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Ethnobotanical and phytopharmacological review of *Scindapsus officinalis* ("*Gajapippali*")



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ABSTRACT

Scindapsus officinalis (*S. officinalis*) holds a reputed position in Ayurvedic system of medicine. It has been ethanobotanically used to treat diarrhea ("*atisara*"), worm infestation ("*krmiroga*"), and as antipyretic. Literature survey on *S. officinalis* was carried out via electronic search in PubMed, SciFinder, Scirus, Google Scholar, Agricola and Web of Science and a library search. Results revealed that a very specific botanical description of the plant is still not available. The plant is mistaken within the hybrids and other plants of genus *Scindapsus* and family Araceae. Since ethnobotanically the plant is of much importance, chemistry of the plant yet needs to be fully explored. Thus the need of the hour is to comprehend the fragmented information available on the botany, traditional uses, phytochemistry and pharmacology of *S. officinalis* which could help in the correct identification of the sample and avoid adulteration due to mistaken identity.

1. Introduction

The genus *Scindapsus* Schott (1832) contains about 35 species from Northeastern India to Western Polynesia [1]. It is an epiphytic climbing shrub, with ovate oblong, ovate oblong cordate or oblong lanceolate leaves [2], bisexual flowers and naked spathe [3]. Florets are without perianth, each having four stamens and a one-celled ovary with a solitary basal ovule [4]. About fifteen species of the plant and numerous hybrids, all of which are evergreen, root clinging climbers with juvenile and adult stages, belong to this genus [5]. The various species of genus *Scindapsus* include *Scindapsus caudatus*, *Scindapsus decursivus* Schott (Sylhet, Bangladesh), *Scindapsus giganteus* Schott (Penang, Singapore), *Scindapsus glaucus* Schott (Khasaya Paras, Nepal), *Scindapsus officinalis* Schott (*S. officinalis*) (India, Burma), *Scindapsus peepla* Endl (Sylhet, Bangladesh), *Scindapsus pertusus* Schott (Coromandel, South Konkan), *Scindapsus pinnatifidus* (Roxb.) [6], *Scindapsus pictus* (*S. pictus*), *Scindapsus scortechinii*, *Scindapsus hederacea*, *Scindapsus perakensis*, *Scindapsus crassipes*, *Scindapsus beccarii* and *Scindapsus cuscuaria* [7]. *S. officinalis*, a plant with perennial stem, is a large epiphytic climber with adventitious aerial roots growing on trees and rocks [8]. The mature inflorescence without the spathe is transversely sliced into pieces and dried [9] and is commonly known as "*Guj-pippul*" [10]. In Ayurvedic system of medicine, it is known to cure "*atisara*" (diarrhea), "*svasa*" (dyspnea), "*kanthmaya*" (throat diseases) and "*krimi*" (parasitic infestation) (Figure 1) [11].



Figure 1. Leaf and fruit of *S. officinalis*.

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2. Botanical description

2.1. Habitat

S. officinalis is a common plant in tropical forests of many parts of India, Myanmar [12], China [13] and Nepal [14]. In India the plant is cultivated for its fruits at Midnapur, Bengal [9,13,15,16] and is found in southern cities of Calicut and Cochin. It is also present in Rosa thicket in managed sal (*Shorea robusta* Gaertn.) forests of Gorakhpur region [17]. Reaching the northeastern states, the plant is strikingly noticeable in Phangpui National Park situated at Blue Mountain, Mizoram [18] and Kurung Kumey, East Kameng and West Kameng districts of Arunachal Pradesh. According to GPS, in the location with coordinates of 27°57.176′ N and 93°09.877′ E, the density of the plant is 0.3/m^2 area in 100 m^2 quadrate size [19]. In Mayanmar, the plant is frequently present in Chappedong, Moulmein, Rangoon and Monghir mountains [13].

2.2. Morphology

The leaves of *S. officinalis* are large (upto 25 cm long), leathery [9], with dark green peduncle. They are solitary with terminal much shorter than the petiole [7]. Their shape is ovate, elliptic ovate or nearly orbicular, caudate acuminate with rounded or slightly cordate base. The primary nerves are distinct [16], marked with the presence of dilated or winged petiolar sheaths [14,16,20]. The stem of the plant is as thick as a little finger [7] and turns almost woody when old [20]. The roots of the plant are adventitious and aerial, clinging on trees and rocks [21]. The flowers are densely arranged in the cylindrical spadix [9], which is elongated with greenish yellow stigma [7], and the filaments are flat and thickened at the tips [3].

The spathe is deciduous [20], coriaceous and oblong with stout, short and terete peduncle [16]. The spathe is about 4–6 inches in length [7] and green outside ultimately yellow within. It terminates by a long acumen [20]. The fruits contain berries which are confluent [9] and fleshy (Nepal origin) [14]. The ovary is densely packed [20], truncate, one-celled with one seed attached in an oblique manner [8]. There is a marked presence of grooves with short four-celled anthers [20]. Substance of the ovary is replete with rigid, sharp, vertical bristles which readily detach and stick in the skin causing pain and itching [8]. The seed has hard testa [3]. The seed is ovate cordate [7,16], kidney-shaped [22] or horseshoe-shaped and is covered by a membrane [23] with the dimensions of 0.3–0.4 cm in width, 0.4–0.6 cm in length which is smooth, shiny, grayish-brown with a dent [22]. Hilum overlies the chalazal end and is marked by an irregularly bordered scar. The micropyle is dorsal to the hilum and is subtended dorsally by a thickened ridge [23].

2.3. Microscopy

Epipremnum and *Scindapsus* are characterized by simple vascular bundles and axial bundles [24].

2.3.1. Fruits

The microscopy showed loosely arranged, thin-walled parenchymatous cells having isodiametric cells filled with brown content and numerous acicular crystals of calcium oxalate [22].

2.3.2. Spadix

Transverse section of the spadix of the fruits of *Scindapsus* revealed a central lobed axis with hollow central core and lobed inflorescence axis. The axis bears radial circle of fruits which are separated from each other by thin radial septa (covering membrane) [25], and also present in sclereids which are branched with arms that project into intercellular spaces (trichosclereids). In lamina distinct idioblasts are present [26].

3. Adulteration

It is of great concern that the plant is often adulterated knowingly or unknowingly due to mistaken identity. Significant pharmacognostical variations were observed in the marketed samples of the fruits collected from five different districts of Uttar Pradesh. Besides macroscopy and microscopy, quantitative estimation of the powder with fluorescence analysis depicted adulteration in the samples [27].

3.1. Adulteration with Piper chaba Hunter (P. chaba)

"*Gajapippali*" (*S. officinalis*) has long been a drug of controversial origin. According to Bhavaprakasa, a lexicon of Ayurveda, *P. chaba* ("*Cavika*" or "*cavya*") has usually been considered as probable adulterant of *S. officinalis* [28]. In Ayurvedic system of medicine "*pippalimula*" *i.e.* root of *Piper longum* (family Piperaceae) is used as "*pratinidhi dravyas*" (substitute drug) for fruit of "*gajapippali*" [29]. Latin name *S. officinalis* is given for "*gajapippali*" and in the same work "*gajapippali*" as well as "*cavya*" are the common names of *P. chaba* [30]. Since the morphology of leaf sheath of *S. officinalis* resembles that of six species of *Piper* [31], it is equated with *P. chaba* and is also used as diaphoretics, sudorifics, antidiarrheals, antiasthmatics and stomachics [32]. *S. officinalis* is used as the biological source for the isolation of piperine, which illustrates significant antimutagenic activity against 2-aminoanthracene-induced mutagenicity and was non-toxic [33]. "*Cavika*" and "*gajapippali*" (*P. chaba* and *Scindapsus*) are alike in their properties, but "*gajapippali*" is more potent as expectorant than "*cavika*" [34].

3.2. Adulteration with Balanophora species

Balanophora fungosa J. R & G. Frost (Balanophoraceae) is a root parasite with a coral-like fleshy body and superficially resembles *Scindapsus*, but it is neither reported to be of any medicinal value [35] nor matches the characteristic pharmacognostic features of *S. officinalis* as seeds, stone cells, epidermis, starch, calcium oxalate crystals, vascular bundles and oil globules are absent in *Balanophora* [36]. Sliced and dried inflorescence of *Balanophora indica* is also sold as "*attittippali*" (another vernacular name of *S. officinalis*) [9]. "*Gajapippali*" is also mistaken with male or female inflorescence of *Borassus flabellifer* Linn [37].

3.3. Adulteration with Pothos scandens

Dried, transverse pieces of *S. officinalis*, known as "*Gujpippul*" are important in Hindoo Materia Medica but are sold by the druggist under the name Roxb. *Pothos scandens*. It is employed in India as a remedy for putrid fever [38,39] and its decoction is used for rheumatic complaints [40].

4. Phytochemistry

Species of Araceae family are rich in simple anthocyanins content present in inflorescence, fruit, leaf or petiole of the plant. Cyanidin 3-rutinoside is the most common pigment; pelargonidin 3-rutinoside and cyanidin 3-glucoside are also present, and C-glycosides (82%) and proanthocyanidins (35%–45%) are the major flavonoids [41]. *Scindapsus* species contain oxalates typically in the form of calcium oxalates [42].

The fruits of *S. officinalis* contain sterol, oil, a mixture of sugars and two glycosidic coloring substances [22,43,44], scindapsin A and B which on hydrolysis yield the aglycons *i.e.* scindapsinidine A and B. Free sugars like rhamnose, fructose, glucose and xylose together with some di- and trisaccharides are identified in the plant [37]. Purification of ethanolic extract of fruits of *S. officinalis* by column chromatography yielded three brownish sticky residues, piperine, mixture of glycerin and ascorbic acid, and ascorbic acid, respectively [45]. Polyphenols mark their prominent presence and are extracted by ultrasonic extraction method [46]. Based on infrared spectroscopy, nuclear magnetic resonance, mass spectroscopy and chemical degradations, a hydroxy fatty acid was isolated from *S. officinalis* seed oil as 11-hydroxy-*cis*,*cis*,5,8-tetracosadienoic acid together with cyclopropenoid fatty acids [47]. The presence of steroids, carbohydrates, flavonoids, alkaloids, tannins, saponins, terpenoid compounds [46,48,49], phenolics, glycosides, fat and oils is noteworthy in the ethanolic extract [50]. In a study, the total phenolics content in acetone extract and methanolic extract of the plant was reported to be (7.81 ± 0.13) and (54.35 ± 0.52) mg/g, respectively. The flavonoids in acetone extract and methanolic extract were reported to be (63.12 ± 0.19) and (33.11 ± 0.18) mg/g, respectively [51]. Inorganic elemental analysis on ash of the fruit revealed the presence of Ca, Fe, Mg, phosphate, K, Na and sulfate [50]. Six essential elements, namely, Ca, Mg, Mn, Fe, Zn and Cr were also acknowledged in *S. officinalis* [52].

Flavonoid sulphates and a mixture of flavone and flavonol sulphates are present in *S. pictus* [41]. *Scindapsus aureus* (*S. aureus*) contains 16 mineral elements including K, P, Ca, Mg, S, Al, Si, Fe, Na, Mn, Zn, Sr, B, Ba, Cu and Ti [53]. Elongated rhombohedral calcium carbonate ($CaCO_3$) crystals [54] were synthesized by using the leaves of the plant *S. aureus*. Biomolecules such as proteins in *S. aureus* leaves were responsible for temptation and control of the nucleation and growth of $CaCO_3$ crystals [55].

5. Traditional and contemporary uses

According to Ayurveda, *S. officinalis* is used to treat "*atisara*" (diarrhea), "*svasa*" (dyspnea), "*Krimiroga*" (worm infestation) and "*kanthya roga*" (throat infections).

According to Ayurveda, the pharmacodynamics of the plant is explained by "*Rasa*" (taste), "*Guna*" (property), "*Virya*" (potency), "*Vipaka*" (post-digestive effect) and "*Karma*" (pharmacology). The taste of the plant is pungent, with dry and sharp properties. The roots have hot ("*Ushna*") potency and the fruits have cold ("*Sheeta*") potency. The fruits have sweet post-digestive effect [56]. The pharmacological activities of the plant include "*Dipana*" (increasing appetite), "*Agnivardhak*" (peptic), treating "*Kanthya*" (throat infections), "*Kaphahara*" (productive cough), "*Stanya*" (breast problems) and "*Varnya*" (improving skin complexion) [22].

Table 1 summaries the traditional use of different parts of the plant for various ailments.

Table 1
The traditional use of different parts of the plant for various ailments.

Plant parts	Uses/ailment	Reference
Leaves	Bone fracture, rheumatism and body pain	[57]
	Applied over spleen	[58]
Stem	Decoction is used to treat gastric complaints	[57]
Fruits	Analgesic and antidiarrheal (aqueous extract or decoction)	[59]
	Infections caused by deranged phlegm	[60]
	Hypoglycemic	[59,61–63]
	Applied externally for rheumatism	[37,57]
	Anti-protozoal	[59,61]
	Aphrodisiac, expectorant, diaphoretic, carminative and anthelmintic. It is useful to combat "*vata*" (the energy of movement and the force governing all biological activity) and "*kapha*" (the energy of building and lubrication that provides the body with physical form, structure, and the smooth functioning of all its parts), cough, bronchitis, pharyngopathy	[9,16,57,60,61,64,65]
Berries	Bone fracture, rheumatism and body pain	[57]
Whole plant	Rheumatism, improving blood circulation and as an agent for hair growth	[57]
	In male reproductive dysfunction, it is used to increase the power of erection and number of coitus	[66]
	Stimulant, diaphoretic and anthelmintic	[67]
	Used as an ingredient of hot poultice for goiter	[59]
	Used in medicated oils administered internally for asthma	[68]
	Used internally for edema, piles, indigestion, colic and intestinal catarrh	[69]
	Powdered and suspended in warm water for bleeding after child birth	[70]
	Used in ghees, powders, medicated ointments, enemas to cure abdominal tumors	[68–70]
	Sweetened with honey and sugar for diarrhea with blood and mucus	[71]
	Used in fracture and abortion	[57]
	Used to treat diabetes mellitus	[62,72]
	Aphrodisiac	[73]

5.1. Marketed formulations of the plant

S. officinalis is used as an active botanical ingredient in the preparation of "*Guggulutiktakam gritham*" (an ayurvedic medicine) employed in the treatment of osteoarthritis [74]. With the aid of high performance thin layer chromatography and gas chromatography-mass chromatography, it was proved that "*Guggulutiktakam gritham*" was polar in nature [75]. Traditionally, there are many formulations which use *S. officinalis* as their ingredient for treatment of "*Kubjaprasarni taila*" (muscular rheumatism), "*Punarnavadi churna*" (dropsy), "*Kantkari ghrita*" (bronchitis), "*Panchgavya ghrita*" (epilepsy, hysteria), "*Kantkarya avaleha*" (cardiac asthma and coughs), "*Devadarvadi lepa*" (abdominal inflammations), "*Sarva jwara hara loha*" (fever), "*Dhatakyadi quath*" (infantile diarrhea and dysentry), "*panchatiktaka guggulu curanam*" (skin diseases including leprosy) and used as "*Vangeshwaradi vati rasa*" (aphrodisiac) [76,77]. Table 2 demonstrates some of the formulations with their uses and manufacturers.

5.2. Traditional uses of the plant in different localities

The plant is conventionally used in different places for different ailments. Table 3 shows the utilization of the different parts or formulations of the plant in different localities.

Table 2
Ayurvedic formulations of the plant with their uses and manufacturers.

Formulation	Uses/ailment	Manufacturers	Reference
"*Agastya Haritaki Rasayana*"	"*Pranavaha Sroto Vikaras*" (respiratory disorders) like "*Kasa*" (cough), "*Swasa*" (asthma), "*Hikka*" (hiccough) *etc.*	Kottakkal Arya Vaidya Sala, Alva Pharmacy, AVP, AVN	[78]
	"*Vataja udararoga*" (dropsy)		[79]
"*Rajanyadi Churna*"	Diarrhea	The Arya Vaidya Nilayam, Ashoka Pharmaceuticals, Nagarjuna Ayurvedic Group	[80]
"*Punarnava asava* "	Dropsy	AVP, AVS (Kottakkal), Baidyanath	[76]
"*Kumari Ashava*", "*Basantmalki rasa*"	Rheumatism	Shree Baidyanath Ayurveda Bhavan Ltd., Patna	[81]
"*Mahayograj Guggulu*" (used as an ingredient of "*Swarna Guggulu*")	Rheumatism and arthritis, neuritis, sciatica, obesity, cardiac diseases and respiratory diseases such as asthma and gastrointestinal diseases such as colitis	Shree Baidyanath Ayurveda Bhavan Ltd., Patna	[82,83]
"*Bheema shakthi rasayana*"	Used as nervine tonic and digestive, to increase sperm production in men and increase blood	SNP Specialty Natural Products Co.	[84]
"*Kunch Pak*"	Used as carminative, stimulant, tonic and anthelmintic ot to treat impotency, spermatorrhea	Vyas Pharmaceuticals, Rasashram, Baidyanath	[85]
"*Divya pidantaka kvath*"	Joint pain, arthritis/rheumatoid arthritis, gout, sciatica	Divya Pharmacy	[86]
"*Chandraprabha Vati*", in a dose of 2 tablets with warm water twice daily "*Chandraprabha vati*" capsules	Urinary tract disorders, anemia, jaundice, backache, orchitis, hyper glycemia, piles, liver and splenic disorders	Dehlvi Naturals	[87–89]
"*Amycordial*"	Restores the hormonal balance, increases the endometrium and improves capillary permeability	Aimil Pharmaceuticals	[90]
"*Aptizoom*"	Improves loss of appetite	Charak	[91]

Table 3
The utilization of the different parts or formulations of the plant in different localities.

Part/formulation	Uses/ailment	Locality	Reference
Crushed roots of young plant (10 g)	Stomachache	Barind Tract of Bangladesh	[92]
The fruit is cut in slices and given with food	Diarrhea and dysentery in animals (cattle and goats)	Nepal	[93]
Stems and leaves boiled with water	Body nourishment	Bung Khong Long Non-Hunting Area, Northeast Thailand	[94]
Whole plant mixed with honey	Sore throats or the ailments related to elephants	Tamil Nadu	[95]
Whole plant	Jaundice	Villages of Challakare Taluk of Chitradurga District of Karnataka	[96]
Fresh or dried fruits with pepper	Throat infections	Dhenkanal Orrisa	[97]
Fruit	Stimulant, diaphoretic, carminative and anthelmintic	Mizoram	[18]
Decoction of green leaves	Asthma		
Leaf	Used as anti-emetic, or to treat helminthiasis, indigestion	Bhola District, Bangladesh	[98]
200 mg–1 g powder of fruits mixed with honey, or decoction, 5–10 mL twice a day orally	Asthma	Andhra Pradesh	[99]
Whole plant	Rheumatoid arthritis	Bangladesh	[100]

5.3. Some different formulations which use S. officinalis as their ingredient

There are some different formulations using *S. officinalis* as their ingredient: (1) *Aegle marmelos* fruit (7.1 g), *S. officinalis* (1.8 g), *Andropogon muricatus* (1.8 g) and *Symplocos racemosa* (1.8 g) in a dose of 1.3–1.9 g are used for chronic diarrhea and dysentery [101]; (2) 4 mg of *S. officinalis* are employed as an ingredient of formulation helpful in curing urinary stones and crystalluria [102]; (3) *S. officinalis* is used in the preparation of "*Suradhyaksha*" (a kind of medicated wine) [103]; (4) *S. officinalis* is used as an ingredient in the treatment of transverse myelitis using "*Rookshana Karma*" (dehydrating therapy) [104]; (5) the powder of *Withania somnifera* Dunal. root, the *S. officinalis* fruit, the *Saussurea lappa* Clarke. root, and the *Acorus calamus* Linn. rhizomes is added to the butter made from buffalo's milk. The preparation increases the bustline, makes the breast firm and improves breast shape [105]; (6) *S. officinalis* is used as an ingredient in the formulation employed to treat "*kushtha*" (obstinate skin disease including leprosy), "*kilasa*" (leucoderma), "*tilakalaka*" (black moles), different types of piles and "*carmakila*" (warts) in skin [106].

6. Pharmacological reports

The methanolic extract of *S. officinalis* exhibits anti-inflammatory, analgesic [48] and antimicrobial activities [107,108]. It normalized the levels of aspartate aminotransferase, alanine aminotransferase and alkaline phosphatase thereby confirming its high antihyperglycaemic properties [46]. The extract shows evidence of mast cell stabilizing properties and acts as bronchodialator due to its anti-asthmatic activity [108]. The methanolic extract shows antioxidant and antitumor effects, substantiating its cytotoxicity on human cancer cell lines [109].

The ethanolic extract is also proved to be anti-inflammatory and analgesic [110] as it triggers significant pain reduction [111] in carrageenan-induced rat paw edema at the doses of 50, 100 and 200 mg/kg [110]. It restrains the digestion and absorption of carbohydrates because of its hypoglycemic properties [49,111]. The ethanolic extract also regularizes the altered levels of serum glutamic pyruvic transaminase, serum glutamic oxaloacetic transaminase, alkaline phosphatase, bilirubin, total protein and tissue glutathione showing evidence of its hepatoprotective activity [112].

Both 50% ethanolic and ethyl acetate extracts were found to exhibit concentration-dependent free radical scavenging activity [113,114] and antidiabetic activity [115].

The hydroalcoholic extract of the fruits of the plant has shown antiulcerative activity contributing to gastric ulcer healing and gastric antisecretory outcomes [116].

Total cholesterol, low density lipoprotein and triglyceride levels were declined after treatment with the plant extract revealing its noteworthy hypolipidemic properties [117]. Prominent *in vitro* effect of the extract on the motility of mature *Haemonchus contortus* of goat origin was observed [118–120].

The extract of *S. officinalis* fruits illustrated dose-dependent positive inotropic effect and transient myocardial depressant activity in frogs [121], and also demonstrated cytotoxic effect. Taking cisplatin as a reference drug, the cytotoxic effect of *S. officinalis* was examined, which exhibited 93% growth inhibition against COLO 320 tumor cells [122]. The plant also revealed the presence of nitrogen-fixing microorganism in its phyllosphere. Most of the isolates appear to be biotypes of *Klebsiella pneumoniae* [123]. A study done on impact of *S. officinalis* on fitness of captive red-eyed tree frog (*Agalychnis callidryas*) revealed that the plant significantly promoted greater diversity of bacteria associated with the skin of the frog and increased the stability and productivity of the community [124].

As far as other species of *Scindapsus* are concerned, ethyl acetate fraction of extract from *S. aureus* has potential inhibitory activity against alpha-glucosidase and antioxidant effects, and *n*-butanol fraction has great antioxidative effects [125] while methanolic extracts of the fruit have significant broad-spectrum antimicrobial activity against *Staphylococcus aureus*, *Escherichia coli* and yeast *Saccharomyces cerevisiae* at a concentration of 2.5 mg/mL [126]. *S. aureus* (syn. *Epipremnum aureum*) also uptakes low-molecular-weight aldehydes and ketones [127]. *S. aureus* sorbed 0.98 μg CO/cm^2 leaf surface in 6-h photoperiod [128]. The decoction of the plant did not exhibit any toxicity upto 10 mL/kg [65]. The species of *Scindapsus*, *i.e*. *S. aureus* and *S. pictus* are proved to purify formaldehyde polluted air [129]. The plant of genus *Scindapsus* was found to stabilize the indoor ion concentration and reduce its fluctuations. These plants help to increase the concentrations of negative ions and decrease the concentration of positive ones [130].

7. Conclusion

S. officinalis is used as an important ingredient in many Ayurvedic formulations just on the basis of its traditional medicinal uses. Due to insufficient and contradictory literature on morphology of the plant, the identification is mistaken most of the times, which results in the adulteration (accidental or intentional). Neither the plant nor its extract is standardized. Thus, it is difficult to pinpoint the bioactive metabolites. Therefore, there is a need of pharmacognostic and phytochemical standardization. The upshot of the review will further assist in presenting its potential scientific use in modern medicine.

Conflict of interest statement

We declare that we have no conflict of interest.

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