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Psoralea corylifolia Babchi: A popular herb of Unani, Ayurvedic and Chinese system of medicine for Vitiligo

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Abstract
Psoralea corylifolia L. found in tropical and subtropical region of the world is one of the medicinal herbs used in Unani System of Medicine (USM) in the treatment of many diseases. The seeds have been specially recommended in the treatment for Leucoderma, leprosy, psoriasis and inflammatory diseases of the skin. A wide range of chemical compounds including psoralen, isopsoralen, bakuchiol, psoralidin, Bakuchalcone, Bavachinin, flavones, volatile oils, lipids etc. are found in different parts of the plant. The plant possesses antibacterial, antifungal, antitumour, immunomodulatory, antidepressant and antifilarial activity**.** This review attempts to highlight the available literature on P. *corylifolia* (seeds) with respect to its Ethnobotany, Pharmacognostic characteristics, traditional uses, chemical constituents, and summary of its various pharmacologic activities. This will be helpful to create interest toward babchi and may be useful in developing new formulations with more therapeutic and economical value.

Keywords: *Psoralea corylifolia*, babchi, skin, Psoralen

1. Introduction
Psoralea corylifolia belonging to Leguminosae family is an annual herb growing throughout the plains of India. It is a popular herb which is commonly known as babchi. Babchi has since long been used in traditional medicine for its magical effects to cure various skin diseases such as psoriasis, Leucoderma, and leprosy. It is an ancient remedy for Leucoderma; it has been tried extensively not only by the practitioners of the Indian medicine but also by the followers of the Western system [1]. It is given the name "Kushtanashini" (leprosy destroyer) due to its effectiveness in treating leprosy [1, 2]. Its medicinal usage is reported in Indian pharmaceutical codex, Chinese, British and the American pharmacopoeias and in different traditional system of medicines such as Ayurveda and Siddha apart from Unani [3]. 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 Leucoderma, skin rashes, infections, and others. Psoralen and isopsoralen isolated from the seeds are considered therapeutically active constituents. Seeds are hot and dry in nature [4-8] and prescribed both for oral administration and for local external application in the form of paste or ointment [9, 10]. In India it is known by different names according to the places, the commonly used ones are Hakuchi [2, 11, 12], Bavachi [2, 11-13, 10, 14, 15], Lata-Kasturi [2, 10-17], Balchi [4-6], Kakuch [10, 14, 15] (Bengali), Babachi [11], Babchi seeds [2, 5, 11, 18, 19], Babchi [4], Black seeds [6], Malaya-tea [14, 18], Bawchang-seeds [14, 18] (English), Bavacha [11, 12], Babchi [10-13] Bawachi [4, 5, 6, 10, 11, 12], Bakchi [20], Bhavaj [11] (Gujrati), Bauchige [11], Bhawantibuja [11], Bhavanchigida [10, 11, 13, 14, 15, 19], Baukuchi [11], Baranchigida [11], Karbekhiya [11, 15] (Kannada), Babchi [11] (Kashmiri), Karkokil [11], Karpokhari [11], Kamkoalan [11] (Malayalam), Babachi [11], Babchi [11], Bavachi [11] (Marathi), Somaraji [2, 11], Bakuchi [10, 11, 13, 14, 15, 17, 19], Vakuchi [2, 19], Sugandha-Kantak [2, 11, 10, 14, 15], Bhavanchi [21], Krishnaphala [2] (Sanskrit), Karpokarishi [2, 11, 15- 17, 19], Karpurarishi [2, 4- 6, 11, 12], Karporgam [11] (Tamil), Bavanchalu [2, 11, 13-15, 22], Bhavanji [11, 12, 16], Karubogi [4, 5, 11, 12, 16, 24], Baaranchalu [11], Bapurlen [11], Baranchalu [11] (Telegu), Babchi [11, 22] (Urdu), Krishanphal [5], Babchi [2, 10, 12-16, 19], Bhavanchi [2, 10, 12-15], Bukchi [10, 13-16, 19] (Hindi).

2. Literature Review
2.1 Morphological Description of Plant in Unani System of Medicine
The plant of babchi is up to one meter height. Stems and branches are grooved, whitish in colour, thin and are covered with hairs. Leaves are a little smaller than the size of palm, green in colour, rounded in shape and dentate at margin (Fig. 1). Flowers appear from the axils of leaves in bunches and are tiny in size, white or yellow or pink in colour ranging from 20 to 30 in numbers. Pods are green when they are immature and black once they become mature.

They are having 3-4 seeds. Seeds are long, compressed, rounded kidney shaped, up to some extent resembling with Chaksu seeds but without luster. Seeds are black outside and white inside (Fig. 2) [4, 6, 18, 21].

Fig 1: Plant of *Psoralea corylifolia* (Source: NIUM herbal garden

Fig 2: *Psoralea corylifolia* Seeds

2.2 Habitat and Distributions

P. corylifolia is not cultivated on a commercial scale anywhere. It is reported to be grown to some extent in Rajasthan and the eastern districts of Punjab adjoining Uttar Pradesh for its seeds. Seeds of good quality are produced in Rajasthan. The plant grows on any average soil. Seed is sown in March-April in lines, 30 cm apart, at the rate of 7 kg per hectare. The plant flowers during rains and seeds mature in November. Under proper care, the plant may continue to grow for 5-7 years [10]. This crop is propagated from seeds with low to medium rain fall. Seeds are sown in a well prepared and fertilized land during rainy seasons. Since the germination rate is very poor therefore seeds need pretreatment before sowing [24].

The plant prefers sandy, loamy, clay soils and can also thrive in acid, neutral and alkaline soils. The germination percentage can be considerably increased by sowing the seeds during March–April and leaving them in the heat of the soil. The crop takes 7–8 months to reach the stage of maturity. As seeds continue to mature continuously, 4–5 pickings usually can be taken between the month of December and March [25]. The genus *Psoralea,* is widely distributed in the tropical regions of the world. It has a wider distribution in parts of Rajasthan, Andhra Pradesh, Bihar, Gujarat and related semi-tropical grasslands in the country [19].

2.3 Botanical description

The plant is an erect annual herb. It grows 30-60 cm tall under natural conditions and up to 160 cm under cultivation. It has profuse branches. The stem and branches are covered with conspicuous glands and white hairs and bear simple leaves, broadly elliptic, rounded and mucronate at the apex. The axillary, solitary inflorescence (raceme) comprises 10 to 30 flowers with a hairy pedicle [26]. The seeds are oblong and flattened, rough, dark brown having an agreeable aromatic odor. The taste is aromatic and Bitterish [16].

3. Phytochemistry

Coumarins, flavonoids and monoterpene phenols are the main active components of *Psoralea corylifolia* seeds. The coumarin components include psoralenoside, isopsoralenoside, psoralen, isopsoralen and prosalidin and they are reported having estrogen-like activity, antitumor activity, and anti-oxidative activity. The main flavonoid components are Bavachin, Neobavaisoflavone (NBIF) and isobavachalcone [27]. Psoralen, isopsoralen, Corylifolin, Corylin and psoralidin have been isolated from the petroleum ether and chloroform extract of the whole plant of *P. corylifolia* [25]. The seeds contain 20.15% unsaponifiable straw-coloured essential oil, 13.5% of extractive matter, albumin, sugar, 7.5% of ash, and traces of manganese. Sen, Chatterjee and Datta in 1923 carried out a thorough examination of seeds and concluded that they contained; (1) An unsaponifiable oil having the chemical formula $C_{17}H_{24}O$ (boiling point 180°C –190 °C) at 11 to 15mm, (2) A yellow acid type substance obtained from alcoholic extract with a chemical formula $C_{40}H_{45}O_{10}$. (3) A methyl glucoside containing four OH groups (melting point of 105–127 °C) [2, 25]. In 1927, Chopra and Chaterjee stated that the chief active principle of the seeds is an essential oil. A fixed oil and resin occur in large quantities but these are not pharmacologically active substances. Traces of alkaloidal content are also present [2, 25]. A monoterpene phenol, bakuchiol and the two novel dimeric monoterpenoids, Bisbakuchiols A and B, have been isolated from the seeds of *P. corylifolia*. The ethereal seed extract showed the presence of Corylinal as well as C-formylated chalcone and Isoneobavachalcone. Psoralenol, a new isoflavone has been isolated from seeds of *P. corylifolia* [25].

Renmin Liu *et al.* carried out a study on crude extract of *Psoralea corylifolia.* They isolated psoralen and isopsoralen from *Psoralea corylifolia* by high-speed counter-current chromatography (HSCCC) with a two solvent system composed of *n*-hexane-ethyl acetate-methanol-water (5:5:4.5:5.5, v/v). 100gm of crude extract yielded 39.6 mg of psoralen and 50.8 mg of isopsoralen with a purity of 99.4 and 99.6% respectively. Five novel compounds, psoracorylifols A–E (1-5) having important activity against *Helicobacter pylori* have also been reported by Sheng Yin *et al*. from seed samples. The structures of psoracorylifols A–E including their

absolute configurations was confirmed on the basis of spectral methods and by a single crystal X-ray diffraction. Psoracorylifols D and E (4-5) represent an unprecedented carbon skeleton [28].

Three new prenylflavonoids have also been reported by Sheng Yin *et al*, namely corylifols A–C (1–3) from the seeds of *Psoralea corylifolia*. Their structures were elucidated by spectral methods including 1D and 2D NMR techniques. Compound 1 (corylifols A), was obtained as a light yellow amorphous powder, showed the molecular formula as $C_{25}H_{26}O_4$ determined by HREIMS at m=z 390.1833 $[M]^+$. Compound 2 (corylifols B) was obtained as a brown amorphous powder. The molecular formula of 2 was arranged to be $C_{20}H_{20}O_5$ by HREIMS at m=z 340.1315 $[M]^+$. Compound 3 was obtained as a yellow amorphous powder. The molecular formula of 3 was determined as $C_{20}H_{18}O_5$ by HREIMS at m=z 338.1161 $[M]^+$ [29].

Bhawna Chopra *et al.* reported four flavonoids bavachinin, bavachin, isobavachin and isobavachalcone. They were isolated from the seeds of *P. corylifolea*. Psoralenoside and Isopsoralenoside, two new benzofuran glycosides were also isolated [25]. Rao G.V *et al.* carried out a chemical examination and biological studies on the seeds of *Psoralea corylifolea* and isolated five known compound namely γ-cadinene, bakuchiol, psoralen, isopsoralen and psoralidin from the acetone extract of seeds. The compound γ-cadinene was first reported from this plant [3].

4. Medicinal Action

4.1 As per Unani literature

Muqawwi-i-Bah (Aphrodisiac) [4, 12], *Qatil-i-Kirm-o-Shikam* (Anthelmintic) [8, 4-6, 30], *Mukhrije-Kirmo-Shikam* (Vermifuge) [23], *Muqawwi-i-Mi'da* (Stomachic) [21, 8, 6, 30], *Mulayyin* (Laxative) [4-6, 11, 21, 23, 30], *Muhallil* (Resolvent) [21], *Nafe Balgham-e-Tapi* [8, 31], *Dafe Bars wa Bahaq* [6, 8, 9, 31], *Kasir-i-Riyah* (Carminative) [4, 5, 21, 30], *Mundij* (Concoctive) [21], *Muraqqiq-e-Balgham-e-Ghaliz* [4, 21], *Jadhib* [21], *Dafe Luab-e-Dehen* [21], *Muqawwi-e-Badan* [21], Muhallil-e-Riyah [8], *Muqawwi-e-Qalb* [8, 21], *Mufarrih* (Exhilarant) [8, 21, 23], *Mushtahi* (Appetizer) [8, 21, 23], *Dafe Kalaf* (Antimelasma/Antichloasma) [6, 9], *Nafkh* [23], *Jali* (Detergent) [6, 9], *Mushil-i-Balgham* (Phlegmagogue) [9], *Muqarrih* (Ulcerative) [21], *Tehleel-i-Riyah* [8], *Musaffi-i-Dam* (Blood purifier) [4, 5, 6, 9, 11, 18, 21, 30], *Mohammir-i-jild* (Rubefacient) [11].

4.2 As per Ethnobotanical literature

Aphrodisiac (*Muqawwi-i-Bah*) [10, 13, 15, 28], Anthelmintic (*Qatil-i-Didan-i-Am'a'*) [13, 10, 16, 17], Vermifuge (*Mukhrij-i-Didan-i-Am'a'*) [28], Stomachic (*Muqawwi-i-Mi'da*) [16, 17, 28], Laxative (*Mulayyin*) [10, 13, 15, 28], Anti-inflammatory (*Muhallil*) [28], Antipyretic (*Dafe Humma*) [28], Diuretics (*Mudirr-i-Bawl*) [10, 13, 15, 16, 17, 28], Deobstruent (*Mufattih*) [16, 17, 28], Diaphoretic (*Mu'arriq*) [10, 13, 15, 17, 28].

5. Pharmacological Studies

5.1 Antibacterial activities

S. Chanda screened out thirteen plants including *Psoralea corylifolia* for their *in vitro* antibacterial potentiality against five medically important bacterial strains. Amongst the thirteen plants screened, *Psoralea corylifolia* was found having best antibacterial activity. The seeds *P corylifolia* were extracted successively with petroleum ether, 1, 4-dioxan, acetone, methanol and N, N-dimethylformamide (DMF). The antibacterial activity of these extract was carried out against five microorganism namely *Proteus morganii, Alcaligenes faecalis, Enterobacter aerogenes, Staphylococcus epidermidis* and *Bacillus megaterium* by agar disc diffusion method. All the extracts were active against *S. epidermidis and P morganii* while none of the extract was active against *A fecalis*. Dioxan extract showed the maximum antibacterial activity [32].

5.2 Antifungal activities

N. Rajendra Prasad reported the qualitatively antifungal activity of crude extract *Psoralea corylifolia* seed against *Trichophyton rubrum, Trichophyton mentagrophytes, Epidermophyton floccosum* and *Microsporum gypseum* by the disc diffusion method on a Sabouraud dextrose agar (SDA) medium. Dried seed powder of *Psoralea corylifolia* was extracted successively with 250 ml of solvents of increasing polarity such as petroleum ether, diethyl ether, benzene, chloroform, acetone, methanol, ethanol and water. The maximum activity was exhibited at 250µg of methanol extract with a halo of 28mm diameter inhibition against *Trichophyton mentagrophytes.* Methanolic extract was subjected to TLC and Six different bands were obtained. The best activity was exhibited against all dermatophytes by a band possessing R_f value 0.97 with an inhibitory halo of 30mm diameter. The band at R_f value 0.91 showed a halo diameter of 15 mm. The remaining bands were inactive against the tested organisms [33].

5.3 Antitumour activity

P.G. Latha *et al.* conducted the antitumour activity of *Psoralea corylifolia* seeds extract (PCSE) in mice. Balb/*c* male mice (20-25 g), housed under standard environmental conditions, were used. Three groups of eight mice each were transplanted i.p. (Intraperitoneally) with 1×10^6 EAC (Erlich ascites tumour) cells. After 24 h, the first group was injected with PCSE 100mg/kg and second group was injected with PCSE 200mg/kg i.p. The third group, serving as the control, was given normal saline (0.25 ml, i.p.). Treatment was continued for 35 days or till death of animals. Body weights were recorded every week. After 35 days of treatment, the surviving animals were killed and the peritoneal cavity was examined carefully for the presence of tumour cells and the number of cells determined if any. PCSE in first and second group prolonged the life span of mice challenged with 1×10^6 tumour cells/mouse and protected 3/10 animals from tumour growth. There was no significant difference between the effects produced by the two tested doses of PCSE [34].

5.4 Immunomodulatory activity

P.G. Latha *et al.* also conducted the antitumour activity of *Psoralea corylifolia* seeds extract (PCSE) in mice. Three groups of 10 mice each were taken for study. First and second group was injected EAC (Erlich Ascites Tumour) cells (1×10^6), i.p. After 30 min, first group was administered PCSE (100 mgr/kg, i.p.), while second group was given normal saline (0.25 ml, i.p.). A third group of mice was given PCSE alone. Treatment was continued every day until the animals were sacrificed. On alternate days after tumour transplantation, one animal from each group was sacrificed, blood collected by heart puncture and the separated serum was used for the study of antibody complement-mediated cytotoxicity (ACC). The spleen was removed aseptically and used for the study of natural killer (NK) cell activity and the antibody-dependent cellular cytotoxicity (ADCC) assay. After the administration of PCSE, in tumour-bearing and normal mice, respectively NK cell activity was significantly enhanced on days 5 and 7 respectively. In the untreated tumour-bearing

control animals, the maximum NK cell activity was observed only on day 11 of tumour inoculation. Administration of the PCSE to normal as well as tumour-bearing animals enhanced the ADCC activity. The maximum ADCC activity in tumour-bearing controls was on day 13 only, whereas in the normal and tumour-bearing mice treated with PCSE, it was on days 7 and 9, respectively. In tumour-bearing control mice, the ACC activity was observed on day 9 and peaked on day 13 for an undiluted antibody concentration, whereas in tumour-bearing animals given PCSE, the values peaked on day 13, even with an antibody dilution of 1:4. Administration of PCSE produced a significant increase in the ASC of the mouse spleen. PCSE-treated groups produced 1000 ASC/10^6spleen cells, whereas the controls produced only 675 ASC/10^6 spleen cells [34].

5.5 Antidepressant activity

Qun XU *et al.* carried out Antidepressant-Like Effects of Psoralen Isolated from the Seeds of *Psoralea corylifolia* in the Mouse Forced Swimming Test (FST). The behavioral and biochemical effects of psoralen, a major furocoumarin isolated from *Psoralea corylifolia*, were investigated in the FST model of depression in male mice. In this study, psoralen decreased immobility and increased swimming in the mouse FST. Psoralen treatment attenuated FST-induced alterations in 5-HT and 5-HIAA levels, as well as 5-HIAA/5- HT ratio in frontal cortex and hippocampus. Furthermore, psoralen ameliorated FST-induced increases in serum corticotropin-releasing factor (CRF) and corticosterone concentrations to normalize the active HPA axis in mice. These results suggested that the antidepressant-like effects of psoralen were mediated by regulating the serotonergic and the HPA axis systems in the mouse FST [35].

5.6 Antifilarial activity

Qamaruddin *et al*. carried out antifilarial activity of the leaves and seeds extracts of *Psoralea corylifolia* on cattle filarial parasite *Setaria cervi*. They studied the effect of aqueous and alcohol extracts of the leaves and seeds of *Psoralea corylifolia*, on the spontaneous movements of both the whole worm and the nerve muscle preparation of *Setaria cervi* and on the survival of microfilariae *in vitro*. Alcoholic extracts of both leaves and seeds caused the inhibition of spontaneous movements of the whole worm and the nerve muscle preparation while the aqueous extracts of both leaves and seeds did not show any effect on the movement of the whole worm and nerve muscle preparation of *S. cervi*. Inhibition of movements was characterized by initial, short lasting small increase in tone of contractions followed by paralysis. The alcohol extract of leaves, produced irreversible while that of seeds produced reversible paralysis on the whole worm. The concentrations required to inhibit the movements of whole worm and nerve muscle preparations for alcohol extracts of leaves were 160 and 30 mg/ml while that of seeds were 150 and 20 mg/ ml, respectively. Alcohol extracts of both leaves and seeds caused death of microfilariae *in vitro*. Concentration related effect of alcohol extract of leaves and seeds on the survival of microfilariae of *S. cervi* were observed. The LC_{50} (Lethal Concentration-50) and LC_{90} (Lethal Concentration-50) as observed after 6 h were 160 mg/ml, and 30 mg/ml for leaves extract and 150 mg/ml and 20 mg/ml for seeds extract, respectively [36].

5.7 Antiplatelet activity

The methanolic extract of the seeds of *Psoralea corylifolia* L. was found to inhibit the aggregation of rabbit platelets induced by arachidonic acid, collagen, and platelet activating factor in a study carried out by Wei-Jern Tsai *et al*. [37].

5.8 Neuroprotective effect

Neuroprotective effects of *Psoralea corylifolia* seed extracts on mitochondrial dysfunction induced by 3-nitropropionic acid was investigated by A-Rang Im *et al*. The results obtained suggested that seed extracts of *P. corylifolia* induced production of ATP and Mitochondrial membrane potential (MMP) and these decreased the mitochondrial superoxide levels. These findings suggested that *P. corylifolia* seed may have potential in treating neurodegenerative diseases [38].

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