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Ethnopharmacological, Phytochemistry and Pharmacological Activities of *Psoralea Corylifolia:* A Review

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ABSTRACT:

The Indian medicinal plant *Psoralea corylifolia* has been used in the traditional Ayurvedic system of treatment for thousands of years. In classical Ayurvedic sources, it is referred to as '*Bakuchi*'. It is also referred as *Kustanaghini* ,*Kustanashini* due to its potent effect in skin disorders. It's an erect annual herbaceous plant of the *Fabaceae* family, native to China & South Africa, also it grows all across the Indian subcontinent (Maharashtra, West Bengal, Uttar Pradesh, Rajasthan, Karnataka, Bihar, and Deccan). Bakuchi root are used for dental carries; its leaves for diarrhea; and fruits for anemia, asthma, bronchitis, dysuria, improving hair and complexion, inflammation, piles, and vomiting, Its seeds are used for the treatment of scabies, ulcers, vitiligo, leukoderma, eczema, leprosy, and psoriasis. Phytochemical investigation indicates the presence of flavonoids, coumarins, quinones, phenols, benzofurans and benzopyrans, sesquiterpenoids, triterpenes, and steroids. Anti-inflammatory, hepatoprotective, hemostatic, anti-oxidant, anti-microbial, antibacterial, anti-fungal, anti-obesity, anti-viral, anti-mutagenic, anti-filarial, estrogenic, anti-cancer, anti-asthma, anti-diabetic, anti-aging and immune-modulatory effects have been found for various parts of the plant. It is also effective in Alzehimer's disease and alopecia areata. Various formulations are present in market such as *babchi churna*, *psoralea ointment*, *babchi oil*, *bakuchi capsule*, *bakuchi vati*, *somaraji taila* & *avalgujadi lepa*. So, an attempt has been made in this article to gathered all the possible significant information about the *Bakuchi.*

Keywords: *Bakuchi*; *Kustanashini*; Bakuchiol; Psorenol; Coumarins; Psoriasis; Vitiligo.

INTRODUCTION

Medicinal plants are used as a remedy against various diseases in the traditional system of medicine from the ancient times. From the past few years, compounds isolated from natural sources have been acquired great importance because of their vast diverse chemical properties, which led to a phenomenal increase in the demand of herbal medicine. Drugs obtain from natural sources are relatively safe, easily available and affordable to the masses. *P.*

corylifolia is one of the plant herbs belongs to family *Fabaceae* which is used from ages in traditional Indian Ayurvedic, Unani, Homeopathy, Siddha and in Chinese medicine. It is known in Ayurveda as '*Bakuchi*'[1] and is referenced in different Ayurvedic classical texts under various names on the basis of its pharamacognostical, organoleptic and pharmacological properties. The plant has immense therapeutic effect and it has been extensively used for its magical effects against several skin diseases such as psoriasis, leukoderma, and leprosy.[2] Due to its skin healing property, it is also known as *Kustanaghini*,[3] *Kustanashini* ,[4] *Kuṣṭhaha*,[5] *Kuṣṭhahantrī*[6] and *Świtraghnī*.[7] It is kept in *tikta skanda*[8] in *Charak Samhita*, *Katu varga* in *Sushruta Samhita* [9], *Haritkyadi varga* in *Bhavprakasha*.[10] It is widely distributed throughout the world's tropical and subtropical areas. It's a Chinese and South African native medicinal plant, widely available throughout India's plains, particularly in semi-arid areas such as Rajasthan, Punjab's eastern area and Uttar Pradesh.[11] It's also found in the Himalayas region.[12] The whole plant is having both curative and nutritive value, but its seeds and seed oil are mainly used as medicine. It contains plenty of phytochemicals such as flavones, coumarins, monoterpenes, chalcones, lipids, resins, stigma steroids, and flavonoids.[13]

MATERIAL & METHODS

For this review all information related to the topic are gathered from classical Ayurvedic literatures, textbooks and from various scientific published journals

Ethnopharmacology

For a long time, *Psoralea* species have been used in folk medicines. In Chinese traditional medicine, *P. corylifolia* is known as Bu Gu Zhi, used as a tonic to promote overall vitality. 'Buguzhi' is a combination of three Chinese words: 'Bu' means 'to invigorate,' 'Gu' means 'bone,' and 'Zhi' means 'fat.' The herb's Chinese name indicates its ability to produce fat for the rejuvenation of bones. *P. corylifolia* is unique in that every part of the plant is beneficial including the roots, stems, leaves, seeds and flowers. *P.corylifolia* is known as "*Kushtanashini*" in Ayurveda because it is used to treat leprosy. Furthermore, it is used in treatment of vitiligo in India and China.[14] The plant has been utilised in Unani System of Medicine to treat fever, skin disorders and internal ulcers.[15] It is also found to be a potent anti-helminthic and sedative.[16] The leaf powder is applied to the skin as a paste or taken orally to cure leprosy and leukoderma.[16] The leaves can also be used to treat dermatitis, inflammation, muco-membranous diseases, oedematous skin problems and diarrhoea.[17,18] Boils, itchy eruptions, ringworm infection, eczema, rough and discoloured dermatosis with fissures and scabies are all treated with this herb because it has blood purifying properties.[19] The essential oil extracted from the plant is beneficial against skin infections caused by *streptococcal* bacteria.[19] Because the seeds have antipyretic and alexiteric properties, they are used to treat scorpion and snake bites as well as bilious diseases.[16,20,21] Psoralen (furocoumarin) is a pigment-regulating chemical found in both seeds and fruits of the plant.[22,23] Anti-hyperglycaemic, anti-depressant, anti-tumour, anti-bacterial and anti-oxidant properties have been found for seeds.[24] Seed extract and seed powder are beneficial as anti-helminthic, in impotency,[25] laxative,[26] hair tonic and diuretic drug.[27] *Bakuchi* seeds are used as stomachic, in heart trouble,[28] diaphoretic,[29] aphrodisiac,[12] carminative, glandular swelling.[30] Seed powder heals scabies, ulcers, skin diseases,[31] vitiligo, leukoderma, eczema, leprosy and psoriasis[32] while applied externally. *Bakuchi* seed oil act on worm infestation,[16] anorexia, constipation,[26] elephantiasis and rheumatism[26] when used internally. When applied externally it is used in chronic skin diseases.[32] The roots of *Bakuchi* treat dental carries. The plant is also having ability to cure chronic diarrhoea and cold, reproductive diseases, cough and urinary frequency in combination with other drugs.[32] It can also treat alopecia areata.[32] The seeds are also used to make perfumed oil.[16] The nitrogen and mineral-rich seed cake is utilised as cattle feed or manure.[18]

Phytochemical Constituents

A very wide range of chemical constituent such as flavonoids, phenol, coumarins, benzopyrans, benzofurans, quinines, triterpenoids, sesquiterpenoids and steroids are reported from the plant *P. corylifolia*. Volatile oil is also reported from some part of plant. It was also observed that seasonal fluctuation has an impact on plant phytochemistry. The active chemicals are mostly found in the seeds of the plant. The phytochemistry of plant is detailed in (**table 1)**.

Pharmacological activities

P. corylifolia is used for a wide range of ethnopharmacological and therapeutic purposes. Many pharmacological studies have led to the identification of various bioactive compounds, which have several therapeutic effects that are summarized below.

Anti-bacterial activity

Corylifolinin and neobavaisoflavone are two isolated compound from *P. corylifolia* showed significant

antibacterial activity against Methicillin-resistant *Staphylococcus aureus*, *Staphylococcus aureus* and β-lactamase positive *Staphylococcus aureus*.[76] The seeds extract contains bakuchiol, which inhibits *Staphylococcus mutans* and *Actinomyces viscosus*.[77] Psoralidin and bakuchicin were shown to have antibacterial action against Gram-negative bacteria *Shigella sonnei* and *Shigella flexneri*, while psoralen and angelicin inhibited Gram-negative bacteria *Staphylococcus aureus* in another research. In the disc diffusion assay, psoralidin had the best antibacterial action against *S. sonnei* and *S. flexneri*.[55] *Bakuchi* ointment inhibits *Bacillus subtilis* and *Escherichia coli*. Bakuchi taila showed higher inhibitory action against *S. aureus* and *Klebsiella pneumonia*, whereas *bakuchi siktha taila* inhibits *Klebsiella pneumonia* more efficiently.[78] In a very low concentration, *bakuchi* mouth rinsing solution inhibits the growth of *S. mutans* bacteria. The ethanol extract of *bakuchi* inhibited the human gingival fibroblast in addition to mouth rinsing ability.[79]

Anti-oxidant activity

According to various scholars in Ayurveda, *bakuchi* is potent *rasayana* drugs. It possessed significant rejuvenating properties. Also, plant has wide range of anti-oxidant compounds responsible for anti-oxidant activity. Several bioactive substances such as bakuchiol, psoralen, isopsoralen, corylin, corylifolin, and psoralidin were evaluated for their anti-oxidant potential. Psoralidin demonstrated the greatest anti-oxidant activity when compared to the standard compounds butylated hydroxytoluene and tocopherol

4.3 Anti-fungal activity

In a study, the essential oil isolated from *P. corylifolia* was evaluated against fungus *Microsporum canis, Trichophyton rubrum*, and *Trichophyton mentagrophytes*. In disc diffusion test, the zone of inhibition for *M. canis, T. rubrum*, and *T. mentagrophytes* were observed 20, 35 and 37 mm respectively, while the minimum inhibitory concentration was observed 1.4/ml, 0.4/ml, and 0.5/ml, respectively.[80] In another study, methanol extract of plant found effective against *phytophthora infestans* which cause tomato blight disease and *Puccinia recondite* which cause wheat rust disease.[81]The crude extract of plant showed inhibitory activity against *Candida albicans*.[85] In another study, mycelial growth was prevented by plant extract of *P. corylifolia* in fungi such as *Alternari brassicae, Aspergillus niger*, *Fusarium oxysporum*, and *Rhizoctonia cerealis*.[82-83] It can also inhibit the growth of *Fusarium verticillioides* and *Aspergillus flavus* which is responsible for various disease in maize crop.[84]

Anti-viral activity

The crude ethanol extract of the seeds of *P. corylifolia* was found to have significant preventive action in severe acute respiratory syndrome corona virus (SARS-CoV) papain like protease (PL pro) with an IC_{50} of 15 µg/ml. SARS-CoV-PL pro is a main enzyme that is responsible SARS virus replication.[86] Another research revealed that the compound bakuchiol which is found in seeds, suppresses influenza A.[87]

Anti-inflammatory activity

In Ayurveda, *bakuchi* is used in *sotha* (inflammation).[10,89] In RAW 264.7 macrophages, which are derived from the Abelson leukaemia virus, bakuchiol suppressed the production of inducible nitric oxide synthase (NOS) gene by inactivating nuclear transcription factor-B.[88] The extract of leaves, fruits and seeds had been shown to suppress tumour necrosis factor-alpha (TNF-α) action and have anti-inflammatory properties.

In skin conditions

In Ayurveda, *bakuchi* is used in *Twaka dosha* (skin disease),[90] *Kusta* (leprosy)[9-91] *Sweta kusta* (leukoderma) *Shwitra* (vitiligo) in various classical texts. The compounds obtained from plants exhibit activity against various skin diseases. Psoralen and isopsoralen assist in production of melanin by transforming di-hydroxyphenylalanine (DOPA) in presence of sunlight, therefore it helps in treating vitiligo, leprosy and psoriasis. [92] Psoralen has found effective for the treatment of psoriasis and alopecia areata when used alone.Different micro-emulsions containing *Commiphora mukul* powder and *bakuchi oil* were used to treat psoriasis in recent research. Because of the synergistic action of both, this herbal combination might be a low-cost and effective source of anti-psoriatic agent.[93]

Immunomodulatory activity

Flavonoids extracted from *bakuchi* have been shown immunomodulatory activity.[94] Ethanol extract of seeds were shown to activate the immune system in mice by enhancing cell mediated and humoral immune responses in another research.[95]

Anti-helminthic activity

The seeds have been clinically proved to have anti-worm properties against both roundworms and flatworms.[96] Aqueous and alcoholic extracts of the leaves and seeds were shown to have excellent anti-filarial efficacy against *Setaria cervi* in research. Alcoholic extracts of both seeds and leaves killed microfilariae in an *in-vitro* assay.[97]

Antimutagenic activity

In a study, Flavonoids isolated from *P. corylifolia* exhibit

antimutagenic activity.[98,99]

Hepatoprotective activity

Bakuchi exhibit significant hepatoprotective activity.[100,101] In a study, three phytochemicals extracted from the plant namely Bakuchiol, bakuchincin and psoralen have showed hepatoprotective activity with EC_{50} values of 1.0, 47.0 and 50.0 μg/mL respectively on tacrine-induced cytotoxicity in human liver derived Hep G2 cells using silymarin as a positive control with EC50 value of 5.0 μg/mL.[102]

Anti-pregnancy and estrogenic activity

It was reported that in a study angelicin and bakuchiol isolated from plant have significant anti-implantation activity on micePsoralidin, a coumestan analogue was discovered to have a novel biological activity as an agonist for both oestrogen receptors (ER and ER). In both ER-positive human breast and endometrial cell lines as well as non-human cultured cells transiently expressing ER or ER, it activates the traditional ER signalling pathway.[103]

Hemostatic activity

The aggregation of rabbit platelets caused by arachidonic acid, collagen and platelet activating factors was inhibited by methanol extract of the seeds of bakuchi. Isobavachalcone's anti-platelet aggregation action was shown to be most effective.[104]

Anti-obesity activity

Genistein extracted from *P. corylifolia* was found to have considerable anti-obesity activity in research. It lowers fat pad weight and increases adipose tissue apoptosis. Furthermore, through affecting the adipocyte life cycle, obesity-related low-grade inflammation and oxidative stress, plant extract has anti-diabetic and anti-obesity properties.[68]

Anti-cancer activity

The anti-cancer chemical genistein is found in significant amounts in *P. corylifolia* leaves (more than 2 g per Kg dry weight). On carcinoma cell lines KB, KBv200, human erythroleukemia cell K562 and K562/ADM the bioactivity of two furocoumarins, psoralen and isopsoralen was investigated for their cytotoxicity. Both molecules triggered apoptosis in these cells, indicating that they had anti-cancer properties. Psoralen had IC_{50} values of 88.1, 86.6, 24.4, and 62.6 µg/ml, whereas isopsoralen had IC_{50} values of 61.9, 49.4, 49.6, and 72.0 µg/ml respectively [105] Bakuchiol also demonstrated extremely selective clearance action in hepatic stellate cells *via* an apoptotic mechanism, suggesting that the plant possesses anticancer properties in liver cancer.[106, 107]

Others

Besides these activities *P. corylifolia* have antiaging [108,] pesticidal [109,] anti-diabeti[110] anti-hypercholesterolemic [111] anti-asthma activity. [112] Also, this plant is found effective for the treatment of Alzheimer's disease.[113]

DISCUSSION

P.corylifolia has anti-oxidant, anti-dermatosis, anti-inflammatory , and other pharmacological effects. The raw herb as well as its active ingredients have been studied in a wide range of conditions and various formulations are available in market for therapeutic uses. The main action of *Bakuchi* on skin is due to its tikta rasa and katu vipak which pacifies pitta -kapha dosha and also helps in blood purification.

CONCLUSION

P. corylifolia commonly known as *bakuchi* is an important drug from the ancient times, it was mentioned in various traditional system of medicine, In Ayurveda, its properties and actions are well documented in various classical text. More than seventy phytochemicals have been isolated from different plant parts which are having significant pharmacological properties. It is a classical remedy for skin disease indicated in so many skin disorders such as leukoderma, vitiligo, leprosy and many more. Also, various pharmacological activities are reported in research from the past few decades. Various formulations of *bakuchi* are available in markets such as *Somaraji taila*, *Avalgujadi lepa*, *bakuchi taila*, *Bakuchi capsules* and many more to treat various diseases. In this review, we have compiled the ethnopharmacology, phytochemistry and pharmacological activities of the plant *P. corylifolia*.

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Table.1 Different phytochemical constituents reported from the plant *P. corylifolia*

S.no.	Chemical Name	Chemical Nature	References
1.	Coryfolin	Flavonoids	68
2.	Psoralen	Furocoumarins	33
3.	Isopsoralen	Furocoumarins	33-34
4.	Neo-psoralen	Coumarins	33-35
5.	Corylin	Flavonoids	33
6.	Psoralidin	Coumarins	33
7.	Bakuchiol	Phenol	34, 36-38
8.	Bavachin	Flavonoids	39
9.	Isobavachin	Flavonoids	37, 40
10.	Sophoracoumestan A	Coumarins	43
11.	Bavachalcone	Flavonoids	40, 58-59
12.	Genistein	Isoflavone	41, 44
13.	Biochanin A	Isoflavonoids	44
14.	Dadzin	Isoflavonoids	43
15.	Dadzein	Isoflavonoids	42, 44
16.	Bakuisoflavone	Flavonoids	47
17.	Bavachinone b	Flavonoids	48
18.	Bavacoumestan C	Flavonoids	48
19.	Neobavaisoflavone	Flavonoids	42, 45-46, 55
20.	Bakuflavanone	Flavone	47
21.	Corylifols	Flavonoids	49
22.	Corylifol A	Flavonoids	50
23.	Corylifol B	Flavonoids	50
24.	Corylifol C	Flavonoids	51
25.	Corylifol D	Flavonoids	52-53
26.	Corylifol E	Flavonoids	52-53
27.	Aryl coumarin	Coumarin	51
28.	Astragalin	Flavonoids	13, 55
29.	Bavachinin	Flavone	39, 50, 55-56, 63
30.	Bakuchicin	Coumarins	57
31.	Corylifolinin	Chalcone	55, 60
32.	Dihydroxy coumestan	Terpene	61-62
33.	Hydroxy bukuchiol	Monoterpene	63
34.	Isobavachalcone	Chalcone	56, 64
35.	Psoracoumestan	Coumestans	51
36.	Xanthoangelol	Chalcone	51
37.	Psoracorylifol D	Flavonoids	63
38.	Psorachalcones A	Chalcones	65-66
39.	Psorelenol	Isoflavone	67
40.	Psorelenol methyl ether	Isoflavone	67
41.	Psorelenol monomethyl ether monoacetate	Isoflavone	67
42.	Psorelenol diacetate	Isoflavone	67

43.	Cyclobakuchiol C	Phenol	69
44.	Corylifonol	Benzofurans	54
45.	Isocorylifonol	Benzofurans	54
46.	Bisbakuchiols A	Phenols	70
47.	Bisbakuchiols B	Phenols	70
48.	Bisbakuchiols C	Phenols	70
49.	Psoracorylifols A	Phenols	59
50.	Psoracorylifols B	Phenols	59
51.	Psoracorylifols C	Phenols	59
52.	Psoracorylifols D	Phenols	59
53.	Psoracorylifols E	Phenols	59
54.	Psoralenoside	Benzofurans	71
55.	Isopsoralenoside	Benzofurans	71
56.	β-Caryophyllene	Sesquiterpene	39
57.	Stigmasterol	Steroids	45, 72
58.	Daucosterol	Steroids	65, 73
59.	Triglycerides	Lipid	65, 72
60.	Triacontane	Organic compound	65, 72
61.	Linolenic acid	Fatty acids	74
62.	Linoleic acid	Fatty acids	74
63.	O-methyl bakuchiols	Phenols	70
64.	O-ethyl bakuchiols	Phenols	70
65.	Acetyl bakuchiols	Phenols	70
66.	Psoralester	-	75
67.	Glucose	Carbohydrates	72
68.	Raffinose	Trisaccharides	72
69.	Pinitol	Polyol	35
70.	Uracil	Amino acid	43