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REVIEW ARTICLE

An update on plants for hair growth promoting activities

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Abstract

Hair loss is a dermatological disorder affecting approximately 2% of the population across the globe. The exploration for the hair treatment resulted in the discovery of minoxidil and finasteride approved by USFDA but have remarkable side effects. Plants have now emerged as an effective alternate to the approved drugs and hundreds of plants are reported to have potential for hair growth promotion. Some of the plants are under investigation for their traditional claim for the hair growth, their efficacy and search for their effective molecule. In this review, we have highlighted the plants that are being extensively investigated and used for their hair growth property.

INTRODUCTION

Plants have always remain to be a very precious, effective and beneficial source of natural products for safeguarding the human health. Medicinal and Aromatic Plants (MAPs) can be used to treat a number of diseases and/or disorder by systematically investigating the presence of the natural products to acquire a better understanding of their properties as well as their efficacy, safety and efficiency in clinical trials. Hair loss has lately been highlighted as a disorder characterized by the unstable hair follicle protection and an abnormal hair cycle. Aging, hormone imbalance, nutritional deficiency, seborrheic dermatitis, and stress are the primary cause of hair loss. Though it is not life threatening but it causes a psychological enigma and social apathy to the human being with less or no hair. USFDA has approved minoxidil and finasteride as a drug of choice for the hair loss treatment. However, the application of the drugs is restricted by low efficacy and adverse effects. Hence, the curiosity and significance to acquire novel therapeutic and/or preventive resources for the hair loss has increased in recent times [74, 25, 33, 53, 75, 41, 15]. Though plants have been used as a remedy for the hair loss since time immemorial, but only a small number of them have been scientifically validated. A number of natural products and plant materials in the form of herbal formulations are available in market as antidandruff agents, hair cleansing agent, hair conditioner, hair growth promoter, hair tonic as well as for the treatment of lice infection and alopecia [82,30].

In this review, an attempt has been made to collate the properties of plants in hair growth promoting and hair regrowth properties. The information assembled together is summarized in terms of the traditional knowledge, active constituents, role in hair growth, effect on hair follicles, biological activity etc. Below are some plants with remedies for hair loss, hair growth

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promotion and hair regrowth based on reported literature and research.

PLANTS WITH KNOWN HAIR GROWTH EFFECTS ON HUMAN

Cuscuta reflexa

C. reflexa Roxb., commonly known as Amar Bel or the giant dodder belongs to the family Convolvulaceae. It is a parasitic plant (perennial herb) with slender yellow stem and golden yellow leafless branches. In traditional system of medicine it is used for the treatment of bone fracture, fever, headache, labour pain, and rheumatism. The major chemical constituents of *C. reflexa* includes: amarbelin, coumarin, cuscutin, dulcitol, kaempferol, mycricetin, quercetin, sitosterol and stigmasterol. The petroleum ether and ethanol extract of *C. reflexa* are reported to prevent hair loss or to treat the alopecia and its isolate has been shown useful in the treatment of androgen-induced alopecia by inhibiting 5α-reductase (3-oxo-5α-steroid 4-dehydrogenase) [66]. During chemotherapy, the ethanolic and petroleum ether extract were used to prevent hair loss or to treat the alopecia (a frequent side-effect in cancer treatment). The extracts have been revealed to be capable of promoting follicular proliferation or preventing hair loss in cyclophosphamide-induced hair fall [72]. An herbal formulation containing the extracts of *C. reflexa*, *Citrullus colocynthis* and *Eclipta alba* in varying ratio show hair growth–promoting activity [82,83].

Eclipta alba

E. alba L. Hassk., commonly known as Bhringraj or the Bhangara belongs to the family Asteraceae (Compositae). It is an annual herb with solitary white flower found in tropical and sub-tropical regions of India. Traditionally, the plant is used as an antiseptic, deobstruent, emetic, febrifuge and tonic. The juice is given in the treatment of anemia, catarrh, cough, edema, fever, liver disorder, rheumatic joint pain and to enhance appetite and to invigorate digestion. In combination with honey, it is used to treat upper respiratory congestion in children. The plant is also used to check hair loss and act as a scalp tonic for stimulating and promoting hair growth. The extracted juice or the boiled leaves with coconut or seasame oil imparts a black and lustrous look to the hair. Wedelolactone and demethylwedelolactone have been identified as the major constituents present in *E. alba* [81, 17, 14, 44]. In published literature and polyherbal formulations *E. alba* has been implicated with hair growth promoting activity [5, 12]. The methanol extract of *E. alba* promotes hair growth by inducing anagen in telogen (resting) phase of hair follicles. Comparatively, the methanolic extract and minoxidil has been observed to reveal a related hair promoting effects in human [17]. The petroleum ether extract acts as an imperative exogenous mediator which stimulates follicular keratinocyte proliferation and hold-up terminal differentiation by down-regulating the expression of TGF-â1 highlighting the potential use of extract in the treatment of alopecia [9].

Ginkgo biloba

G. biloba L., commonly known as maiden hair tree or the Ginkgo belongs to the family Ginkgoaceae. Ginkgo trees are widely cultivated in China and Japan reaching a height of 20-35 metre and spread to the Tibetan region. The leaf extract contains flavonoid glycosides, phenolic acids and proanthocyanidins like kaempferol, isorhamnetin, myricetin, quercetin and the terpene trilactones (bilobalides, ginkgolides) [90, 91]. Alkylphenols and polyprenols are exclusive ginkgo biflavones also present in leaves [86, 79]. The leaf extract of *G. biloba* is used in various hair care formulations which is exogenously applied and kindle the hair growth and therefore found useful in the treatment of alopecia or baldness. The plant has an anti-clotting effect that increases the circulation and supply of oxygen thereby resulting in improved hair growth. The extracts of *G. biloba* (5-40%), *Liquiritia officinarum* extracts (3-35%) glycerrhizinate were found synergistic in promoting hair growth and stated to be useful for hair treatment. The leaf extract of *G. biloba* also encourages hair regrowth by promoting the proliferation of hair follicle suggesting it as a hair tonic [93, 89, 45].

Panax ginseng

Panax ginseng, commonly known as Asian ginseng, Chines ginseng and/or Korean ginseng, belongs to the family Araliaceae, the root of which is the original source of ginseng (http://apps.who.int/medicinedocs/en/d/Js2200e/19.html) [97]. Being slow growing and perennial in nature, the plant is cultivated in the mountains of Eastern Asia including China, Korea and part of Russia. The dried and steamed root of ginseng is considered to be a vital crude drug used since ancient time for improving the overall immune system that adds to better stress-tolerance, life expectancy and quality well being. The ginseng root extracts also advance hair growth by increasing blood circulation. Roots mainly contain amino acids, carbohydrates, choline, essential oil, fatty acid, ginsenosides, peptidoglycans, polyacetylenes, polysaccharides, sesquiterpenes, steroid, vitamin B, C, and E. It has been revealed that the methanol extract (70%) from red ginseng possess superior activity compared to white ginseng in a hair growth-promoting test using mouse vibrissal follicles in organ culture. The activity is ascribed to the saponin component which was supposed to act as a 5α-reductase inhibitor [58, 54]. Ginsenoside Rb1 (GRb1) might be the active constituents of *G. radix*. In androgenetic alopecia model, Ginsenosides Ro was observed to enhance hair regrowth *in vivo* by inhibiting 5α-reductase activity. The increased blood circulation in the dermis of the scalp supply supplementary energy to the hair follicles and promote hair growth [76, 62, 73].

Hibiscus rosa-sinensis

H. rosa-sinensis L., commonly known as China rose or the shoe black plant belongs to the family Malvaceae. Native to East Asia, it is widely cultivated in the tropical regions and occurs in diverse type along with dissimilar colours of flowers. The red pigment in flower contains cyanidin glycosides. In ancient literature and texts, the leaves and flowers have been described to possess a great prospective for hair growth and also act as an anti-greying agent. Beside a hair growth promoter, the plant also assists in ulcer healing [1, 63, 47]. Experimentally, it was noticed that the flower and leaf extract-treated groups produced a significant effect with respect to the control and placebo. Conversely, the hair length was significantly higher in group treated with leaf extract compared to flower extract-treated group [2]. In India, the marketed herbal products intended for the hair growth include the extracts of china rose. The petroleum ether extract of leaf was also reported for its hair growth promoting property in albino rats and mice along with the pharmacological activity. Benzene, chloroform, methanol, and aqueous extracts of leaves were also reported for its effect on hair growth in mice [73, 77].

Rosmarinus officinalis

R. officinalis L., commonly known as rosemary or the dew of the sea belongs to the mint family Lamiaceae (Labiateae). Being native to the Mediterranean region, the plant is a perennial herb with evergreen, fragrant, sessile, needle-like leaves, woody stem and blue, pink, purple and white flowers nurturing well under diverse ecological conditions [8]. The plant was contemplated as sacred to Egyptian, Greek and Romans and its oil have been used in folk medicine, in making perfumes and incense, shampoos and cleaning products. The leaves of the rosemary have been used in herbal teas and as a food flavouring agent in traditional Mediterranean cuisine [78, 10]. The essential oil of rosemary has antioxidative, antifungal and antibacterial properties with reported variation in their pharmacological activity [60, 55]. The rosemary leaves contains numerous phytochemicals including α and β-pinene, apigenin, borneol, betulinic acid, caffeic acid, camphor, camphene, carnosic acid, carnosol, chlorogenic acid, cineole, diosmetin, diosmin, genkwanin, hispidulin, labiatic acid, linalool, luteolin, neochlorogenic acid, oleanolic acid, rosmarinic acid, salicylates, ursolic acid and verbinol (https://www.drugs.com/npp/rosemary.html). In scalp region, rosemary increases the blood circulation to deliver the nutrients to the follicles, stimulates hair growth and sustains a healthy hair growth. It is also acknowledged to remove dandruff and preserve hair follicles cells in active and dividing state. Mercenary, the oil of rosemary is used in

distinct hair formulations, shampoos and lotions to prop up hair growth and shining [4, 30].

Trigonella foenum-graecum

T. foenum-graecum L., commonly known as methi or fenugreek or the greek hay belongs to the family Fabaceae. The leaves and seed of the plant are used in several cuisine including Egyptian, Ethiopian and Iranian dishes (https://en.wikipedia.org/wiki/Fenugreek). They are also utilized for medicinal purposes as a potent herbal drug for abscesses, burns, eczema and gout. Traditionally, it has been used to reduce blood sugar levels, induces labour, increases breast milk in women, help in digestion and imparts numerous pharmacological effects including antibacterial, anticancer, antidiabetic, antifungal, antioxidant and antipyretic [96, 7, 61, 26] . The plant contains high source of proteins, lecithin, phytoestrogens, steroidal saponins which divulge hair growth promoting effect. The constituents of the seeds contain alkaloids, coumarins, flavonoids, saponins and vitamins. Cinnamic acid, scopoletin and trigonelline are the most ubiquitous natural products present in fenugreek [65]. The seeds of trigonella are very useful in hair fall treatment and have been used as an antidandruff and antilice agent for hair growth and soothing effects [73, 94]. With high source of protein and lecithin (a natural emollient), the seeds aid in treating baldness, hair fall and thinning of hair, helps in moisturization and strengthening of hair [94]. The regular application of leaves extract to the scalp has also shown to treat dandruff, enhance hair growth, preserve the natural colour of the hair and soften the hair [73,96]. The phytoestrogen present in seeds is believed to improve hair growth process and the hair tonic containing extracts of the seeds (10%) result in an optimistic effect on hair growth in rabbit. The leaves of fenugreek acts to stimulate blood circulation to the hair follicles, while the steroidal saponins interact with dihydrotestosterone metabolism. In addition, the fenugreek extract (10%) has been found to resemble the hair growth effects of minoxidil (2% hair tonic) which is very trendy hair growth medicine with merely mild irritation as a side effect [73,19, 71, 87].

Platycladus orientalis

P. orientalis, commonly known as arborvitae (tree of life), biota thuja or chinese thuja or the oriental thuja belongs to the family Cupressaceae. Earlier known as *Thuja orientalis*, it is native to China but now it is indigenous to India, Iran, Japan and Korea (https://en.wikipedia.org/wiki/Platycladus). It is also grown in several places across the globe viz. in cemeteries, hedges, home yards, gardens and parks. The leaves of the tree are fan shaped, flattened and scaly, containing essential oil (0.12%) with caryophyllene and pinene as the main components. The wood is used for temple construction and for incense burning. The roots have gasoline (2.75%) [37]. Traditionally, thuja has been used in oriental medicine to promote hair growth. The extracts of the plant contain diterpenes and flavonoids which have been reported as 5α-reductase inhibitor for the treatment of androgen-related diseases including alopecia [70]. The hot water extract of *T. orientalis* prop up hair growth in mice by increasing the size and number of hair follicles through anagen induction. The immuno-histochemical analysis of the skin tissues substantiate the early induction of Shh proteins and â-catenin in extract treated mice, compared to minoxidil (1%) or the control group suggesting *T. orientalis* as a prospective hair promoting agent [99].

Lygodium japonicum

L. japonicum (Thunb.) Sw., commonly known as Japanese climbing fern or the vine-like fern belongs to the family Lygodiaceae. Being a native of tropical region including Asia and Australia, the plant has also been reported from some part of the United States (https://en.wikipedia.org/wiki/Lygodium_japonicum). The plant comprises about 40 species with creeping stem and long leaves producing spore termed as Lyodiispora. This lygodiispora is the natural crude drug expected to have anti-androgenic and hair growth promoting activities. Linolenic, oleic and palmitic acids have been identified as the active principles from lyodiispora which inhibits testosterone 5α-reductase activity [**73**, 59]. It was found that hydro-alcholic extract, aqueous extract, ethanolic extract

and 50% ethanol extract showed significant hair regrowth promoting and anti-androgenic activity. The hydro-alcohlic extract was deliberated for anti-androgenic and testosterone 5α-reductase inhibitory activity using growth of flank organ in castrated Syrian hamsters and hair regrowth experiments in testosterone-treated C57Black/6CrSlc mice after shaving. The aqueous extract and ethanol extract of lygodiispora display testosterone 5α-reductase inhibitory activity *in vitro* and anti-androgenic activity *in vivo* [73, 59].

Buxus wallichiana

B. wallichiana Baill, commonly known as papri or sansad or shamsad belongs to the family Buxaceae. It is an evergreen monoecious tree with variable forms and shape. Traditionally, the plant was used as analgesic, antiepileptic, antihelmentic, antileprotic, antirheumatic, bittertonic, diaphoretic, diuretic, purgative and vermifuge. The bark is febrifuge and is used as hair growth stimulant. The wood is diaphoretic and the leaves are purgative, diaphoretic and bitter. They have been demonstrated to be valuable in the treatment of syphilis, rheumatism and hair growth (https://pfaf.org/user/Plant.aspx?LatinName=Buxus+wallichiana). Plants can also be developed as a hedge, used for fine carving, engraving and in the making of mathematical instruments etc.

The phytochemicals reported from *B. wallichiana* are alkaloids Buxatine, Buxiramin D, Buxemenol E, Buxandrine F, Buxamine F, Buxidine F, Buxaltine H, (+)-16α, 31-diacetylbuxadine and semperviraminol, (http://jkmpic.blogspot.com/2013/09/buxus-wallichiana-seedplants-are.html). In rats, buxemenol E produced hypotensive effect ascribed by the peripheral and central activation of muscranic receptor and acetyl cholinesterase inhibition. It was noticed that *B. wallichiana* acquire good antioxidant and hair growth promoting properties. The methanol extract accomplish good antioxidant and hair growth activity which supports the traditional assertion of the plant [73, 68, 69, 64].

Carthamus tinctorius

C. tinctorius L., commonly known as safflower belongs to the family *Asteraceae* (Compositae). Being herbaceous, thistle like and highly branched, the plant is commercially cultivated for the vegetable oil, flavoring and colouring of foods, in medicines and making of yellow and red dyes. The dried petals are also utilized as a herbal tea variety and seeds are used in cosmetics (https://en.wikipedia.org/wiki/Safflower). Traditionally, the florets have been used for hair growth promotion and the aqueous extract of flowers for hair colour enrichment and for raising blood circulation [73, 23, 3]. In mice, the extract was reported to stimulate the hair growth by inhibiting 5α-reductase activity. The ethanol extract of floret promoted the proliferation of HaCaT and dermal papilla cells by stimulating the hair growth-promoting genes, VEGF and keratinocyte growth factor. It was also observed that the extract suppresses the expression of hair loss related gene and TGF-β1. The extract treatment resulted in a noteworthy increase in the hair follicles length and kindles the growth of hair [46].

Avicenna marina

A. marina (Forssk.) Vierh., commonly known as white or grey mangrove belongs to the family Acanthaceae (Avicenniaceae or Verbenaceae). In folklore medicine, the plant is used against asthma, paralysis, rheumatism, skin disease, snake bites, and ulcer. The antimicrobial, antitumor, antiatherosclerotic, anti-inflammatory and antioxidant activities have also been reported from *A. marina*. The plant contains a variety of natural products including abietane ditrerpenoid glucosides, flavones, flavonoids, iridoid glucosides, naphthalene derivatives, prenylpropanoid glycosides, steroids and terpenoids. In cell-based assay using human hair dermal papilla cells it was revealed that the constituents avicequinone C (furanonaphthaquinone) is a potent inhibitor of 5α-R type 1 (5α-R1) [85, 36].

Sophora flavescens

S. flavescens Aiton, commonly the shrubby sophora belongs to the family Fabaceae (Leguminosae). The plant has antiinflammatory, antioxidant, antiatherosclerosis, cholesterol-lowering, antiarthritic, neuroprotective, cytochrome P450 3A4 (CYP450 3A4) inhibitor. Together with

licorice (Glycyrrhiza glabra), sophora acts as anti-hepatocarcinogenic and better liver protective agent, reduces the incidence of water and sodium retention, protection against pseudo-hypercorticosteroidism. It is a potential source of a natural and antifoulant, inhibits tyrosinase-dependent melanin biosynthesis and makes skin color whiter [102, 20, 31, 43, 41, 68, 92, 32, 50, 42]. The methanol extract revealed a compelling glycosidase inhibition. The phytochemicals isolated from the plant includes alkaloids (oxysophocarpine, sophocarpine), flavonoid (Trifolirhizin), isoflavonoid (Kushenin), quinolizidine (matrine, matrine oxide), prenylflavonoid (8-Prenylkaempferol), Sophora-flavanone G, Sophoridine, 7,9,2',4'-Tetrahydroxy-8-isopentenyl-5-methoxychalcone. Experimentally, the root extract has antiandrogen, antibacterial and vasodilatory effects and it may be seen as a valuable treatment for the hair loss. In mice, it has hair promoting effect and the topical application of the extract on C57BL/6 a prior adaptation of telogen-to-anagen phase was induced. In addition, the extract revealed to have potent inhibitory effect on type II 5α-reductase activity. The impending hair growth promoting effect of *S. flavescens* entails it as a superior candidate for hair growth promotion. However, some lethal side-effect from the use of sophora has also been observed which include constipation, disturbance of speech, dizziness, irregular breathing, nausea, respiratory failure, spasms and vomiting. In chemotherapy, the injection of sophora can reduce the adverse and toxic effect [23, 35, 34, 11, 13, 20, 102, 52, 40,101, 104, 70].

Tectona grandis

T. grandis L.f., commonly known as Teak or the Burmese teak belongs to the family Lamiaceae. A high oil content, tight grain and tensile strength render it as weather resistance, water resistance and termite resistance. In India, it is used to make outdoor furniture (beam, column, door, window), boats and indoor flooring, countertops and as a veneer. The leaves of the plant are used in making gudeg and pellakai gatti (https://en.wikipedia.org/wiki/Teak). Traditionally, the seeds have been acclaimed as a hair tonic in Indian System of Medicine. In albino mice, the petroleum ether extract of seeds has been reported for its effect on hair growth. A noteworthy effect of petroleum ether extract (5% and 10%) was observed on the length of the hair follicles. The topical application of seed extract lessens the time vital for the hair growth initiation and was observed to be superior to minoxidil (2%). It also revitalizes the growth of hair in mice and improves the length of the hair follicles. A larger number of hair follicles (64% and 51%) were observed in anagen phase compared to minoxidil (49%) [39].

Naringi crenulata

N. crenulata (*Roxb.*) D.H. *Nicolson, commonly known as beli belongs to the family Rutaceae.* The root extract of the plant prevent from snake bite, stops vomiting and dysentery. The stem or bark powder arrest fever, diminish the severity of acne, has antipyretic and anti aging assets. The juice of the bark cures throat infection and gives respite from pain. The leaves decoction is the remedy against cough and cold. The paste of the leaf when consumed with milk eases digestive disorder, epilepsy and mental disorders. The extract of the leaf can alleviate cancer, cardiac, diabetes and hepatic diseases including jaundice. The raw consumption of leaves regularly ropes pregnancy and eliminate sterility in women. The fruit decoction is an antidote for intestinal worm infestation and insect bite. Together with *Phyllanthus reticulates*, beli has the knack of curing scabies and eczema. The external application of fresh leaf extract has hair growth promoting potential which may be due to the presence of flavonoids and terpenoids. In rodent model, the hair growth promotion activity, increase in number of hair follicles, length and weight of the hair and improved blood circulation of fresh leaf extracts have been reported. The acetone and chloroform extracts of leaf encompass hair growth promoting activity by reinforcing the capillary wall of blood vessels perk up blood circulation to nurture the hair follicles and have invigorating actions on growth factors for enhancing the hair growth [56, 57, 86].

Asiasari radix

A. radix L., commonly known as Saishin or the chinese wild ginger root belongs to the family Aristolochiaceae. The extract has been reported to promote hair growth activity (https://miraherbals.ca/six-herbs-that-regrow-hair-fast/). In C57BL/6 mice, the topical application 30 days on the back of animals induces earlier telogen-to-anagen adaptation compared to vehicle control. In histological examination, the extract distinctly improved the size and depth of the hair follicles with respect to control. In experiments with C3H and C57BL/6 mice the extract demonstrated the most potent hair growth stimulation. It has also been observed that the extract improved the proliferation of human DP and HaCaT cells and augment the protein synthesis in vibrissae follicle cultures *in vitro*. Furthermore, the extract induces the VEGF expression in human DP cells and early onset of anagen phase thereby stimulating the growth of hair [80].

Erica multiflora

E. multiflora L., commonly known as Mediterranean heath or the heather belongs to the family Ericaceae. Being native to the Mediterranean basin, it is well-known plant from Italy, Sicily and the Iberian Peninsula and found in North West Africa (https://www.first-nature.com/flowers/erica-multiflora.php; https://en.wikipedia.org/wiki/Erica_multiflora). In folk medicine, it is used as an antiseptic and as a diuretic agent. The plant extract have hair growth promotion activity as it support growth of dermal papilla cell, increasing the cell cycle activity and persuades hair growth *in vivo* by the initiation of anagen from the telogen phase [73,28].

Piper nigrum

P. nigrum L., commonly known as pepper or the black pepper or the flowering vine belongs to the family Piperaceae. Being native to Kerala, India it is extensively cultivated in the tropical regions across the globe. It is world's most traded spice, the dried powder of which is used for its flavour in various cuisines (https://en.wikipedia.org/wiki/Black_pepper). In folk medicine, it was assumed that pepper cures abscesses, constipation, eye problems, insomnia, sun burn, toothaches and cause sneezing. The principal component piperine increases the absorption of β-carotene, curcumin, selenium and vitamin B12. Other constituents present in pepper include pyrrolidines, piperidines, amides and trace amount of safrole can be studied for a number of physiological effects [21, 18, 88]. The leaf extract of pepper showed an effective stimulation on melanogenesis. The active constituents 3,4-dimethoxy-3,4-desmethylenedioxycubebin and cubebin were segregated as hair growth promotion agent. In C57Black/6CrSlc mice treated with testosterone after saving noticed a regrowth of hair. The aqueous and ethanol extracts from different parts of *P. betle*, *P. cubeba*, *P. kadsura*, *P. longum*, *P. methysticum* and *P. nigrum* were observed to have 5α-reductase inhibitory activity. The leaf extract also showed *in vivo* anti-androgenic activity in mice [73, 21, 18, 88].

Nardostachys jatamansi

N. jatamansi (D. Don) DC, commonly known as muskroot or nard or nardin or spikenard belongs to the family Caprifoliaceae. Being native to Himalayan region, the plant also grows in Bhutan, Kumaon, Sikkim and Nepal. It is the source of intense aromatic oil used in incense, perfume and as a sedative to fight insomnia, as a herbal medicine to combat minor ailments and birth difficulties (https://en.wikipedia.org/wiki/Nardostachys_ jatamansi). The phytochemicals present in nardin includes acaciin, aristolen-9β-ol, β-sitosterol, jatamansic acid, kanshone A, nardal, nardin, nardosinone, nardosinonediol, octacosanol, oleanolic acid and ursolie acid [9, 16, 100, 98]. The rhizome of the plant showed an affirmative promotion of hair growth and is being grounded with medicinal oil to divulge blackness. The essential oil from the rhizome of nardin showed antimicrobial and fungi toxic activity. Nardin, nardal and jatamansic acid demonstrate modest reduction in in the timing of hair growth [84, 27].

Rumex japonicus

R. japonicas Houtt., commonly known as goat hoof or the Japanese dock belongs to the family

Polygonaceae. The plant contains high level of oxalic acid and it can be used as a vegetable. The dried leaves can be added to soups and the seed is used with rice or pulverized into a powder to prepare dumplings (https://pfaf.org/User/Plant.aspx?LatinName=Rumex+japonicus). Being native to China, Japan and Korea, traditionally, the plant has been used for the cure of constipation, heat phlegm, jaundice, skin disease and uterine hemorrhage. The phytochemicals present in the plant includes anthraquinones, flavones and oxanthrones which revealed its inhibitory effect of atopic dermatitis, antioxidant, antibacterial, anti-inflammatory effect in skin disease. The root has hair growth promoting effect in HaCaT cells, human dermal papilla cells and in animal. In C57BL/6 mice, the extract has been shown to up regulate â-catenin and ki-67 expressions signifying the effect of hair growth via hair cell proliferation. The extract has been found in soaps and shampoos claiming to promote hair growth and prospective anti-hair loss products. It has less hair growth effect with that of minoxidil and it excite hair growth by inducing anagen phase and proliferation of hair follicle cells [48, 49, 51, 98, 29, 103, 22. 38, 95].

Conclusion and Future Perspective

Plants with hair growth promoting activity have gained alluring attention due to minimal or least side effect. The above-listed plants, their parts, extracts and their molecules prop up hair growth promotion activities without causing any reported major side effect compared to the approved drugs for hair growth. A large number of herbal products, herbal formulations are available in the market used for the betterment of the hair texture, shine, cleansing and as an antidandruff agent as well as for the treatment of alopecia. Thus, plant could be useful in incorporating some novel molecules from the crude extract for enhancing hair growth as well as therapy or prevention of hair loss.

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REFERENCES

1. Ali M, Ansari SH. 1997. Hair care and herbal drugs. *Indian J Nat Prod* **13**: 3-5.
2. Adhirajan N, Ravi Kumar T, Shanmugasundaram N, Babu M. 2003. *In vivo* and *in vitro* evaluation of hair growth potential. *J Ethnopharmacol* **88**: 235-239.
3. Al Snafi AE.2015.The chemical constituents and pharmacological importance of *Carthamus tinctorius*-An overview. *J Pharma Bio* **5**:143-166.
4. Al-Sereiti MR, Abu-Amer KM, Sen P.1999. Pharmacology of rosemary (Rosmarinus officinalis Linn.) and its therapeutic potentials. *Indian J Exp Biol* **37**: 124-130.
5. Baishiyou Ri. 1993. Hair tonic. Japanese Patent No. 5201833.
6. Bakhru HK. 1993. Herbs that heal natural remedies for good health (3rd print ed.). New Delhi, Orient Paperbacks. P 117.
7. Bazzano AN, Hofer R, Thibeau S, Gillispie V Jacobs M, Theall KP. 2016. A review of herbal and pharmaceutical galactagogues for breast-feeding. *Ochsner J* **16**: 511-524.
8. Begum A, Sandhya S, Ali SS, Vinod KR, Reddy S, Banji D.2013.An in-depth review on the medicinal flora *Rosmarinus officinalis* (Lamiaceae). *Acta Sci Pol Technol Aliment* **12**: 61-73.
9. Begum S, Lee M, Gu LJ, Hossain J, Sung CK. 2015. Exogenous stimulation with *Eclipta alba* promotes hair matrix keratinocyte proliferation and downregulates TGF-β1 expression in nude *mice Int J Mol Med* **35**: 496-502.
10. Capuano T. 2005. Las Huellas De Otro Texto Médico En “Don Quijote: Las Virtudes Del Romero”. *Romance Note* **45**: 303-310.
11. Cha JD, Moon SE, Kim JY, Jung EK, Lee YS.*2009. Antibacterial activity of sophora flavanone G isolated from the roots of Sophora flavescens against methicillin-*

*resistant Staphylococcus aureus. Phytother Res **23**: 1326-1331.*

12. Cheol, Ryu G. 2004. Hair restorer and manufacturing process there of. KR20040016331.

13. Choi BM, Oh GS, Lee JW, Mok JY, Kim DK, Jeong SI, Jang SI. *2010. Prenylated chalcone from Sophora flavescens suppresses Th2 chemokine expression induced by cytokines via heme oxygenase-1 in human keratinocytes. Arch Pharma Res **33**: 753-760.*

14. Chopra RN, Nayar SL, Chopra IC. 1956. Glossary of Indian Medicinal Plants. Publication and Information Directorate, CSIR, New Delhi.

15. Crabtree JS, Kilbourne EJ, Peano BJ, Chippari S, Kenney T, McNally C, Wang W, Harris HA, Winneker RC, Nagpal S, Thompson CC.2010. A mouse model of androgenetic alopecia. *Endocrinol* **151**: 2373-2380.

16. Dalby A. 2000. Dangerous Tastes: the story of spices. London British Museum Press 1st Edition, 83-88.

17. Datta K, Singh AT, Mukherjee A, Bhat B, Ramesh B, Burman AC. 2009. *Eclipta alba* extract with potential for hair growth promoting activity. *J Ethnopharmacol* **124**: 450-456.

18. Dawid C, Henze A, Frank O, Glabasnia A, Rupp M, Büning K, Orlikowski D, Bader M, Hofmann T. *2012. Structural and Sensory Characterization of Key Pungent and Tingling Compounds from Black Pepper (Piper nigrum L.) J Agric Food Chem **60**: 2884-2895.*

19. Didarshetaban MB, Saeid Pour HR, Kor NM.2013. Fenugreek (*Trigonella foenum-graecum* L.) as a valuable medicinal plant. *Int J Adv Biol Biomed Res* **1**: 922-931.

20. Dong HL, Dong SS, Dai YC, Beom JK, Yun YL, Young HK. 2010. Anti-inflammatory and anti-oxidant effects of *Sophora flavescens* root extraction in lipopolysaccharide-activated raw 264.7 cells. *Korean J Med Mycol* **15**: 39-50.

*21. Dudhatra GB, Mody SK, Awale MM, Patel HB, Modi CM, Kumar A, Kamani DR, Chauhan BN. 2012. A comprehensive review on pharmacotherapeutics of herbal bioenhancers. Scientific World Journal **2012**: 637953.*

22. Elzaawely AA, Xuan TD, Tawata S. 2005. Antioxidant and antibacterial activities of *Rumex japonicus* Houtt. aerial parts. *Biol Phara Bull* **28** 2225-2230.

23. Fan L, Zhao HY, Xu M, Zhou L, Guo H, Han J, Wang BR, Guo DA.2009. Qualitative evaluation and quantitative determination of 10 major active components in *Carthamus tinctorius* L. by high-performance liquid chromatography coupled with diode array detector. *J Chromatogr A* **1216**: 2063-2070.

24. Feng DQ, Ke CH, Lu CY, Li SJ.2009. Herbal plants as a promising source of natural antifoulants: Evidence from barnacle settlement inhibition. *Biofouling* **25**: 181-190.

25. Goluch ZS, Koniuszy. 2016. Nutrition of women with hair loss problem during the period of menopause. *Prz Menopauzalny* **15**: 56-61.

*26. Gong J, Fang K, Dong H, Wang D, Hu M, Lu F. 2016. Effect of Fenugreek on Hyperglycaemia and Hyperlipidemia in Diabetes and Prediabetes: a Meta-analysis. J Ethnopharmacol **194**: 260-268.*

27. Gotumukkala VK, Annamalai T, Mukhopadhyay TK. 2011. Phytochemical investigation and hair growth studies on the rhizome of *N. jatamansi* DC. *Pharmacogn Mag* 7: 146-150.

28. Gratani L, Varone L. 2004. Leaf key traits of *Erica arborea* L., *Erica multiflora* L. and *Rosmarinus officinalis* L. co-occurring in the Mediterranean maquis. *Flora-Morphology, Distribution, Functional Ecol of Pl* **199**: 58-69.

29. Guo S, Feng B, Zhu R, Ma J, Wang W .2011.Preparative isolation of three anthraquinones from *Rumex japonicus* by high-speed counter-current chromatography *Molecules* **16**: 1201-1210.

30. Gupta A, Malviya R, Singh TP, Sharma PK .2010. Indian Medicinal Plants Used in Hair Care Cosmetics: A Short Review*. Phcog Net* **2**: 361-364.

31. Han JM, An S, Kim MJ, Jin YY, Baek SW, Park JS, Lee WS, Park KH, Jeong TS. 2008. *Sophora flavescens* attenuates atherosclerosis and hyperlipidemia in LDL receptor deficient mice. *Arterioscler Throb Vasl Bio* **28**: 6.

32. Hong M H, Lee JY, Jung H, Jin DH, Go HY, Kim JH, Jang BH, Shin YC, Ko SG. 2009. Sophora flavescens Aiton inhibits the production of pro-inflammatory cytokines through inhibition of the NFêB/IêB signal pathway in human mast cell line (HMC-1). *Toxicol In Vitro* **23**: 251-258.

33. Hunt N, McHale S. 2005. The psychological impact of alopecia. *BJM* **331**: 951-953.

34. Hwang JH, Lee BM. 2007. Inhibitory effects of plant extracts on tyrosinase, L-DOPA oxidation, and melanin synthesis. *J Toxicol Environ Health A* **70**: 393-407.

35. Hyun SK, Lee WH, Jeong DM, Kim Y, Choi JS .2008. Inhibitory effects of kurarinol, kuraridinol, and trifolirhizin from *Sophora flavescens* on tyrosinase and melanin synthesis. *Biol Pharm Bull* **31**: 154-158.

36. Itigowa M, Ito C, Tan HT, Okuda M, Tokuda H, Nishino H, Furukawa H. 2001. Cancer chemopreventive activity of naphthoquinones and their analogs from *Avicennia* plants. *Cancer Lett* **174**: 135-139.

37. Jagel A, Stützel T. 2001. Studies on the morphology and morphogenesis of the seed cones of *Platycladus orientalis (L.)* Franco, *Thuja orientalis* L. and *Microbiota decussata* Kom. (Cupressaceae). *Bot Year Syst Bd* **123**: 337-404.

38. Jang DS, Kim JM, Kim JH, Kim JS. 2005. 24-nor-Ursane type triterpenoids from the stems of *Rumex japonicas. Chem Pharm Bull* **53**: 1594-1596.

39. Jaybhaye D, Varma S, Gagne N, bonde V, Gite A, Bhosle D. 2010. Effect of *Tectona grandis* Linn. seeds on hair growth activity of albino mice. *Int J Ayurveda Res* **1**: 211-215.

40. Jin JH, Kim JS, Kang SS, Son KH, Chang HW, Kim HP. 2010. Anti-inflammatory and anti-arthritic activity of total flavonoids of the roots of *Sophora flavescens*. *J Ethnopharmcol* **127**: 589-595.

41. Kaufman KD. 2002 .Androgens and alopecia. *Mol Cell Endocrinol* **198**: 89-95.

42. Kim J H, Ryu YB, Kang NS, Lee B W, Heo JS, Jeong IY, Park KH. 2006. Glycosidase inhibitory flavonoids from *Sophora flavescens. Biol Pharm Bull* **29**: 302-305.

43. Kim HY, Jeong M, Jung HJ, Jung YJ, Yokozawa T, Choi JS. 2008. Hypolipidemic effects of *Sophora flavescens* and its constituents in poloxamer 407-induced hyperlipidemic and cholesterol-fed rats. *Biol Pharm Bull* **31**: 73-78.

44. Kirtikar KR, Basu BD. 1975. Indian Medicinal Plants, Vol. II, Jayyed Press, New Delhi, 2nd Edition

45. Kobayashi N, Suzuki R, Koide C, Suzuki T, Matsuda H, Kubo M. 1993. Effect of leaves of *Ginkgo biloba* on hair regrowth in C3H strain mice. *Yakugaku Zasshi* **113**: 718-724.

46. Kumar S, Ambreen H, Variath MT, Rao AR, Agarwal M, Kumar A, Jagannath A. 2016. Utilization of Molecular, Phenotypic, and Geographical Diversity to Develop Compact Composite Core Collection in the Oilseed Crop, Safflower (*Carthamus tinctorius* L.) through Maximization Strategy. *Front Plat Sci* **7**: 1-14.

47. Kurup PNV, Ramdas VNK, Joshi P. 1979. Handbook of Medicinal Plants. *New Delhi*, P 86.

48. Lee H, Kim Na-H, Yang H, Bae SK, Heo Y, Choudhary I, Kwon YC, Byun JK, Yim HJ, Noh BS, Heo JD, Kim E, Kang C. 2016. The Hair Growth-Promoting Effect of *Rumex japonicus Houtt. Evid Based Complement Alternat Med* **2016**: 1873746.

49. Lee HS, Kim SK, Han JB, Choi HM, Park JH, Kim EC, Choi MS, An HJ, Um JY, Kim HM, Min BI. 2006. Inhibitory effects of *Rumex japonicus Houtt.* on the development of atopic dermatitis-like skin lesions in NC/Nga mice. *Br J Dermtol* **155**: 33-38.

50. Lee SS, Zhang B, He M L, Chang VS, Kung HF. 2007. Screening of active ingredients of herbal medicine for interaction with CYP450 3A4. Phytother Res **21**: 1096-1099.

51. Li YP, Takamiyagi A, Ramzi ST, Nonaka S. 2000. Inhibitory effect of *Rumex japonicus Houtt* on the porphyrin photooxidative reaction. *J Dermatol* **27**: 761-768.

52. Liu G, Dong J, Wang H, Hashi Y, Chen S. 2011.Characterization of alkaloids in Sophora flavescens Ait. by high-performance liquid chromatography-electrospray ionization tandem mass spectrometry. J Pharm Biomed Anal **54**: 1065-1072.

53. Liu N, Wang LH, Guo LL, Wang GQ, Zhou XP, Jiang Y, Shang J, Murao K, Chen JW, Fu WQ, Zhang GX. 2013. Chronic restraint stress inhibits hair growth via substance p mediated by reactive oxygen species in mice. *PLoS One* **8**: e61574.

54. Liu WK, Xu SX, Che CT. 2000. Anti-proliferative effect of ginseng saponins on human prostate cancer cell line. *Life Sci* **67**: 1297-1306.

55. Luqman S, Dwivedi GR, Darokar MP, Kalra A, Khanuja SP. 2007. Potential of rosemary oil to be used in drug-resistant infections. *Altern Ther Heath Med* **13**: 54-59.

56. Manjula V, Selvin Jebaraj Norman T. 2017. Skin healing activity of *Naringi crenulata* and *Phyllanthus reticulatus*. *The Pharma Inno J* **6**: 376-378.

57. Manjula V, Selvin T, Jebaraj Norman, Senthilnathan S. 2017. *Naringi crenulata* RoxbA potential drug for the future. *The Pharma Innovation* **6**: 261-263.

58. Matsuda H, Yamazaki M, Asanuma Y, Kubo M. 2003. Promotion of hair growth by *Ginseng radix* on cultured mouse vibrissal hair follicles. *Phytother Res* **17**: 797-800.

59. Matsuda H, Yamazaki M, Naruo S, Asanuma Y, Kubo M. 2002. Antiandrogenic and hair growth promoting activities of *Lygodii spora* (spore of *Lygodium japonicum*) I. Active constituents inhibiting testosterone 5α-reductase. *Biol Pharm Bull* **25**: 622-626.

60. Moreno S, Scheyer T, Romano CS, Vojnov AA. 2006. Antioxidant and antibacterial activities of rosemary extracts linked to their polyphenol composition. *Free Radic Res* **40**: 223-231.

61. Mortel M, Mehta SD. 2013. Systematic review of the efficacy of herbal galactogogues. *J Hum Lact* **29**: 154-162.

62. Murata K, Takeshita F, Samukawa K, Tani T, Matsuda H. 2011. Effects of ginseng rhizome and ginsenoside Ro on testosterone 5á-reductase and hair re-growth in testosterone treated mice. *Phytother Res* **26**: 48-53.

63. Nadkarni AK. 1954. The Indian Plants and Drugs. Indian Materia Medica 3rd Revised and Enlarged Edition, Popular Prakashan, Bombay, P 291.

64. O'Neill AR, Badola HK, Dhyani PP, Rana*k* SK*. 2017. Integrating ethnobiological knowledge into biodiversity conservation in the Eastern Himalayas. J Ethnobiol Ethnomed **13**: 21.*

65. Ouzir M, El Bairi K, Amzazi S*. 2016. Toxicological properties of fenugreek (Trigonella foenum graecum). Food Chem Toxicol **96**: 145-154.*

66. Pandit S, Chauhan NS, Dixit VK. 2008. Effect of *Cuscuta reflexa Roxb* on androgen-induced alopecia. *J Cosmet Dermatol* **7**: 199-204.

67. Pant S. 2011. *Buxus wallichiana* L., a multipurpose Himalayan tree in peril. *Int J Biodiver Conserv* **3**: 175-177.

68. Park SJ, Nam KW, Lee HJ, Cho EY, Koo U, Mar W. 2009. Neuroprotective effects of an alkaloid-free ethyl acetate extract from the root of *Sophora flavescens* Ait. Against focal cerebral ischemia in rats. *Phytomedicine* **16**: 1042-1051.

69. Park WS, Lee CH, Lee BG, Chang IS.2003.The extract of *Thuja occidentalis* semen inhibited 5alpha-reductase and androchronogenetic alopecia of B6CBAF1/j hybrid mouse. *J Dermatol Sci* **31**: 91-98.

70. Park WS, Son ED, Nam GW, Kim SH, Noh MS, Lee BG, Jang IS, Kim SE, Lee JJ, Lee CH. 2003.Torilin from *Torillis japonica*, as a new inhibitor of testosterone 5 alpha reductase. *Planta Med* **69**: 459-461.

71. Parthasarathy VA, Kandinnan K, Srinivasan V. 2008. Fenugreek. Organic Spices. New India Publishing Agency. Vol. XVI, P 694.

72. Patel S, Sharma V, Chauhan SN, Dixit VK. 2014. A study on the extracts of *Cuscuta reflexa Roxb*. in treatment of cyclophosphamide-induced alopecia. *Daru* **22**: 7.

73. Patel S, Sharma V, Chauhan NS, Thakur M, Dixit VK. 2015. Hair Growth: Focus on Herbal Therapeutic Agent. *Curr Drug Discov Technol* **12**: 21-42.

74. Paus R. 1998. Principles of hair cycle control. *J Dermatol* **25**: 793-802.

75. Perera E, Yip L, Sinclair R. 2015. *Alopecia areata*. *Curr Probl Dermatol* **47**: 67-75.

76. Prager N, Bickett K, French N, Marcovici G. 2002. A randomized, double-blind, placebo controlled trial to determine the effectiveness of botanically derived inhibitors of 5-alpha-reductase in the treatment of androgenetic alopecia. *J Altern Complement Med* **8**: 143-152.

77. Punasiya R, Verma R, Pillai S. 2014. *In vitro* hair growth promoting activity of various leaves extract of *Hibiscus syriacus* L. on albino rat. *Int J Pharma Life Sci* **5**: 3565-3569.

78. *Queralt AV, Regueiro J, Alvarenga JFR,* Huelamo *MM,* Leal *LN,* Raventos *RML. 2014.* A comprehensive study on the phenolic profile of widely used culinary herbs and spices: Rosemary, thyme, oregano, cinnamon, cumin and bay. *Food Chem **154**: 299-307.*

79. Rastogi RP, Mehrotra BN. 1998. Compendium of Indian Medicinal Plants. 2nd Reprint, Central Drug Research Institute, Lucknow and National Institute of Science Communication, Council of Scientific and Industrial Research, New Delhi, P 434-436.

80. Rho SS, Park SJ, Hwang SL, Lee MH, Kim CD, Lee IH, Chang SY, Rang MJ. 2005. The hair growth promoting effect of *Asiasari radix* extract and its molecular regulation. *J Dermatol Sci* **38**: 89-97.

81. Roy RK, Thakur M and Dixit VK. 2008. Hair growth promoting activity of *Eclipta alba* in male albino rats. *Arch Dermatol Res* **300**: 357-364.

82. Roy RK, Thakur M, Dixit VK. 2007. Development and evaluation of polyherbal formulation for hair growth promoting activity. *J Cosmet Dermatol* **6**: 108-112.

83. Roy RM, Thakur M, Dixit VK. 2009. Development and evaluation of polyherbal formulation for hair growth promoting activity *Int J Pharmtech Res* **4**: 1251-1254.

84. Sahu R, Dhongade H J, Pandey A, Sahu P, Sahu V, Patel D, Kashyap P. 2016. Medicinal properties of *Nardostachys jatamansi*. *Orient J Chem* **32**: 859-866.

85. Shanmugapriya R, RamanathanT, Renugadevi G. 2012. Phytochemical characterization and antimicrobial efficiency

of mangrove plants *Avicennia marina* and *Avicennia officinalis. Int J Pharmaceu Biol Arch* **3**: 348-351.

86. Sharma PC, Yelne MB, Dennis TJ. 2001. Database on medicinal plants used in Ayurveda, Central Council for Research in Ayurveda and Siddha, New Delhi, P 1-3.

87. Sinha R, Rauniar GP, Panday DR, Adhikari S. 2016. Fenugreek: Pharmacological Actions. *Int J Pharm Pharm Sci* **5**: 1481-1489.

88. Srinivasan K. 2007. Black pepper and its pungent principle-piperine: a review of diverse physiological effects. Crit Rev Food Sci Nutr **47**: 735-748.

89. Szaloki Bakos E, Kristof Szvitil I, Pal P. 1997. Hair preparations containing *Ginkgo biloba* and *Liquiritia officinarum* extracts for treatment of hair loss. Patent No. BE 1009298. *Chem Abs*: **127**: 39461.

90. Van Beek TA. 2002. Chemical analysis of Ginkgo biloba leaves and extracts *J Chromatogr A* **967**: 21-55.

91. Van Beek TA, Montoro P. 2009. Chemical analysis and quality control of Ginkgo biloba leaves, extracts, and phytopharmaceuticals. *J Chromatogr A* **1216**: 2002–2032.

92. Wan XY, Luo M, Li XD, He P. 2009. Hepatoprotective and anti-hepatocarcinogenic effects of glycyrrhizin and matrine. *Chem Biol Interact* **181**: 15-19.

93. Watanabe C, Naito Y. 1991. Hair tonics containing hormones and *Ginkgo extracts*. Patent No. JP 03161426 **115**: 214519.

94. Wijaya WH, Munim A, Joshita D. 2013. Effectiveness test of fenugreek seed (*Trigonella foenum-graecum* L.) extract hair tonic in hair growth activity. *Int J Curr Res* **5**: 3453-3460.

95. Xie QC, Yang YP. 2014. Anti-proliferative of physcion 8-O-β-glucopyranoside isolated from *Rumex japonicus Houtt*. on A549 cell lines via inducing apoptosis and cell cycle arrest. *BMC Complement Altern Med* **6**: 377.

96. Yadav R, Kaushik R. 2011. A study of phytochemical constituent and pharmacological actions of *Trigonella foenum-graecum*: A review. *Int J Pharm Technol* **3**: 1022-1028.

97. Yun TK. 2001. Brief introduction of *Panax ginseng* C.A. Meyer. *J Korean Med Sci* **16** (Suppl): S3-5.

98. Zee OP, Kim DK, Kwon HC, Lee KR. 1998. A new epoxynaphthoquinol from *Rumex japonicas. Arch Pharm Res* **21**: 485-486.

99. Zhang NN, Park DK, Park HJ. 2013. Hair growth-promoting activity of hot water extract of *Thuja orientalis. BMC Complement Altern Med* **13**: 9.

100. Zhang X, Lan Z, Dong XP, Deng Y, Hu XM, Peng T, Guo P. *2007. Study on the active components of Nardostachys chinensis. Zhong Yao Cai* ***30****: 38-41.*

101. Zhang Y, Zhu H, Ye G, Huang C, Yang Y, Chen R, Yu Y, Cui X. *2006. Antiviral effects of sophoridine against coxsackie virus B3 and its pharmacokinetics in rats. Life Sci* ***78****: 1998-2005.*

102. Zhou H, Lutterodt H, Cheng Z, Yu L. *2009. Anti-Inflammatory and antiproliferative activities of trifolirhizin, a flavonoid from Sophora flavescens roots. J Agric Food Chem* ***57****: 4580–4585.*

103. Zhou X, Xuan L, Zhang S. 2005. Study on the chemical constituents from *Rumex japonicus Houtt*. *Zhong Yao Cai* **28**: 104-105.

104. Zhu ZC, Wang HZ, Yang F. 2009. Composite sophorae injection in prevention of toxicity and adverse effects caused by chemotherapeutic agents. *J Pratical Oncol* **24**: 592-594.