

# *Psoralea corylifolia* Linn.—“Kushtanashini”

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## ABSTRACT

Plants have been the basis of many traditional medicines throughout the world for thousands of years and continue to provide new remedies to mankind. Plants have been one of the important sources of medicines since the beginning of human civilization. The recent resurgence of plant remedies resulted from several factors, such as effectiveness of plant medicines and lesser side effects compared with modern medicines. *Psoralea corylifolia*, commonly known as babchi, is a popular herb, which has since long been used in traditional Ayurvedic and Chinese medicine for its magical effects to cure various skin diseases. This plant is also pharmacologically studied for its chemoprotective, antioxidant, antimicrobial, and antiinflammatory properties. This review attempts to highlight the available literature on *P. corylifolia* with respect to its ethnobotany, pharmacognostic characteristics, traditional uses, chemical constituents, and summary of its various pharmacologic activities and clinical effects. Other aspects, such as toxicology and precautions are also discussed. This will be helpful to create interest toward babchi and may be useful in developing new formulations with more therapeutic and economical value.

**Key words:** Babchi, leukoderma, *Psoralea corylifolia*, psoriasis, psoralen

## INTRODUCTION

Indigenous herbs are used as remedies against various diseases in the traditional system of medicine or in ethnomedical practices. For the past few decades, compounds from natural sources have been gaining importance because of the vast chemical diversity they offer. This has led to a phenomenal increase in the demand for herbal medicine in the last 2 decades. They are relatively safe, easily available, and affordable to the masses. These drugs have given important lead in drug research, resulting in the discovery of novel molecules.

Dry fruit of leguminous plant *Psoralea corylifolia* Linn. (syn: *Cullen corylifolium* Linn.) is one of the most popular Traditional Chinese Medicine and officially listed in Chinese Pharmacopoeia.<sup>[1]</sup> *P. corylifolia* is an annual herb growing throughout the plains of India. The plant is of immense biological importance, and it has been widely exploited since ages for its magical effect against several skin diseases, such as psoriasis, leukoderma, and leprosy.<sup>[2]</sup>

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## CLASSIFICATION

The plant classification details are<sup>[3]</sup>

Kingdom: Plantae  
Division: Angiospermae  
Class: Dicotyledoneae  
Order: Rosales  
Family: Leguminosae  
Subfamily: Papilionaceae  
Genus: *Psoralea*  
Species: *corylifolia* Linn.

## REGIONAL NAMES

Regional name of the plants based on<sup>[4-23]</sup>

Beng: Bavachi, Hakuch, Latakasturi, Kakuch, Barachi, Bakuchi  
Bomb: Bawachi, Bobawachi  
Hindi: Babachi, Babchi, Bavanchiyan, Bhavaj, Bakuci, Bemchi  
Guj: Babchi, Bavacha, Babichi, Bawchi  
Mar: Babachi, Bavachya, Bavachi, Bavanchi  
Pers: Waghchi, Vabkuchi, Ba bakhi  
Punj: Babchi  
Sans: Aindavi, Avalguja, Bakuchi, Chanderlekha, Chanderprabha, Kushthahantri, Sitavari, Somaraji, Vejani, Vakuchi, Sugandha kantak, Krishnaphala, Chandraraji, Asitavacha, Kalameshi, Somavalli, Bakuci, Sasankarekha

Urdu: Babechi  
 Eng: Babchi seeds, *Psoralea* seeds, Malay tea, Scurf-pea, Fountain bush, West Indian Satinwood  
 Tel: Bavanchalu, Bavanchi-vittulu, Bogi-vittulu, Karu-bogi, Kala-ginja  
 Tam: Karpokarishi, Karpuva-arishi, Karpuvanshi, Kaarbokarishi, Karpogalarisi  
 Kan: Somaraji, Bavanchigida, Karbekhiga  
 Mal: Karkokil, Karkokilari, Kaurkoalari  
 Assam: Habucha  
 Kash: Babchi  
 Oriya: Bakuchi  
 Nepalese: Bakuchi  
 Sinhalese: Bodi- ata  
 German: Bawchan  
 Bangladesh: Buckidana  
 Arabic: Loelab el abid, Mahalep  
 Srilanka: Ravoli  
 Chinese: Ku Tzu, Pu Ku Chih, Bu Ku Zhi, Cot Chu

## DISTRIBUTION/HABITAT

It grows throughout the plains of India, especially in the semi-arid regions of Rajasthan and Eastern districts of Punjab, adjoining Uttar Pradesh. It is also found throughout India in Himalayas, Dehra Dun, Oudh, Bundelkhand, Bengal, Bombay, some valley in Bihar, Deccan, and Karnataka.<sup>[2,7]</sup> This plant is also widely distributed in the tropical and subtropical regions of the world, especially China and Southern Africa.<sup>[10,11,21]</sup>

## PROPAGATION AND CULTIVATION

The plant thrives well in areas with low to medium rainfall during the summer months and on a variety of soils ranging from sandy, medium loam to black cotton in dry tropical regions of India. The germination percentage can be considerably increased by sowing the seeds during summer, that is, March–April and leaving them in the heat of the soil. Mechanical puncturing of the seed coverings or presowing treatment with concentrated sulfuric acid for 60 min has also been found effective in breaking the dormancy of the seeds and increasing the germination percentage considerably. The crop takes 7–8 months to reach maturity. As seeds continue to mature continuously, 4–5 pickings are usually taken between December and March. Clonal propagation of *P. corylifolia* through shoot tip and axillary bud culture is done. Survival rate on transfer to field was 95%.<sup>[7]</sup>

## PARTS USED

Seeds, seed oil, roots, and leaves.<sup>[16,24,25]</sup>

## DESCRIPTION OF THE PLANT

It is a small, erect, annual herb growing up to 60–120 cm in

height throughout sandy, loamy plains of Central and East India [Figures 1 and 2].<sup>[12,26]</sup>

Seeds are brownish black in color, oblong, and flattened. Das, described the seeds as kidney shaped, 2–4 mm long, 2–3 mm broad, and 1–1.5 mm thick, hard, smooth, exalbuminous with straw-colored testa, with an agreeable aromatic odor and a pungent-bitter taste.<sup>[4,6]</sup> They have grooved and gland-dotted stems.<sup>[27]</sup> Leaves are simple, broadly elliptic, rounded, and mucronate at apex, clothed with white hairs on both surfaces, covered with numerous black dots, 5 main nerves springing from the base.<sup>[27]</sup> Flowers are dense, corolla yellow or bluish purple,<sup>[27]</sup> axillary, 10–30 flowered racemes.<sup>[7]</sup> Flowering time is from August to December.<sup>[19]</sup> Fruit is small, 5 mm long, subglobular, slightly compressed, pitted black, beaked without hairs, indehiscent, one-seeded pod, which is adhering to the pericarp.<sup>[27,28]</sup>

## MICROSCOPY

Transverse section of the fruit shows pericarp with prominent



Figure 1: *Psoralea corylifolia* seeds



Figure 2: *Psoralea corylifolia* plant

ridges and depressions, consisting of collapsed parenchyma and large secretory glands containing oleo-resinous matter; testa, an outer layer of palisade epidermis, layer of bearer cells, and 2–3 layers of parenchyma; cotyledons of polyhedral parenchyma and 3 layers of palisade cells on the adaxial side.<sup>[29]</sup>

## PROPERTIES

The ayurvedic properties of plants based on<sup>[6,7,24]</sup>

Bakuci alleviates kapha and vata doshas but aggravates the pitta dosha.<sup>[30]</sup>

Rasa: Katu, Tikta

Guna: Laghu, Ruksha

Veerya: Ushna

Vipaka: Katu

Prabhava: Shvitrukushthanashaka

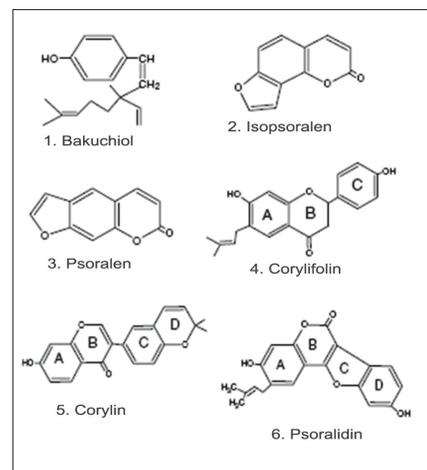
Doshagnata: Vatakaphashamaka

Rogagnata: Mahakushtha, Kshudrakushtha, Shvitra, Khalitya, Vrana, Nadidaurbalya, Agnimandya, Amadosha, Vibandha, Krimi, Arsha, Kasa, Shwasa, Pandu, Hritshaithilya, Hritshotha, Klaibya, Twaka roga, Jeerna jwara.

Karma: Kushthaghna, Jantughna, Vranashodhana, Vranaropana, Keshya, Nadibalya, Deepana, Pachana, Anulomana, Krimighna, Yakridottejaka, Hridayottejaka, Shothahara, Kaphaghna, Pramehaghna, Vajikara

## PHYTOCHEMISTRY

The fruits of *P. corylifolia* consist of a sticky oily pericarp (12% of the seed), a hard seed coat and kernel.<sup>[10]</sup> Chopra *et al* found that the seeds contain an essential oil (0.05%), a nonvolatile terpenoid oil, a dark brown resin (8.6%), and traces of alkaloidal substance.<sup>[4-5]</sup> Dymock stated that the seeds contain 13.2% of extractive matter, albumin, sugar, ash 7.4%, and traces of manganese.<sup>[4-5]</sup> Sen *et al* found that the seeds contained an unsaponifiable oil having the formula  $C_{17}H_{24}O$ , boiling between 180 and 190°C, a yellow acid substance  $C_{40}H_{45}O_{10}$  from the alcoholic extract and a methyl glycoside having a m.p. 105–107°C, containing 4 (OH) groups.<sup>[4-5]</sup> A pigment (probably a hydroxy flavone), a monoterpene phenol named bakuchiol ( $C_{18}H_{24}O$ , b.p. 145–147°C), a brown fixed oil (10%), and raffinose and coumarin compounds were also found in the seeds.<sup>[10]</sup> The essential oil contains limonene,  $\alpha$ -elemene,  $\gamma$ -elemene,  $\beta$ -caryophyllene oxide, 4-terpineol, linalool, geranylacetate,<sup>[6,7]</sup> active component psoralen (identical with fucusin;  $C_{11}H_6O_3$ , m.p. 161–162°C),<sup>[31]</sup> angelicin, and bakuchiol.<sup>[8]</sup> Siddhiqui isolated psoralidin ( $C_{16}H_{14}O_4$ ; m.p. 315°C) and isopsoralen, along with the above constituents.<sup>[4]</sup> Two new benzofuran derivatives—corylifonol and isocorylifonol—were isolated from the seeds.<sup>[32]</sup> The seeds also contained flavonoids, such as corylifolean, corylifolin, corylifolinin,<sup>[27]</sup> bakuchicin, psoralidin, isopsoralidin, bavachin, isobavachin, bavachinin, bavachalcone, isobavachalcone,<sup>[33]</sup> 7-O-methyl bavachin, bavachromanol, corylin, corylidin, corylinal, 4-O-methyl bavachalcone, neobavaisoflavone, bavachromene, neobavachalcone,<sup>[34]</sup> bakuchalcone, isoneobavachalcone,



**Figure 3:** Structure of major constituents in *Psoralea corylifolia*

psoralone, isopsoralone, psoralenol, and psoralidin-2,3-oxide diacetate.<sup>[35]</sup> Also astragalin, *p*-hydroxybenzoic acid,<sup>[32]</sup> stigmaterol, triaconate, and  $\beta$ -sitosterol-D-glucoside<sup>[34]</sup> were present in the seeds. Fixed oil of the seeds is viscous, bitter in taste, and on keeping deposits psoralen.<sup>[10]</sup> Jois obtained considerable resin acids (21.5%) along with glycerides of oleic, stearic, palmitic, myristic, myristolic, linoleic, and linolenic acids from the petroleum ether extract of the seeds.<sup>[4]</sup> Two new coumestans—bavacoumestans A and B along with sophoracoumestan A were isolated from the seeds of *P. corylifolia*.<sup>[32]</sup> Qiao and co-workers isolated 2 new benzofuran glycosides, namely, psoralenoside and isopsoralenoside, from the seeds, which could be easily converted into psoralen and isopsoralen on hydrolysis.<sup>[36,37]</sup> 6-(3-Methylbut-2-enyl)-6'-7'-dihydroxycoumestan was obtained from the crude chloroform extract of the seeds of *P. corylifolia*.<sup>[38]</sup> New isoflavone, corylinin, was also isolated from the plant.<sup>[39]</sup> Other compounds present are  $\beta$ -D-glucosyl-*cis*-O-hydroxycinnamic acid,<sup>[40]</sup> 2H-furo[3',2'-g][1]benzopyran-2-one, 2H-furo[2',3'-h][1]benzopyran-2-one;<sup>[2]</sup> 8-oxo-8H-furo[2,3-f][L]benzopyran, mono-, di-, and triacylglycerols;<sup>[11]</sup>  $\Delta^1,3$ -hydroxybakuchiol;  $\Delta^3,2$ -hydroxybakuchiol; and 6-prenylnaringenin.<sup>[41]</sup>

Leaves contain raffinose, psoralen, and isopsoralen. From the petroleum ether extract of *P. corylifolia* roots, diadzein,<sup>[39]</sup> trilaurin, and coumesterol<sup>[35]</sup> were isolated along with angelicin, psoralen, and sitosterol. Fruit contains corylinal and neobavaisoflavone, including the methyl esters of the 2 compounds, psoralenol, 5'-formyl-2',4'-dihydroxy-4'-methoxychalcone, and bavachromanol [Figure 3].<sup>[7]</sup>

## USES

The most amazing aspect of this plant is that every part of it is useful. Roots, stems, leaves, seeds, and whatever blooms it has, all are used to treat a variety of skin problems, such as leukoderma, skin rashes, infections, and others.<sup>[42]</sup> It is given the name “Kushtanashini” (leprosy destroyer).<sup>[21]</sup> *P. corylifolia* is a

very ancient remedy for leukoderma; it has been tried extensively not only by the practitioners of the Indian medicine but also by the followers of the Western system.<sup>[4]</sup> The furanocoumarins, which contain psoralens, promote pigmentation.<sup>[26]</sup> The powder is used by Vaidyas internally for leprosy and leukoderma and externally in the form of paste and ointment.<sup>[5,9]</sup> Oil has a powerful effect on the skin *Streptococci*.<sup>[27]</sup> It helps fight vitiligo, a disorder in which patches of skin lose their pigmentation.<sup>[11]</sup> It is used in the inflammatory diseases, mucomembranous disorders, dermatitis, and edematous conditions of the skin.<sup>[7,23,27]</sup> It also alleviates boils and skin eruptions. The plant has blood purifying properties. It is used to treat itching red papules, itching eruptions, extensive eczema with thickened dermis, ringworm, rough and discolored dermatosis, dermatosis with fissures, and scabies.<sup>[16]</sup> It has shown to improve the color of skin, hair, and nails.<sup>[20,25]</sup> Seeds are given in scorpion-sting and snake bite.<sup>[5,9]</sup> Seeds are useful in bilious disorders.<sup>[5,6]</sup> *P. corylifolia* extracts have found to possess antitumor, antihyperglycemic, antidepressant, and antioxidant activities.<sup>[43]</sup> Its water extract possesses antibacterial property.<sup>[44]</sup> Seed and extract powder are used as diuretic, anthelmintic, laxative, and for healing wounds.<sup>[3,27]</sup> Seeds are used as stomachic, stimulant, aphrodisiac,<sup>[3]</sup> and diaphoretic.<sup>[7]</sup> It is used in the treatment of various kinds of disorders, such as asthma, cough, nephritis, and others. The major components psoralen and isopsoralen have antitumor, antibacterial, and antiviral properties.<sup>[45]</sup> It is a good hair tonic and hence used in alopecia areata and hair loss.<sup>[24,37]</sup>

It is an effective invigorant against impotence, menstruation disorder, and uterine hemorrhage.<sup>[39]</sup> It is a cure for gynecologic bleeding.<sup>[36]</sup> It is also useful to treat spermatorrhea and premature ejaculation.<sup>[14]</sup> It shows coronary vasodilatory activity.<sup>[39]</sup> The seeds act as deobstruent and heal ulcer, heart troubles, and cure blood disorders and elephantitis.<sup>[38]</sup>

The crude drug has been used for the treatment of enuresis, pollakiuria, painful feeling of cold in the waist and knees, and weak kidney.<sup>[46,47]</sup> It is used in the treatment of debility and other problems related to kidney inefficiency, such as febrile disorders, low back pains, frequent urination, incontinence, and bed wetting.<sup>[11]</sup>

The root is useful in treating the caries of the teeth. *P. corylifolia* is used to promote bone calcification, making it useful for treating osteoporosis and bone fractures.<sup>[10-12]</sup> Leaves are used to alleviate diarrhea.<sup>[10]</sup> Fruit is bitter, helps to prevent vomiting, cures difficulty in micturition, used in treating piles, bronchitis, and anemias and improves complexion.<sup>[12]</sup> *P. corylifolia* contains bavachinin, corylifolinin, and psoralen all of which inhibit the multiplication of osteosarcoma and lung cancer cells.<sup>[11]</sup> They are also useful in fibrosarcoma, malignant ascites, and leukemia. It has hepatoprotective properties.<sup>[48]</sup>

*P. corylifolia* is used in lumbago and tuberculosis.<sup>[13,24]</sup> Essential oil is used as tonic and aphrodisiac. Seeds are sweet, bitter,

acid, and astringent. They impart vigor and vitality; improve digestive power and receptive power of mind.<sup>[12]</sup> Seeds are antipyretic and alexiteric.<sup>[19]</sup> *P. corylifolia* is a well-known nervine tonic in vata diseases.<sup>[30]</sup> It is used in the treatment of intestinal amebiasis.<sup>[49]</sup> The herb is cytotoxic, antimutagenic, and antirepellant.<sup>[2]</sup>

**Other uses:** Seeds are used to make perfumed oil.<sup>[9]</sup> The ethanolic extract has been used as a food additive for the preservation of some processed foods or pickles in Japan.<sup>[37]</sup> The seed cake rich in nitrogen and minerals is used as feed or manure.<sup>[10]</sup>

## PHARMACOLOGIC/BIOLOGICAL ACTIVITIES

Essential oil has a distinct stimulatory action on voluntary muscles in high dilutions (1 in 100,000).<sup>[27]</sup> It produced contraction of isolated rectus abdominis muscle of frog.<sup>[8]</sup> Also, the isolated uterus of guinea pig showed tonic contractions. Well-marked contraction of the arterioles of the frog was seen on perfusion of oil.<sup>[4]</sup> Petroleum ether extract of seeds produced a rise in the blood pressure on anesthetized dogs and caused stimulation of the intestinal smooth muscle.<sup>[6]</sup> Corylifolinin isolated from the benzene extract produced coronary vasodilation and inhibitory action on HeLa cells and an estrogenic effect.<sup>[8,22]</sup>

The essential oil in dilution of 1 in 50,000 and 1 in 10,000 has been found to kill paramecia and streptococci within 15 and 10 min, respectively.<sup>[27]</sup> The oil also showed selective antifungal activity.<sup>[6]</sup> The fruit extract inhibits the growth of *Staphylococcus citrates*, *Staphylococcus aureus*, *Staphylococcus albus*, including strains resistant to penicillin and other antibiotics. Psoralen shows strong inhibition of bacteria, such as *Microsporium canis*, *Microsporium gypseum*, *Trichophyton rubrum*, *Trichophyton mentagrophytes*, *S. aureus*, *Candida albicans*, *Escherichia coli*, *P. aeruginosa*, and others.<sup>[11]</sup> Katsura *et al* proved that bakuchiol is a useful compound against oral pathogens and has a great potential for use in food additives and mouthwashes for preventing and treating dental caries. The cell growth of *S. mutans* was inhibited in a bakuchiol concentration-dependent manner and the growth of *S. mutans* was completely prevented with 20 µg of bakuchiol/mL.<sup>[50]</sup> Psoralidin showed stronger antibacterial activity against Gram-negative bacteria *Shigella sonnei* and *Shigella flexneri*.<sup>[47]</sup>

Bavachinin A isolated from fruits revealed a marked anti-inflammatory, antipyretic, and mild analgesic properties at a dose of 25–100 mg/kg. It has demonstrated better antipyretic activity than paracetamol and showed no effect on the central nervous system, and the maximum lethal dose was greater than 1000 mg/kg in mice.<sup>[27]</sup> It also showed anti-inflammatory activity against carrageenan-induced edema in rats.<sup>[6]</sup>

Bakuchiol, one of the major constituent of *P. corylifolia*, has been

shown to possess a prominent cytotoxic effect on L929 cells in all cultures. It also showed cytotoxicity against cultured human cell lines, namely, A549, SK-OV-3, SK-MEL-2, XF-498, and HCT-15.<sup>[32]</sup> Psoralidin, a coumestan derivative isolated from the seeds, showed a cytotoxic effect on stomach cancer cell line with IC50 values of 53 µg/mL in SNU-1 and 203 µg/mL in SNU-16.<sup>[27]</sup> Byung *et al* showed antitumor and cytotoxic activity of the drug.<sup>[38]</sup> Guo and co-workers proved that psoralen and isopsoralen had antitumor activity against BGC-823 cancer cells.<sup>[51]</sup>

The water-soluble extract containing bakuchiol has been found to possess hepatoprotective activity in tacrine-induced cytotoxicity in human liver-derived HepG2 cells. The EC50 value of bakuchiol was 1 µg/mL and of silymarin was 5 µg/mL.<sup>[27]</sup>

Bakuchiol and 2 of the flavonoids, isobavachin and isobavachalcone, showed broad antioxidant activities in rat liver microsomes and mitochondria.<sup>[27]</sup>

*P. corylifolia* seed extract has been reported to stimulate the immune system in mice. Administration of the seed extract was also found to inhibit EAC ascitic tumor growth and stimulate natural killer cell activity, antibody-dependent cellular cytotoxicity, antibody forming cells, and the antibody complement-mediated cytotoxicity during tumor development.<sup>[27]</sup>

A potential antifilarial activity of *P. corylifolia* leaves and seeds on cattle filarial parasite *Setaria cervi* was observed.<sup>[27]</sup> The alcoholic extract produced death of microfilariae and showed antimycobacterial activity.<sup>[8]</sup> Khatune *et al* proved pesticidal activity of 6-(3-methylbut-2-enyl)-6',7'-dihydrocoumestan.<sup>[38]</sup>

It was observed that flavonoids, mainly corylin and bavachin, have osteoblastic proliferation-stimulating activity and thus might stimulate bone formation and act against osteoporosis.<sup>[27]</sup> Rashid Ali and Agarwal showed that psoralen accelerates the photooxidation of DOPA under sunlight as well as photo flood lamp light.<sup>[6]</sup> The oleoresinous extract of seeds given to nonsyphilitic leukoderma patients has been found to be effective.<sup>[6]</sup> Topical application prepared from *P. corylifolia* gave positive results in epilating folliculitis. The coumarinic extracts from seeds showed photosensitizing activity in guinea pigs. Topical application of active fraction from seeds inhibited the growth and delayed the onset of papilloma formation.<sup>[8]</sup> Psoralen, when orally taken by rabbit at a dose of 4 mg/g and exposed in sun, there was pigment deposition.<sup>[11]</sup> Petroleum ether extract of the seeds showed anthelmintic activity against earthworms.<sup>[6]</sup> Chandhoke and Ray reported that isopsoralen showed tranquilosedative, anticonvulsant, and central muscle-relaxant properties in rats, mice, and rabbits.<sup>[6]</sup>

Methanolic extract of seeds containing isobavachalcone and neobavaisoflavone inhibited the aggregation of

platelets.<sup>[11]</sup> Bakuchiol prevented mitochondrial lipid peroxidation.<sup>[8]</sup> Psoralen extended sleeping time in mice induced by phenobarbital sodium. Psoralen has an effect on medicine metabolism. It increases liver microsome protein concentration thus increasing the concentration of P-250 and NADPH-cytochrome C.

Anti-early pregnancy experiment showed that 10 mg injection of isopsoralen to mice uterus released strong anti-early pregnancy effects. Anti-skin transplantation rejection effects of isopsoralen was proved by 2 mg/cap isopsoralen dose to rabbit, one capsule daily for 20–30 days.<sup>[11]</sup> Psoralen, only in large doses, induces embryo deformity in guinea pigs.<sup>[44]</sup> Bakuchiol possesses DNA polymerase inhibitory activity.<sup>[14]</sup>

The glucoside of the isoflavonoid, diadzein, called diadzin, inhibits the enzymes alcohol dehydrogenase and NAD-dependent alcohol aldehyde dehydrogenase. These enzymes catalyse the oxidation of acetaldehyde, the primary product of alcohol metabolism. So, when diadzin is present, alcohol levels in the bloodstream increase and cannot be metabolized by the enzymes. An important consequence of this is that alcoholics soon lose their appetite for alcohol.<sup>[17]</sup>

Chen *et al* studied the antidepressant activity of total furanocoumarins present in *P. corylifolia* (TFPC) in the chronic mild stress model of depression in mice. The results revealed that TFPC possess potent and rapid antidepressant properties that are mediated via MAO, the hypothalamic–pituitary–adrenal axis, and oxidative symptoms. Thus, it makes *P. corylifolia*, a potentially valuable drug for the treatment of depression in the elderly.<sup>[52]</sup> Xu and co-workers also proved psoralen's antidepressant effects, using forced swimming test model of depression in male mice.<sup>[53]</sup>

Guo and co-workers proved that the powder and extracts of *P. corylifolia* possessed strong antioxidant properties when tested in lard at 100°C by using oxidative stability instrument. Antioxidant activity of compounds decrease in the following order: Psoralidin > BHT > α-tocopherol > bakuchiol > corylifolin > corylin > isopsoralen > psoralen.<sup>[54]</sup>

Matsuda *et al* stated that from the ethanol soluble fraction of *P. corylifolia*, Δ<sup>1</sup>,3-hydroxybakuchiol; Δ<sup>3</sup>,2-hydroxybakuchiol, bavachin, and psoralidin showed inhibitory activities against antigen-induced granulation in RBL-2H3 cells.<sup>[41]</sup>

## CLINICAL STUDIES

A clinical trial was carried out on 30 patients having vitiligo by the local application of an Ayurvedic preparation containing *P. corylifolia* as the main ingredient, along with oral administration of Gandhaka rasayana. Early cases of vitiligo showed maximum improvement within 1–10 months, whereas chronic cases having vitiligo of lip showed a poor response.

Oral administration of 8-methoxypsoralen along with exposure of the patient to sunlight for 5–30 min daily for 1–7 weeks gave very encouraging results. Results of another trial showed that the use of psoralen along with its chemical derivatives, namely, trioxalen, supplemented with exposure to sunlight is a more effective treatment for psoriasis. In one study, 49 patients underwent 6 months of *Psoralea corylifolia* treatment. Of these patients, 14% were cured and another 19% regained pigmentation on at least two-thirds of the affected skin.<sup>[7]</sup> A clinical trial was conducted in 76 patients in the age group 16–24 years with grade II and III acne vulgaris. They were advised to apply a topical preparation, Clarina cream, along with herbal Purim tablets containing *P. corylifolia* as one of the ingredients. Results revealed that patients with grade II acne had an excellent response in 56.25% and good response in 43.75%. Patients with grade III acne had an excellent response in 38.30% and good response in 56.66%. Thus, the combination of the 2 preparations is effective.<sup>[55]</sup>

## MECHANISM OF ACTION FOR LEUKODERMA

The drug appears to have a purely local action with a specific effect on the arterioles of the subcapillary plexuses, which are dilated so that the plasma is increased in this area. The skin becomes red and the melanoblasts (pigment-forming cells) are stimulated. In leukoderma, melanoblasts do not function properly and their stimulation by the drug leads them to form and exudate pigments, which gradually diffuse into the white leukodermic patches.<sup>[10,56]</sup> Also, the phytochemically induced covalent binding of the drug to pyrimidine bases is responsible for its therapeutic effect. The photoconjunction involves thymine dimer adducts on the opposite strands of DNA. Psoralen has been found to intercalate into DNA, where they form mono- and di-adducts in the presence of long wavelength UV light and thus are used for the treatment of hypo-pigmented lesions of the skin, such as leukoderma.<sup>[57]</sup>

### Dosage<sup>[6,26]</sup>

Seed powder: 1–3 gm  
Oil: applied externally  
Tincture: 3–15 mL/day

### Marketed formulations

Algushadi yoga, Sarvangasundari gutika, Bhallatakawaleha, Dhatrayawaleha, Shashanglekhadileha, Maheshwara ghritha, Ayorajodi lepa, Sashishekara vati, Brihatsomaraji taila, Mahatrinaka taila, Kandarpasara taila, Somaraji ghritha, Bawchi tel, Bawchi churna, Shwitra vati, Khadirarista, Mahamanjistha kvatha, and so on.<sup>[7,19]</sup>

### Suggested combinations

Manjistha, neem, kutki for skin conditions; nutmeg, haritaki for chronic diarrhea with cold symptoms and loose, watery stool; haritaki, gokshura for urinary frequency; ashwagandha and bala for reproductive imbalances; and pippali and ashwagandha

for coughs.<sup>[26]</sup> For vitiligo, powder of bakuchi seeds was administered with the decoction of Bibhitaka (*Terminalia bellirica* bark) and Kaakodumbara (*Ficus hispida*). For ringworm, one part of tila (sesame seeds), mixed with bakuchi was prescribed.<sup>[16]</sup> In leukoderma, bakuchi is mixed with haratala bhasma and applied externally.<sup>[30]</sup>

### Toxicity

When psoralen and its derivatives are used for sun-tanning, residual edema of the legs, and cutaneous damage may occur. In some cases, acute dermatitis with blistering, edema, and possibly renal complications have been noticed. Other side effects observed were nausea and vomiting, insomnia, malaise, loose motions, headache, mental depression, and hepatotoxicity. Extensive chromosome damage was produced in mammalian cells by psoralen treatment and high-intensity long wavelength irradiations; therefore, caution should be exercised in the use of psoralen and light therapy because this could lead to later malignancy. Long-term therapy has been found to affect eyes, liver, and immune system.<sup>[27]</sup> A mixture of psoralen, isopsoralen, and imperatorin caused hypertrophy of liver, kidney, and spleen in rats at a daily dose of 2.5 mg/75 g for 60 days.<sup>[7]</sup>

### Acute Toxicity<sup>[11]</sup>

Psoralen:

LD50 oral in mice: 625 mg/kg; LD50 s.c. in mice: 480 mg/kg  
LD50 oral in rat: 1330 mg/kg; LD50 s.c. in rat: 830 mg/kg

Isopsoralen:

LD50 i.m. in mice: 180 ± 29.6 mg/kg; LD50 i.p. in mice: 138 ± 10.9 mg/kg

### Treatment of Adverse Effects

Emptying stomach by aspiration and lavage may treat overdose of the drug. The patient should be kept in a dark room for a minimum of 12 h.<sup>[27]</sup>

### Precautions

Use with caution in pregnancy. Excessive UV therapy causes high pitta.<sup>[26]</sup> It is not given to patients suffering from liver diseases, lupus erythematosus, hydroa porphyria, or other diseases associated with light sensitivity. It is advised to avoid spicy diet, salt, and late nights during bakuchi regimen. Milk, ghee, and butter should be consumed in the diet.<sup>[30]</sup> Seed oil should be avoided on eyes, and it should be mixed with coconut oil before application, because it is thermogenic.<sup>[58]</sup>

### Safety

No herb–drug interactions are known, but caution should be observed with external applications. The drugs in their prescribed doses may be considered safe.<sup>[4,8]</sup>

## CONCLUSION

*P. corylifolia* is commonly found as herb on the way side and at waste places throughout India. The plant has been used

since centuries in leukoderma, psoriasis, vitiligo, asthma, ulcers, kidney disorders, and as an aphrodisiac and an anti-inflammatory. It is reported to contain essential oil, coumarins, alkaloids, flavonoids, and terpenoids. Concentrated fruit and seed extract can be found in various herbal preparations that are in market today. The pharmacologic and clinical studies reported in the present review confirm the therapeutic value of *P. corylifolia*. It is an important source of various types of compounds with diverse chemical structures as well as pharmacologic properties. Presence of such a wide range of chemical compounds indicates that the plant could serve as a “lead” for the development of novel agents having good efficacy in various disorders in the coming years.

## REFERENCES

1. Qiao CF, Han QB, Song JZ, Mo SF, Kong LD, Kung HF, et al. Quality assessment of Fructus Psoraleae. *Chem Pharm Bull* 2006;54:887-90.
2. Sah P, Agrawal D, Garg SP. Isolation and identification of furocoumarins from the seeds of *Psoralea corylifolia* L. *Indian J Pharma Sci* 2006;68:768-71.
3. Mukherjee PK. Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals. New Delhi: Business Horizons; 2002. p. 761-3.
4. Chopra RN, Chopra IC. Indigenous Drugs of India. 2nd ed. Kolkata: Academic Publishers; 1958. p. 391-4.
5. Panda H. Herbs, Cultivation and Medicinal Uses. New Delhi: National Institute of Industrial Research; 2000. p. 479-81.
6. Kapoor LD. Handbook of Ayurvedic Medicinal Plants. Boca Raton, Florida: CRC Press; 2001. p. 274-5.
7. Sharma PC, Yelne MB, Dennis TJ. Database on Medicinal Plants used in Ayurveda. Vol. 2. New Delhi: Central Council for Research in Ayurveda and Siddha; 2001. p. 89-93.
8. Gupta AK, Neeraj T, Madhu S. Quality Standards of Indian Medicinal Plants. Vol. 3. New Delhi: ICMR; 2005. p. 290-8.
9. Nadkarni KM. Indian Materia Medica. Vol. 1. Mumbai: Popular Prakashan Pvt. Ltd; 1976. p. 1019-22.
10. Krishnamurthi AK, Manjunath BL, Sastri BN, Deshaprabhu SB, Chadha YR. The Wealth of India: Raw Materials. Vol. 7. New Delhi: CSIR; 1969. p. 295-8.
11. Available from: <http://www.mdidea.com>. [accessed 2009 Mar 23].
12. Joshi SG. Medicinal Plants. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd; 2000. p. 206-7.
13. Available from: <http://www.plantsforafuture.org.uk>. [accessed on 2008 Aug 11].
14. Lin CF, Yu-Ling H, Mei-Yin C, Shuenn-Jyi S, Chien-Chin C. Analysis of Bakuchiol, Psoralen and Angelicin in crude drugs and commercial concentrated products of Fructus Psoraleae. *J Food Drug Anal* 2007;15:433-7.
15. Joy PP, Thomas J, Mathew S, Skaria BP. Medicinal Plants: Tropical Horticulture. Vol. 2. Calcutta: Naya Prokash; 2001. p. 449-632.
16. Khare CP. Encyclopedia of Indian Medicinal Plants. New York: Springer-Verlag; 2004. p. 384-6.
17. Peter BK. Natural Products from Plants. Boca Raton, Florida: CRC Press; 1998. p. 105-6.
18. Warriar PK, Nambiar VP, Ramankutty C. Indian Medicinal Plants: A Compendium of 500 Species. Vol. 4. India: Orient Blackswan; 1995. p. 374.
19. Agharkar SP. Medicinal Plants of Bombay Presidency. India: Scientific Publishers; 1991. p. 176-7.
20. Available from: <http://www.holisticonline.com>. [accessed on 2009 Feb 25].
21. Available from: <http://www.herbsguide.net>. [accessed on 2009 Feb 27].
22. Available from: <http://www.himalayahealthcare.com>. [accessed on 2009 Feb 25].
23. Available from: <http://www.wikipedia.com>. [accessed on 2009 Mar 11].
24. Available from: <http://www.motherherbs.com>. [accessed on 2009 Feb 27].
25. Available from: <http://www.india-shopping.net>. [accessed on 2009 Feb 25].
26. Sebastian P. Ayurvedic Medicine: The Principles of Traditional Practice. Vol. 2. New York: Elsevier Health Sciences; 2006. p. 135-6.
27. Rajpal V. Standardization of Botanicals. Vol. 2. New Delhi: Eastern Publishers; 2005. p. 284-95.
28. Available from: <http://www.alibaba.com>. [accessed on 2009 Feb 25].
29. The Ayurvedic Pharmacopoeia of India. 1st ed, Vol. 1. India: Govt. of India Ministry of Health and Family Welfare Dept. of Health; 1989. p. 25. The book has no author, it's a publication of Govt. of India
30. Available from: <http://www.herbcureindia.com>. [accessed on 2009 Feb 27].
31. Khastgir HN, Duttagupta PC, Sengupta P. Psoralen and Isopsoralen from *Psoralea corylifolia*. *Indian J Appl Chem* 1959;22:82-5.
32. Rastogi RP, Mehrotra BN. Compendium of Indian Medicinal Plants. Vol. 5. Lucknow, CDRI and New Delhi: NISCIR; 1998. p. 703-4.
33. Rastogi RP, Mehrotra BN. Compendium of Indian Medicinal Plants. Vol. 1. Lucknow, CDRI and New Delhi: NISCIR; 2004. p. 332-3.
34. Rastogi RP, Mehrotra BN. Compendium of Indian Medicinal Plants. Vol. 2. Lucknow, CDRI and New Delhi: NISCIR; 1999. p. 567-8.
35. Rastogi RP, Mehrotra BN. Compendium of Indian Medicinal Plants. Vol. 3. Lucknow, CDRI and New Delhi: NISCIR; 2001. p. 535- 536.
36. Qiao CF, Han QB, Mo SF, Song JZ, Xu LJ, Chen SL, et al. Psoralenoside and Isopsoralenoside, two new benzofuran glycosides from *Psoralea corylifolia*. *Chem Pharm Bull* 2006;54:714-6.
37. Qiao CF, Han QB, Song JZ, Mo SF, Kong LD, Kung HF, et al. Chemical fingerprint and quantitative analysis of fructus psoraleae by high-performance liquid chromatography. *J Sep Sci* 2007;30:813-8.
38. Khatune NA, Islam ME, Rahman MA, Baki MA, Sadik G, Haque MA. Pesticidal activity of a novel coumestan derivative isolated from *Psoralea corylifolia* L. against *Tribolium castaneum* Herbst. adults and larvae. *Pak J Agron* 2002;1:112-5.
39. Ruan B, Kong LY, Takaya Y, Niwa M. Studies on chemical constituents of *Psoralea corylifolia* L. *J Asian Nat Prod Res* 2007;9:41-4.
40. Bourgaud F, Poutaraud A, Guckert A. Extraction of coumarins from plant material. *Phytochem Anal* 2008;5:127-32.
41. Matsuda H, Sugimoto S, Morikawa T, Matsuhira K, Mizuguchi E, Nakamura S, et al. Bioactive constituents from Chinese natural medicines. XX. Inhibitors of antigen- induced degranulation in

- RBL-2H3 cells from the seeds of *Psoralea corylifolia*. Chem Pharm Bull 2007;55:106-10.
42. Available from: <http://www.suyashherbs.trustpass.alibaba.com> [accessed on 2009 Feb 27].
  43. Steven MC, Russell JM. Bioactive Natural Products: Detection, Isolation and Structural Determination. 2nd ed. USA: CRC Press; 2007. p. 254.
  44. Wang D, Yang G, Engelhardt H, Zhang H, Micellar electrokinetic capillary chromatography of psoralen and Isopsoralen, Electrophoresis 1999;20:1895-9.
  45. Liu R, Li A, Sun A, Kong L. Preparative isolation and purification of psoralen and isopsoralen from *Psoralea corylifolia* by high-speed counter-current chromatography. J Chromatogr A 2004;1057:225-8.
  46. Zhao L, Haung C, Shan Z, Xiang B, Mei L. Fingerprint analysis of *Psoralea corylifolia* L. by HPLC and LC- MS. J Chromatogr B Analyt Technol Biomed Life Sci 2005;821:67-74.
  47. Zhao LH, Wu MH, Xiang BR. Analysis of *Psoralea corylifolia* L. fruits in different regions. Chem Pharm Bull 2005;53:1054-7.
  48. Available from: <http://www.cancercliniconline.com>. [accessed on 2009 Jan 11].
  49. Available from: <http://www.pharmaceuticals.indiabizclub>. [accessed on 2009 Feb 25].
  50. Katsura H, Tsukiyama RI, Suzuki A, Kobayashi M. In vitro antimicrobial activities of bakuchiol against oral microorganisms. Antimicrob Agents Chemother 2001;45:3009-13.
  51. Guo J, Hou W, Xinchu W, Jianhua Y, Kaishun B. Studies on extraction and isolation of active constituents from *Psoralea corylifolia* L. and the antitumor effect of the constituents in vitro. Zhong Yao Cai 2003;23:185-7.
  52. Chen Y, Wang HD, Xia X, Kung HF, Pan Y, Kong LD. Behavioral and biochemical studies of total furocoumarins from seeds of *Psoralea corylifolia* in the chronic mild stress model of depression in mice. Phytomedicine 2007;14:523-9.
  53. Xu Q, Pan Y, Yi LT, Li YC, Mo SF, Jiang FX, et al. Antidepressant-like effects of psoralen isolated from *Psoralea corylifolia* in the mouse forced swimming test. Biol Pharm Bull 2008;31:1109-14.
  54. Guo J, Weng X, Xinchu W, Hou W, Qinghua L, Kaishun B. Antioxidants from Chinese medicinal herb-*Psoralea corylifolia* L. Food Chem 2005;91:287-92.
  55. Gopal MG, Farahana B. Effectiveness of herbal medications in the treatment of acne vulgaris: A Pilot Study. Indian Pract 2001;54:723-8.
  56. William B. New Manual of Homeopathic Materia Medica and Repertory. 9th ed. New Delhi: B. Jain Publishers Pvt. Ltd; 2002. p. 1129.
  57. Vaidya AD. Reverse Pharmacological correlates of Ayurvedic drug actions. Indian J Pharmacol 2006;38:311-5.
  58. Ashok Seth. The Herbs of Ayurveda. 1st ed, Vol. 4. Gujarat: Hi Scan Pvt. Ltd; 2005.p. 950.

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