of susceptibility. Hahnemann proposed homeopathy in reaction to the traditional western medicine at that time, which often was brutal and more harmful than helpful. He believed that by using drugs to induce symptoms, the artificial symptoms would stimulate the vital force, causing it to neutralise and expel the original disease. Homeopathic remedies are prepared by successive dilution with shaking forcefully, it uses much animal, plant, mineral, and synthetic substances in its remedies. Depending on the dilution, homeopathic remedies may not contain any pharmacologically active molecules (12x)^[7], it is based on the belief that a substance in large amount will produce a symptoms of a specific disease will cure it in very small doses and during the process of dilution a lot of energy is released which helps in curing the ailment.

2. Material and Methods

2.1 Medicinal Plants used in Ayurveda

2.1.1 *Withania somnifera* *Withania somnifera* commonly known as *Ashwagandha* is an

important plant of family Solanaceae known for its rejuvenating properties^[8,9,10] it is also known as Indian Ginseng. It is a very important herb of ayurvedic indigenous medical system known for more than 3000 years. *Withania somnifera* is a very small woody shrub native to drier parts of India. It is commonly found in India, Pakistan, Afghanistan and Africa. It is about 6 feet in height and herbaceous in nature, stem bases of the plant are thickened, cylindrical and green; leaves are erect, ovate in shape petiolate and glabrous. Roots are thickened, branched and brown in colour; fruits are orange coloured berries enclosing many small seeds covered with green persistent calyx.

2.1.2 Chemical Constituents The major constituents of *Ashwagandha* root are steroidal alkaloids and steroidal lactones of a class of compounds known as withanolides. Near about 12 alkaloids and 35 withanolides have been isolated from the plant so far. The whole plant is used for the extraction of compounds. From leaves 9 –steroidal lactones of withanolide series from E-M are extracted. Stem bark contains some withanolides while root contains few alkaloids, flavonolides and free amino acids.

2.1.2.1 Medicinal Properties *W. somnifera* inhibits growth in central nervous system, lung, colon and breast cell illness^[11]. Extract of *Withania somnifera* was found helpful in preventing tumour growth in cancer patients. Studies show that ashwagandha possesses anti-inflammatory, antistress, antioxidant, immunomodulatory, hemopoetic, and rejuvenating properties. It also appears to exert a positive influence on the endocrine, cardiopulmonary, and central nervous systems. Found effective in the treatment of osteo-arthritis inflammation. According to the ayurvedic practitioners in ashwagandha Rasa is tikta, Guna – snigdha, Veerya- ushna and Vipaka is madhura. It is helpful in kapha and vata dosas, and very effective in controlling blood sugar and cholesterol level. It improves overall health so given as rejuvenating drug to the aged persons.

2.3 *Tinospora cordifolia* *Tinospora cordifolia* belongs to the family Menispermaceae and is commonly known as giloiya, guduchi or amruta^[12], the plant is commonly known as Giloya, which is a Hindu mythological term that refers to the heavenly elixir that have saved celestial beings from old age and kept them eternally young. It is used in ayurvedic medicine from a long time (the traditional medicine of India). *Tinospora cordifolia* is a large, glabrous, deciduous climbing shrub^[13]. It is distributed throughout tropical Indian subcontinent, China, Pakistan and Srilanka, ascending to an altitude of 300 m. The stem of *Tinospora cordifolia* is succulent with long hanging aerial roots from its branches. The bark is creamy white to grey, leaves are membranous and heart shaped, flowers are small and yellowish green in colour. Male flowers are in cluster and female flowers are solitary. Fruits are red, ovoid in shape, succulent and single seeded drupe.

2.3.1 Chemical Constituents From the stem of *Tinospora cordifolia*^[14] alkaloid berberin, tinosporin and palmitin are isolated while from roots, tinosporin and palmatine are isolated. From the whole plant, the diterpenoidal lactone tinosporide and tinosporon are obtained. Beside these compounds giloin, giloinin and tinosporic acid are also isolated from the whole plant of *Tinospora cordifolia*.

2.3.2 Medicinal Properties *Tinospora cordifolia* or giloya is widely used medicine in ayurvedic system of medicine for its general tonic, antiperiodic, anti-spasmodic, anti-inflammatory, anti-arthritic, anti-allergic and anti-diabetic properties^[15]. The plant is used in ayurvedic, "Rasayanas" to improve the immune system and the body resistance against infections. The root of this plant is known for its anti-stress, anti-leprotic and anti-malarial activities. The stem is bitter, stomachic, diuretic, stimulates bile secretion, causes constipation, allays thirst, enriches the blood and cures jaundice. The extract of its stem is useful in skin problems. The root and stem of *T. cordifolia* are prescribed in combination with other drugs as an anti-dote to

snake bite and scorpion. Dry barks of *T. cordifolia* has anti-spasmodic antipyretic, anti-allergic, anti-inflammatory^[16,17] and anti-leprotic properties. According to ayurvedic practitioners Rasa of the plant are –tikta, Virrya is heating and Vipaka is madhura. It is widely used for urinary complaints and rheumatism.

2.4 *Calotropis gigantea* *Calotropis gigantea* is a plant of family Asclepidaceae commonly called milk-weed or madder. It is found throughout the India in dry waste lands upto a height of 900m. Madar is a large hard much branched shrub, 3-4 feet in height. The whole plant is used as medicine; it is covered with soft white wool. Leaves of the plant are opposite, subsessile and ovate in shape. Flowers are beautiful purple and white in colour, fruits are fleshy and green in colour.

2.4.1 Chemical Constituents Latex of the plant *Calotropis gigantea* contains the cardiac glycosides, a complex mixture of chemicals, some of which are steroidal heart poisons known as "cardiac aglycones". *Calotropis* contains some glycosides known as calotropin, calotoxin, calactin. Uscharidin and voruscharin are the sugars with nitrogen and sulphur in their structures. Lupeol is isolated from latex. Quercetin-3-rutinoside is identified in the roots, stem, leaves, flowers and latex.

2.4.2 Medicinal Properties The whole plant is used as medicine; its latex is used for the skin problems. In Ayurveda the madar plant is used for asthma, bronchitis, dyspepsia, and swelling^[18,19,20]. Heated leaves are applied on the painful and swollen joints, it relieves the pain due to arthritis. Powdered root bark of the plant is given to the patient suffering from jaundice, asthma and bronchitis. It is used as febrifuge, anthelmintic, expectorant and antidote to snake bite. Its latex is used to induce abortion by folk people. According to Ayurveda, *Calotropis* is used in Kapha and vata dosa, its Rasa is tikta, Virrya is ushna, Vipaka is katu and Guna is snigdha. *Calotropis* is also used as an important homeopathic drug.

2.5 Andrographis paniculata *Andrographis paniculata* is a shrub of family Acanthaceae .It grows in most places in India, including the plains and hilly areas up to 500 m, which accounts for its wide use. Native populations of *A. paniculata* are spread throughout south India and Sri Lanka which perhaps represent the centre of origin and diversity of the species. Since the time immemorial *Andrographis paniculata* or kalmegh is a popular Ayurvedic and Chinese house hold remedy for the common cold, digestive issues and many other illness^[21,22]. Kalmegh grows erect to a height of 30- 100 cm in height with glabrous leaves and white flowers having purple spots on the petals . Flowers are solitary and small in size; fruit is 2 cm long with numerous yellow brown seeds.

2.5.1 Chemical Constituents *Andrographis paniculata* is a plant is known to possess a variety of pharmacological activities. Andrographolide bitter water –soluble bicyclic diterpenoid lactone is the major constituent extracted from the leaves, beside this compound andrographine and many flavanoids are also extracted from the root of the plant. Neoandrographolide and Oxyandrographolide from whole plant have also been isolated

2.5.2 Medicinal Properties *A. peniculata* is used in traditional ayurvedic and siddha^[23] systems of medicine as well as in tribal medicine in India and some other countries for multiple clinical applications. Leaves of the herb *Andrographis paniculata* are used for ailments ranging from poor digestion to hepatitis. In the Chinese medical tradition, the plant has been used to treat everything from gastrointestinal complaints to throat infections. The plant extract exhibits anti-typhoid, anti-diabetic and antifungal activities. Kalmegh is also reported to possess, antibiotic, antimalarial, antithrombogenic, antiinflammatory, and anti hepato toxic, anti-snake venom, antipyretic and anti-cancer drug. It is used to regulate high blood pressure but it is restricted for pregnant women. *Andrographis* balances pitta and kapha dosas, its rasa is tikta

guna is ruksha, veerya is ushna and vipaka is katu.

2.6 Medicinal plants used in Homeopathy

Homeopathy is a totally different therapy than ayurveda and allopathy, in it drug is decided by studying the symptoms of the patient. Each patient is treated by different medicines for the same ailments according to their symptoms. It is a therapy of like cures like.

2.6.1 Pulsatilla nigricans: The genus *Pulsatilla* contains about 33 species of herbaceous perennials native to North America, Europe and Asia. Its common name is pasque flower or the meadow anemone. It is a member of family Ranunculaceae, widely used in homeopathic medicines^[24,25]. The petals are deeply cut, bell-shaped, dark purple flowers and are valued for ornamental purpose, leaves are finely dissected. According to a Roman myth, the pasque flower has its origin in the tears of goddess Venus and, hence, people in ancient times used this flower to treat tearfulness. *Pulsatilla* is highly toxic, and produces cardiogenic toxins and oxytoxins. Excess use can lead to diarrhoea, vomiting, convulsions and coma.

2.6.2 Therapeutic use of Pulsatilla It has been found that *Pulsatilla* works best for those people who have a sweet and gentle nature. It is pre-eminently a female remedy, especially for mild, gentle, yielding disposition. Sad, thirstless, crying readily; weeps when talking. The patient seeks the open air; always feels better in open air. In 1805 Hanemann proved that pulsatilla is an effective remedy for an assortment of disorders that may vary from cold and cough to gynecological problems like delayed, scanty and painful menstruation.

2.6.3 Bryonia alba: *Bryonia alba* is a plant of family cucurbitaceous, it grows in Europe, North Africa and South Asia. It is a perennial climbing herb with palmately lobed leaves; flowers are white in colour and grow in axillary clusters. The whole plant is very poisonous and fatal. It

contains highly toxic compound cucurbitacin, having antitumour and anti-microbial activity.

2.7 Therapeutic use of Bryonia Bryonia patients are emotionally, bodily and mentally dried up^[26,27]. He wants to be left alone, undisturbed, while at the same time constantly needing great quantities of water to balance his dryness. The Bryonia individual is most often a male. The sensation of dryness of the mucous membranes is most frequently reported. Symptoms of bryonia patients are dried mucous membranes, very few or scanty expectorations, thirsty, urine very dark and scanty, stinging and tearing pains, increasing by motion. Bryonia is given to the patients suffering from constipation, stiffness of joints due to rheumatism, headache, bronchitis, pneumonia and in measles.

2.7.1 Aconitum napellus: *Aconite* is a herbaceous perennial 2-5 feet in height, familiarly known as Monk's Hood, it bears beautiful hooded violet flowers that appear in mid-summer and grows from Himalayas to Europe. It is a member of family Ranunculaceae the plant is known for its poisonous alkaloids, benzaconine and aconine, found in the highest degree of concentration in the roots. Historically the poison from this plant was used as an arrow toxin. This plant was first used as a homeopathic remedy in 1805 by the founder of homeopathy, Samuel Hahnemann. This remedy is especially useful for symptoms that come on suddenly after a fright^[28,29] or exposure to cold. Physical symptoms that develop as a result of shock, especially coughs, colds and fevers, respond well to this remedy.

2.7.2 Therapeutic use of Aconite: *Aconite* is a staple remedy in any homeopathic first aid kit. It is useful for extreme fear and anxiety that comes on suddenly. Fear of death, fear of crowd, going out. Patient is always in great anxiety and restless, does not want to be touched, aconite patient is over sensitive to noise and cannot bear music. Complaints from exposure to cold and hot weather, feels better in open air but worse in warm room, pains are intolerable, always aggravated at night. *Aconite* is a remedy to the

patients of anxiety, rheumatism, cardiac patient, and fever due to measles and typhoid, it relieves pain and induces sweating. It is a general remedy for gastro-intestinal troubles. It is also used in ayurvedic medicine.

2.7.3 Berberis vulgaris: *Berberis* is a plant of family Berberidaceae an ever green shrub, 1-5m tall with thorny shoots, native to the temperate and subtropical region of Europe, Asia, Africa, and America. Species diversity is greatest in South America, Africa and Asia; Europe has a few species. *Berberis Vulgaris* known as "barberry" is a thorny shrub with yellow flowers, small red fruits. Leaves are of two types some are thorny while some are leathery with spines on their edges. Flowers are beautiful and yellow in colour. Stem is brown from outside but yellow inside. Barberry fruits contain glucose, fructose, malic acid, pectine and vitamin C. In some countries fruits are used to prepare jam and jellies.

The herb contains a number of active components used as haemostatic, diuretic, and vasodilator, and hypotensive, antibacterial and anti-inflammatory agent. Root bark of the plant is known for containing Berberine^[30,31,32], agent which stimulates digestion and reduces the gastrointestinal pains, it is also used as antidiabetic and anti-tumor agent. It is also known that this substance toughens the immune system. The bark contains a large number of alkaloids like berberine, berbamine, and tannins.

2.7.4 Therapeutic use of Berberis *Berberis* is used in bruised pain, with numbness in the region of kidney. *Berberis Vulgaris* patients feel stiffness and lameness with painful pressure in lumbar and renal region and chill along the spine. *Berberis* is prescribed to the patients suffering from kidney and urinary problems, gallstone pain, burning pain in the joints and scanty menses. *Berberis* is also used in ayurveda for the liver problems.

Table 1: Summary of discussed plants.

S.N	Botanical Name	Family	Chemical constituents	Used for
1.	<i>Withania somnifera</i>	Solanaceae	Withanolides	Osteo- arthritis, depression
2.	<i>Tinospora cordifolia</i>	Menispermaceae	Tinosporin, tinosporic acid, gilonin	Diabetes, malaria, jaundice
3.	<i>Calotropis gigantea</i>	Asclepidaceae	Calotropin, calotoxin, lupeol from latex	Asthma, bronchitis, fever, jaundice
4.	<i>Andrographis paniculata</i>	Acanthaceae	Andrographolide, andrographine	Typhoid, cancer blood pressure
5.	<i>Pulsatilla nigricans</i>	Ranunculaceae	Anemonin, isoanemonin (C ₁₀ H ₈ O ₄)	Fever, mumps, sore - throat
6.	<i>Bryonia alba</i>	Cucurbitaceae	Cucurbitacin, bryonin	Synovial inflammation, pneumonia and measles
7.	<i>Aconitum napellus</i>	Ranunculaceae	Aconitin, isoaconitin, aconitic acid	Stress, anxiety fever due to typhoid, measeles.
8.	<i>Berberis vulgaris</i>	Berberidaceae	Berberin	Liver and kidney problems

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4. References

1. www.wikipedia .org
2. Revitalizing Indian systems of herbal medicine by the National Medicinal Board through institutional networking and capacity ,Current science,,93,(6),2007
3. Kala, C.P.,Indigenous uses, population density, and conservation of threatened medicinal plants in protected areas of the Indian Himalayas.Conserv. Biol,19,368-378 .2005
4. Aggarwal, B.B., Sundaram, C., Malani, N., Ichikawa, H. "Curcumin: the Indian Solid Gold". Advances in Experimental Medicine and Biology. 595,1-75. 2007.
5. en.wikipedia.org.
6. Ernst, E ,Asystematic review of systematic reviews of homeopathy, British Journal of Clinical pharmacology, 54 (6): 577-82, (2002),
7. Lakshmi Chandra Mishra et.al.Alternative Medicine Review 5(4), 334-346 2000.
8. Dhuley JN. Effect of Ashwagandha on lipid peroxidation in stress-induced animals. J.Ethnopharmacol;60,173-178,1998
9. Indigenous Ethnomedicinal plants, Trivedi P.C.Pointer publisher,Jaipur,271-284,2009.
10. Malhotra CL, Das P, Dhalla MS, and Prasad K, Studies on *Withania somnifera* Dunal Part IV, The effect of total alkaloids on the cardiovascular system and respiration. Ind. J. Med. Res 49,448-460.1961. ,

11. Kuttan,G.,Use of *Withania somnifera* Dunal as an adjuvant during radiation therapy , *Indian J. Exp.Biol.*,34,354 -856,1996.
12. Mahendra kumar shastri Viradh Dravya Gunadarsh, 1st edn. Ayurvedic and Tibbi academy Uttar Pradesh, Lucknow, 1978.
13. Rajlakshmi M,Eliza JPriya CE, Nirmala A, Daisy P. Antidiabetic properties of *Tinospora* stem extract on streptozotocin induced diabetic rats, *Afri. J. Pharm.Pharmco.*,3(5),171-180,2009.
14. Singh S.S.,Pandey SC, Shrivastav S,Gupta VS,Patro B,Ghosh AC,Chemistry and medicinal properties of *Tinospora cordifolia* ,*Indian J. Pharmacology*, 35,83-91,2003
15. Kumar S, Verma NS, Pande D,Srivastava PS. In vitro regeneration and screening of berberine in *Tinospora cordifolia*. *J. Med. Arom. Plant Sci.* 22:61, 2000.
16. Bhatt RK, Sabata BK. Furanoid diterpene glucoside from *Tinospora cordifolia*. *Phytochemistry*; 28, 2419-22,1998.
17. Rao E V, Rao MV,Studies on the polysaccharide preparation (Guduchi Satwa) derived from *Tinospora Cordifolia* .*Indian J.pharm.Sci.*, 43,103-6, 1981.
18. Nalwaya N, Pokhrana G,Debl,Jain N K,Wound healing activity of latex of *Calotropis gigantea* , *International J. of Pharmacy and pharmaceutical Sci*, 1(1),176-181,2009.
19. Shilpkar P,Shah M,Chaudhary D R, An Alternative Use of *Calotropis gigantea* Biomehtnation , *Current Science* ,92(4),2007
20. Manoyuan W,Wenli M,Yuanyuan D,Shenglan L,ZhumianW, Haofu D, Cytotoxic cardinolides from the roots of *Calotropis gigantea*, *Modern Pharmaceutical Research*, 1(2),4-9,2008.
21. Shukla PK, Chaubey O P, Threatened Wild Medicinal Plants Assessment, Conservation and management ,Anmol Publication ,New Delhi,1st edn.116 ,2007.
22. Madav. H.C,T. Tripathi, and S.K. Mishra. Analgesic, antipyretic, and anti ulcerogenic positive side effects of andrographolide. *Indian J. Pharm. Sci.* 57 (3)121-25,1995.
23. Chopra RN, Chopra IC,Handa KL ,*Indigenous Drugs of India* , 2nd edn .Academic Publishers ,New Delhi ,1982.
24. YaprakA E, Koroklu S T, Ketenoglu A O, A synopsis of Genus *Pulsetilla* (Ranunculaceae) in Turkey, *T urk J. Bot.* 35,351-355, 2011.
25. Goel S.and kumar S., Anti-Anxiety Activity Studies On Various extracts of *Pulsetilla nigaricans* ,*Int.J.Pharmaceuticals and Drug Research*,2(4),291-293 ,2010.
26. Farington E.A., *Clinical Materia Medica*, B.Jain Pulishers New Delhi ,1975.
27. Allen H C, Allen's Keynoes ,B Jain Publishers , 10th edn. , 2000.
28. Nautiyal BP, Prakash V,Bahuguna R,Mathani U,Bisht H, Nautiyal MC, Population Study For Monitering the Status of Rarity of three Aconite species in Garhwal Himalayas ,*Tropical Ecology* , 43(2), 297-303 ,2002.
29. Davidson JR, Morrison RM , Shore J ,Davidson RT, Bedyan G, Homeopathic treatment of Depression and Anxiety , *Alternative Therapies*, 3 (1), 46-49 , 1997.
30. Fatehi M, Saleh TM, Hassanaba ZF ,Farrokhfa K, Jafarzadeh M ,Davodi S, Pharmacological study on *Berberis vulgaris* Fruit extract, *J.Ethnopharmacology*,102(1), 46-52 , 2005.
31. Meliani N.,Amine M E ,Allali H, Tabti B, Hypoglycemic Effect of *Burberis vulgaris* in normal and Streptozotocin induced Diabetic rats , *Asian Pacific J. Tropical Biomedicine* ,468-471, 2011.
32. Ivanovska N,Phillipov S , Study on the anti-inflammatory action of *Berberis Vulgaris* root extract alkaloid fraction and pure alkaloid .*Inte. J. Immunopharmacology* .18(10),553-561, 1996.