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Diplocyclos palmatus (L.) C. Jeffrey - An important medicinal plant: A review on taxonomy, ethnobotany, and pharmacological prospects

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ABSTRACT

Diplocyclos palmatus (L.) C. Jeffrey is a medicinal plant of significant ethnopharmacological relevance, especially in rural healthcare systems of India, where it is traditionally recognized as the botanical source of the Ayurvedic fertility drug "Shivlingi." In addition to its use in treating infertility, the plant is also employed in folk medicine for managing inflammation, obesity, snakebite, malaria, and various skin disorders. This review synthesizes current knowledge on the taxonomy, vernacular nomenclature, distribution, morphology, anatomy, phytochemistry, and therapeutic potential of *D. palmatus*, supported by both field-based observations and literature analysis. A particular focus is given to the recurring taxonomic confusion in the literature, where multiple and sometimes erroneous scientific names have been used, leading to misidentification and challenges in consistent communication among researchers. Field surveys confirm the perennial nature of the plant, which contradicts some earlier classifications. Various bioactive compounds and pharmacological properties have been reported, substantiating several of its traditional uses. However, while preliminary studies support many ethnomedicinal claims, further targeted research, particularly into its application for fertility enhancement, is needed to validate its efficacy through experimental and clinical investigations.

Keywords: *Diplocyclos palmatus*, Shivlingi, Ethnomedicinal, Erroneous.

INTRODUCTION

Diplocyclos palmatus (L.) Jeffrey, a tendril climber known for its uses in folk medicines from aegis. An important medicinal plant mentioned in Ayurvedic scriptures as Vrishyarasayana. This plant is basically known for various properties like anti-inflammatory, anti-venom, anti-pyretic, anti-oxidant, androgenic *etc*., but utmost importance of this plant is as miracle herb to treat infertility. As far as nomenclature is concerned, this plant is known by various vernacular names as mentioned in next paragraphs but the most common used name by local communities of India is "shivlingi". Although, the correct botanical identity of ayurvedic "shivlingi" plant cleared by Balkrishna A et al [1], still erroneous use of scientific names for this plant prevailed. In this review an attempt to have correct botanical nomenclature of the plant by more extensive literature studies has been made. Shivlingi as name itself suggests, something related to "lingam of the God shiva". These are the seeds of this plant that resemble the lingam of the shiva hence leads to common name shivlingi. As mentioned above "miracle herb", the context of these words lies in the miracle showed by this herb in treating sterility from aegis. In tribal society this plant holds a vital part for its ethnomedicinal properties. It is used in many tribes, such as Gond and Bharia tribes of Pathalkot valley revere this plant. According to them, this herb is a great virtue for the childless folks. Seeds of the plant possesses a stimulating component to improve sperm quality. As per them, this acts as a tonic and enhances youthfulness in advancing age. Tonic improves physical and psychological health. Bhumkas (the home-grown healers) set up certain mix of herb and recommend it to the required individual. Bhumkas in Harra-ka-Chhar town in Patalkot recommend the seeds of this herb for expecting male children. Customary healers in Gaildubba make a mix of shivlingi seeds with Tulsi leaves and blend it in Jaggery, offer it to the woman who is not imagining infant because of any reason [2].

No doubt, a few review articles of this plant are present in literature and are a good source of information, but still certain gaps exist in the studies particularly in nomenclature and habit of the plant. Also, the information is fragmented. Thus, present review is an attempt to fill those gaps, and explore the current knowledge about *D. palmatus* particularly in view of its nomenclature, habit and uses in many areas. Field surveys were conducted to have clear observation of habit of the plant.

Taxonomic Status

Comprehensive study of literature shows the use of various scientific names for "shivlingi" plant. These

are *Bryonopsis laciniosa*, *Bryonia laciniosa, Diplocyclos palmatus, Cayaponia laciniosa etc.* In this review efforts were made to identify a correct name to this plant. Firstly, it was observed that *Bryonin laciniosa*, and *Bryonopsis laciniosa* were used interchangeably for the same plant in experimental studies. In literature, it was seen that *Bryonopsis laciniosa* was used frequently for shivlingi plant as can be seen in studies namely, "A Review On Shivlingi Seeds For Fertility", "An Ayurvedic Herbal Plant '*Bryonia laciniosa*' with its Ethnomedicinal significance", "Antimicrobial Efficacy of *Bryonopsis laciniosa* "(Shivlingi stem and fruit)","Phytopharmacognostic Review on *Bryonia lacinosa* (Shivlingi Beej)", "A scientific review on shivlingi beej (*Bryonia laciniosa*): a mystical ethno-medicine for infertility", "*Bryonialaciniosa*: A Ethnopharmacological Approach of Ayurvedic Shivlingi". "Super-critical fluid extract of *Bryonopsis laciniosa* (Shivlingi) seeds restores fertility in zebrafish models through revival of cytological and anatomical features". On reviewing literature, it was found that there are two checklists of the Cucurbitaceae of India that are critically followed. These lists date back to 1980s viz. Jeffrey's (1980) and Chakravarthy's (1982). After these two checklists, the most authentic one checklist followed in this study was as under the name of "The Cucurbitaceae of India: Accepted names, synonyms, geographic distribution, and information on images and DNA sequences by Susanne S. Reener and Arun K. Pandey (2013) [3] published in Photo Keys, a peer reviewed, open access journal dealt with taxonomy, phylogeny, biogeography and evolution of plants. In this checklist 400 relevant names along with information on the collecting locations and herbaria for all types, links to online images of herbarium or living specimens, brief information on whether or not DNA sequences are available in GenBank at NCBI with citation of relevant studies are provided. *Diplocyclos palmatus* (family: Cucurbitaceae) was first described and published as *Bryonia palmata*, now heterotypic synonym, by Carolus Linnaeus in species plantarum 2:1012 (1753). *Diplocyclos* as a genus, *Diplocyclos* (Endl.) Post and Kuntze, first published in Lex. Gen. Phan.: 178 (1903). Later, C. Jeffrey transferred this species from genus *Bryonia* to *Diplocyclos* and thus published a *Diplocyclos palmatus* (L.) C. Jeffrey in Kew Bulletin 15: 325 (1962) [4]. *Bryonopsis laciniosa (L.) Naud.* In Ann. SC. Nat.IV,12:141 (1859)., *Bryonia laciniosa* L., Sp. Pl.: 1013 (1753) are synonym of *Cayaponia laciniosa* (L.) C. (Figure 1A) Jeffrey which is endemic to Jamaica, but widely misapplied to *Diplocyclos palmatus* (Figure 1B) as mentioned by Jeffrey in writing named "Further Notes on Cucurbitaceae: V: The Cucurbitaceae of the Indian Subcontinent" published in Kew Bulletin, 1980 [5].

Figure 1: **(A)** *Diplocyclos palmatus* (L.) C. Jeffrey herbarium specimen (source: Plants world online, Royal Botanic Garden, Kew. **(B)** *Cayaponia laciniosa* (L.) C. Jeffrey herbarium specimen (source: Plants world online, Royal Botanic Garden, Kew

Earlier these two were considered different species. This clearly indicates the erroneous use of *Bryonopsis laciniosa* for shivlingi plant. Now as per the claim of [1] through Indian folklore information and taxonomic literatures, the correct taxonomic identity for Shivlingi is established as *Diplocyclos palmatus* (L.) C. Jefferey but not the *Bryonia laciniosa* L. or *Cayaponia laciniosa* (L.) C. Jeffrey as considered earlier as these two are entirely a different species. Other heterotypic synonyms available for *Diplocyclos palmatus* (L.) C. Jeffrey are *Bryonia palmata* L. and *Coccinia palmate* (L.) M. Roem. Further while searching *Diplocyclos palmatus* in "Plants of the world online" an online database published by Royal Botanic Gardens, Kew; 11 heterotypic synonyms of concerned plant have been mentioned including *Bryonopsis laciniosa* var. walkeri Chakrav. In Rec. Bot. Surv. India 17:138 (1959), *Diplocyclos palmatus* var. walkeri (Chakrav.) Babu in Herb. Fl. Dehradun: 198 (1977). All these studies clearly identified the erroneous and misapplied names of concerned plant. An absolute conclusion that can be made by these studies is that *Bryonopsis laciniosa* (L.) Naudin is erroneously applied to a species not found in India, still many studies pertaining to the "shivlingi" plant using this as accepted scientific name.

Distribution

Diplocyclos palmatus (L.) C. Jeffrey is a weak climber found distributed in tropical India, tropical Nepal, Indo-China, Pakistan, Indonesia, Sri Lanka, Philippines, Papua New Guinea, and some parts of central and West Africa [1,6]. In India it is distributed in Andhra Pradesh, Arunachal Pradesh, Bihar, Jharkhand, Goa, Gujarat, Himachal Pradesh, Jammu & Kashmir, Karnataka, Kerala, Madhya Pradesh, Chhattisgarh, Maharashtra, Manipur, Rajasthan, Tamil Nadu, Tripura, Uttar Pradesh [3]. It grows in a humid climate, prefers shady areas.

Habit

Diplocyclos palmatus (L.) C. Jeffrey belongs to family of vines that climbs by means of tendrils. In terms of the habit whether it is annual, biennial or perennial it was found during literature investigation that there was a lot of confusion in it. Some research papers had mentioned this herb as annual or some as perennial. For this, comprehensive study of literature is done. Also, field surveys were made to have clear observance of the plant growth for almost three years.

Study area

A humid, shady area where this plant was growing previously in its natural habitat in two places was selected. This study was conducted in district Kangra of Himachal Pradesh for almost three years.

Observations and findings

It was observed during first year, this plant shows good growth during rainy season in the month of July-Sept. It shows vigorous growth of stem, climbing by means of tendrils. Humid environment, rainy season favors it growth. After growing vegetatively, it starts flowering in end July or early August. After flowering, fruiting started by end of September month. Ripening of fruits can be seen in December. Next year in summer season when it was observed, dry wilted parts of the plant were seen. It shows that plant died after completing its life cycle. But in the rainy season, it was seen that green plant had grown at the same place. After digging root system of the plant, extensive growth of root in the soil observed. Roots were eradicated from the place and caution was taken that no seed of the plant was there to further grow. Next year no plant was there. At another place where root was not eradicated plant showed the growth in next rainy season.

Large perennial roots lead to the growth of *Diplocyclos palmatus* (L.) C. Jeffrey annually. Same result was supported by Moghe AS et al [7]. Present writing supported the perennial nature of the plant.

Morphology and Anatomy

Diplocyclos palmatus (L.) C. Jeffrey is a dioecious climber having several metres long green stem that coils around the support with the help of tendrils. Morphological features of the plant are explained in Table 1 along with pictures Figure 2 A to J taken from the wild habitat

of the plant. Detailed morphological features are also explained in previous work of Dwivedi S et al [8].

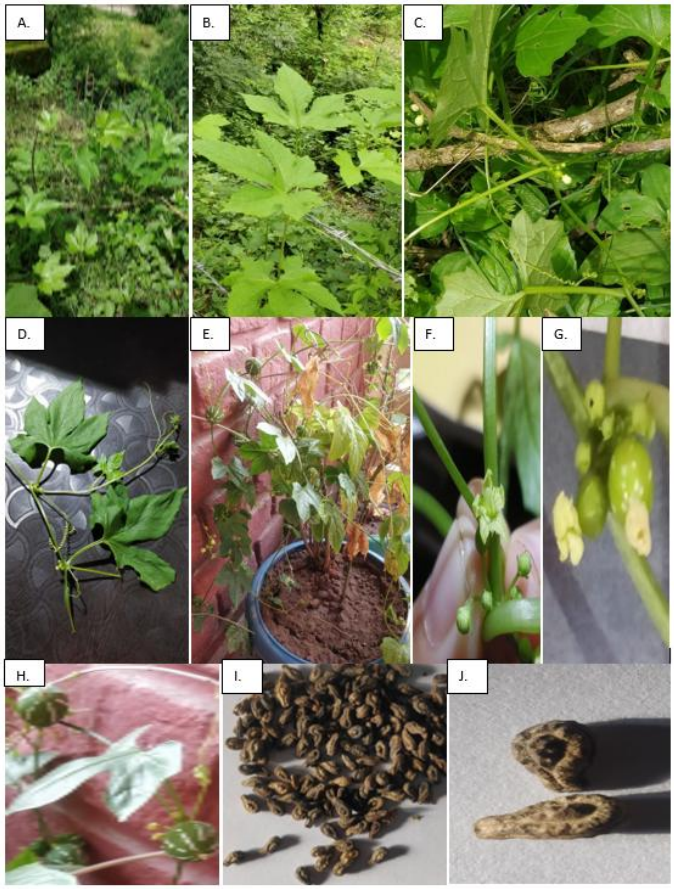


Figure 2: (A, B)- plant growing in wild; **(C)-** plant with young growing fruit; **(D)-** a part of plant with tendrils and leaves; **(E)-** plant with fruits growing in pot; **(F)-** flower of plant; **(G)-** young emerging fruit; **(H)-** developed fruits; **(I)-** seeds in bulk; **(J)-** seeds showing peculiar "shivlingi" shape

Table 1: Morphological features of plants

Plant Parts	Morphology
Root	Perennial tap root system, secondary roots with root hairs. Many fibrous roots can be seen arising from the nodes of plant
Stem	Green during vegetative phase becomes dry pale yellow after fruiting, several meters long, ridged, glabrous, weak
Leaves	Green, thin lamina, palmately, 3-5 lobes present, central lobe largest, upper surface of leaf rough with many white hairs, lower surface samooth having five veins arise from the base of leaf
Tendrils	Green bifid coiled, arise from the axillary node of the leaves
Inflorescence	Monoecious plant, unisexual flower, male flowers present with female flowers in groups in cymose manner in the axil
Flowers:	Unisexual flower, pale yellow in colour, incomplete, pentamerous, actinomorphic, epigynous
(a) Male flowers	Actinomorphic, pentamerous, calyx tube long, gamosepalous (5), pointed; gamopetalous (5), alternates with sepals; stamens three, two with dithecous anther, one with monothecous anther, dehisce by longitudinal slits
(b) Female flowers	Actinomorphic, pentamerous, calyx tube smaller that male flower, gamosepalous (5); petals 5, gamopetalous; gynoecium, carpels three syncarpous, inferior, style single, stigma furcated, trilocular, bifurcating parietal placenta, fleshy ovary with many ovules inserted in it
Fruits	Special type of berry present termed pepo, usually present in clusters, green when unripe, red after ripening, white streaks are present on fruits
Seeds	Many in a fruit, compressed, unique shape resembling to shivlingi hence plant is commonly known as shivlingi, whitish green when young turned dark brown at maturity

Anatomy

Detailed explanation of the plant is done by Shashikala M et al. [9] which are mentioned in a Table 2.

Table 2: Anatomy of the plant

Plant Parts	Anatomy
Stem	T.S. of the young stem shows following features: • It is angular with 5-6 well developed wings which give pentagonal to hexagonal outline • Epidermis is single layered having elongated, tubular, parenchymatous cells, covered with thin cuticle. • Pericycle is a band of sclerenchymatous, 3-5 rows, continuous in old stem • Vascular bundle is conjoint, bicollateral and open, present in two rings • Inner ring consists of 3-4 large sized and the outer ring 6-7 small sized vascular bundles • Latex cells are scattered throughout the phloem tissue • Phloem consists of sieve tube, companion cell and phloem parenchyma • Xylem is lignified, consists of xylem vessels, xylem fibres, and xylem parenchyma • Pith of young stem is made up of large parenchymatous cells with big intercellular spaces and lignified and in old stem, it is occupied by phloem. Calcium carbonate crystals are embedded throughout the parenchymatous.
Petiole	T.S. of petiole shows following features: • Transverse section of petiole is 5-6 angled. • It consists of epidermis, hypodermis, cortex, vascular bundles and pith. • Epidermis is single layered and made up of thin-walled polygonal cells. • The hypodermis is present as groups of collenchymatous cells under each angle of epidermis. Cortex is parenchymatous. Vascular bundles consist of xylem and phloem which is conjoint and bicollateral, 5-7 in numbers below each angle. • Xylem is lignified, made up of xylem vessels, xylem parenchyma and phloem consists of sieve tubes, companion cells and phloem parenchyma, Pith is large, parenchymatous with intercellular spaces.
Leaf	T. S. of leaf shows following features: • Lamina is dorsiventral, consisting of epidermis and mesophyll region • Upper epidermis is a thin-walled polygonal cells, filled with chloroplast, lower epidermal cells measuring 4-6 micro, upper epidermal cells measure 8-10 micro. • Trichomes are covering and uniseriate, characterized by the presence of calcium carbonate crystals • Mesophyll in the lamina region is differentiated into upper palisade layer and lower spongy parenchyma • Palisade is two layered and present below the upper epidermis filled with chloroplasts. • Spongy parenchyma consists of 3-5 layered thin-walled polygonal cells with chloroplast and a few with calcium carbonate crystals. • Midrib consists of collenchymas tissue below the upper and above the lower epidermis.

	• Vascular bundle is bicollateral lying in the center of midirib. • Leaf surface shows the presence of anomocytic stomata. • Leaf constants show stomatal no. 5-7, stomatal index17.24-22.41, vein-islet no. 9.0-12.5 and vein termination 10.0-13.5 and palisade ratio 3-4.
Seed	T.S. of the seed consists of: • Transverse section of the seed consists of testa and endosperm. • The entire testa is covered on the external side by thin, flattened or collapsed parenchyma called as 'memberaneous arillus' • Testa is divided into outer and inner integuments. Outer integument consists of epidermis, outer and inner parenchymatous layer. Epidermis is single layered. • Outer parenchyma layer is characterized by the presence of elongated parenchyma cells with wavy walls, brown in colour First few layers of parenchyma contain starch and most of the cells contain aleurone grains followed by inner thin-walled parenchyma layer and pigment layer. • The pigment layer is dark brown with starch grains. Inner integument consists of single layered schlerenchymatous with bowl shaped cells, narrow lumen 2-4-6µ followed by 2-3 layers of parenchyma cells with starch grains.
Fruit	T.S. of fruit shows following features: • Transverse section of the fruit is almost circular in outline. • Epidermis is single layered followed by 3-4 layers of schlerenchyma tissue. • Mesocarp is starchyand transverse by vascular strands 4-7-9µ in length. • It penetrates in the form of cleft up to the center of the seed. • Endocarp issingle layered encircling each loculi of the seed and is lignified. • In each loculi lies a single seed covered by the pulpy arillus which contains aleurone grains.
Root	T.S. of root shows following features: • Cork is 3-5 layered, outer cork is non- lignified and inner cork is lignified, tangentially elongated cells. • Cortex is narrow and parenchymatous with few latex cells. Phloem becomes narrow in older root with latex cells. • Xylem is lignified with four triangular shaped xylem bundles and separated by multiseriate medullary rays. • It consists of xylem vessels measuring 8-10-12µ, xylem fibres. Groups of inter xylary phloem 2-6-8 µ; are embedded throughout the • Testa is divided into outer and inner integuments. Outer integument consists of epidermis, outer and inner parenchymatous layer. Epidermis is single layered. • Outer parenchyma layer is characterized by the presence of elongated parenchyma cells with wavy walls, brown in colour First few layers of parenchyma contain starch and most of the cells contain aleurone grains followed by inner thin-walled parenchyma layer and pigment layer. The pigment layer is dark brown with starch grains. Inner integument consists of single layered schlerenchymatous with bowl shaped cells, narrow lumen 2-4-6µ followed by 2-3 layers of parenchyma cells with starch grains.

Vernacular name

Common English name of the plant is "lollypop climber". It is known by various vernacular names in different regions and languages (Table 3) [1, 10-12]. These are given below:

Common English names: Lollipop climber, Marblevine, Native bryony, Red striped cucumber, Striped cucumber.

Table 3: Vernacular name in different languages

Regions and Languages	Vernacular Names
Hindi	Bonkakra, Bankakra, Isvarlingi, Putloguli
Gujrati	Shivalingi
Tamil	Aivirali, Aiviralkkovai, Iyveli, Iyvirali, Shivalingakkay, Shivalingakkay
Kannada	Angathondeballi, Limgatomdeballi, Lingakonde Balli, Lingatondeballi, Mahaalinganaballi, Maaninganaballi, Panchaguriya, Sivalingi
Konkani	Karta
Malayalam	Aiviralikkova, Iyiviralikkova, Kakkakothi, Naiunnikai, Namkai, Nehoemeka, Neysatti, Neyyunni, Neyyuruni, Pambukodi, Sivalingakkaya, Sivavalli
Marathi	Kavdoli, Mahadevi, Shivlinge
Sanskrit	Apashtambhini, Chitraphala, Lingaja, Linguini, Shivavalli, Putrada
Telugu	Lingadond
Garhaawal	Put-loguli
Kumaon	Syapa Karyal, Ishari
Paliyartribe (Tamil Nadu)	Aiviralkkovai
Chandra prabha wildlife sanctuary (UP)	Ban-kakra

Ethnomedicinal uses

Ethnomedical uses are mentioned in a Table 4.

Table 4: Plant parts and Ethnomedical uses

Plant Parts	Uses
Seeds	Diabetes [13], Infertility [16], Laxative [29] Paralysis [36], Leucorrhoea [37], Impotence and oligospermia, Swelling spleen [38], Diarrhea [39]
Whole plant	Skin diseases, Cough [14], Asthma [42]
Fruits	Fever [15,22,23], Skin infection, Tonic [17,19,20], Ephemeral fever in cattle [25], Stomachache [27,28], Chronic constipation [32], Leucorrhoea [37]
Root decoction	Aphrodisiac [17,18]
Leaves	Anti-inflammation [21], Ephemeral fever in cattle [25]
Root and jagerry paste	Root and jagerry paste [27]
Paste of seeds, Ocimum tenuiflorum leaves and jiggery taken orally	Flatulence [30], Conception [31]
Leaf paste and leaf juice	Scorpion sting [33]
Decoction of plant parts	Anti asthmatic [34], Cough [35]
Entire plant along with fruits	Septics [40]
Plant paste	Rheumatism [41]

Phytochemistry

Various phytochemical constituents like terpenoids, flavonoids, alkaloids, phenolics, tannins, flavonoids, triterpenoid saponins, steroids and proteins, and resins with sugars and starch, carbohydrates amino acids, polyphenols, glycosides, proteins, anthocyanins, coumarins, emodins have been extracted from different parts of the plant i.e. leaf, seed, fruit [43-46]. Total phenolics, tannins, flavonoids, terpenoids have been calculated in plant extracts prepared in chloroform, hexane, methanol, aqueous [43]. The seeds have been reported to contain 12% oil, protein, along with goniothalamin, bryonin, punicic acid, and lipids [45]. Recently tetracyclic triterpenoids e.g. cucurbitacin I and cucurbitacin B have been reported from the fruits of the plant. Similarly, isoquercetin isolated from methanol extract of whole plant and characterized by several separation techniques like TLC, UV, FTIR, H-NMR and HR-LCMS (Metri *et al*., 2019) [47]. Plant was evaluated for the quantification of phenolic acids. For this HPLC was performed which highlighted the richness of three phenolic acids in order of gallic acid (1708 µg/g), caeffic acid (437 µg/g) and protocateuchic acid (337.7 µg/g) [48]. The species is rich in three phenolic acids, among which gallic acid (1708 ug/g) is in maximum concentration followed by caeffic acid (437 ug/g) and protocateuchic acid (337.7 ug/g). The seeds of *Diplocyclos palmatus* L. (Cucurbitaceae) contained 23% oil and 15% protein. The UV, IR, ^{1}H-NMR and ^{13}C-NMR spectrometry of the oil, and oxidation, reduction and gas liquid chromatography (GLC) of the methyl ester of conjugated fatty acid isolated by preparative thin layer chromatography (TLC) showed the presence of punicic (octadeca-*cis*-9,*trans*-11,*cis*-13-trienoic) acid [49]. Quantification of β-carotene from the fruit rind of *D. palmatus* was done, amounting 0.0065±0.0003 mg/g [50]. Some other compounds viz. rutin, quercetin, isovaleric acid,luteolin 7-(2"-p-coumaroylglucoside), deserpidine (alkaloid), beta-hederin (saponins), cardiac glycosides (digitalosebufadienolide, cardioprotective steroids (digoxigenin monodigitoxoside and minabeolide-8) catechin, hydroxybenzoic acid, chlorogenic acid, gallic acid, protocatechuic acid, caffeic acid, vanillic acid etc. have been also reported [51]. HPLC analysis showed the presence of three phytocompounds, i.e., flavonoids - Quercetin (peak 4.867), Tannic acid (peak 2.497) and Rutin (peak 3.440) in the ME of the seeds of *D. palmatus* [52]. Chemical structures of few compounds are given in Figure 3.

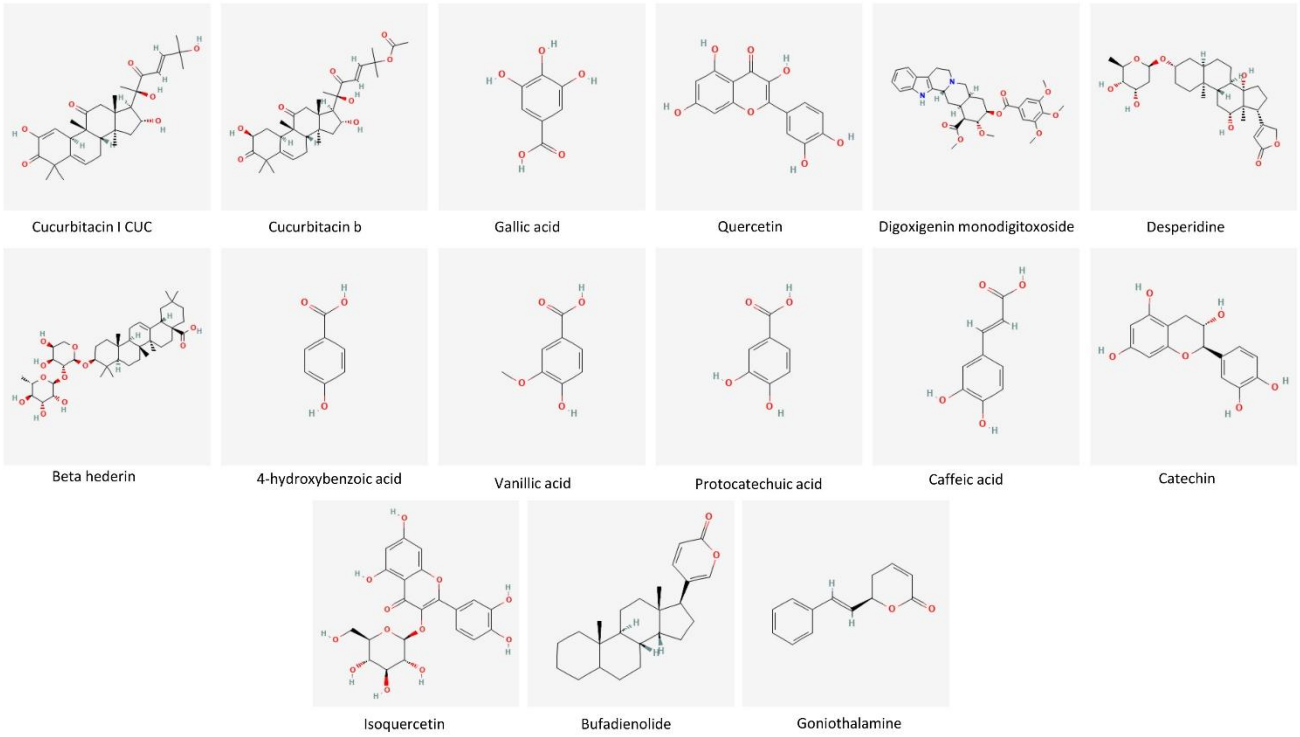


Figure 3: Chemical structures of compounds

GC-MS Analysis

Several compounds were reported in the GC-MS analysis of methanolic leaf extract of *D. palmatus* plants reported by Upadhyay A et al [53]. In addition to the compounds, related chemical structure has been also mentioned in Table 5.

Biological properties

Antimicrobial activity

Fruits of *Diplocyclos palmatus* were used to make ethanolic extract and tested for its antimicrobial activity using agar diffusion method against gram negative bacteria (*E. coli*.) and gram-positive bacteria (*Bacillus sp*.) to compare its effect with the marketed standard streptomycin, ciprofloxacin. The result depicted the maximum zone of inhibition in gram negative bacteria compared to standard and control [45]. Ethanolic extracts of leaf and stem also reported to have antimicrobial activities against different bacterial strains such as *Staphylococcus aureus, Micrococcus luteus* and *Bacillus cereus*. In addition to that aqueous extract of leaves of *Diplocyclos palmatus* possess antibacterial activity against *Staphylococcus pyogenes*, *Staphylococcus aureus*, *Klebsiella aerogenes*. Antibacterial activity was shown against *E. coli* at different dosage.

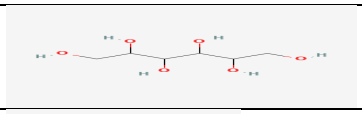
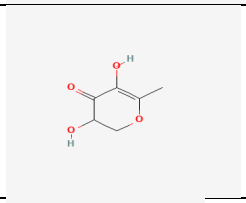
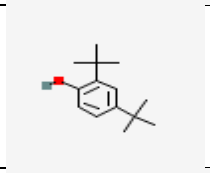
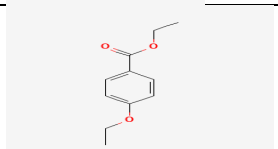
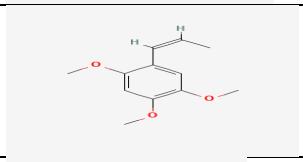
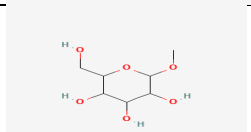
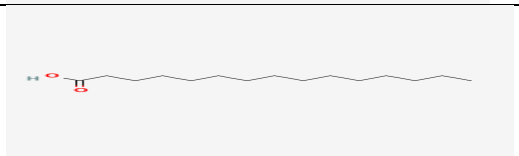
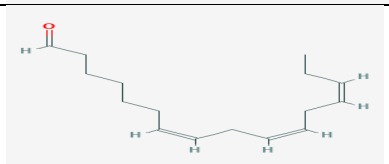
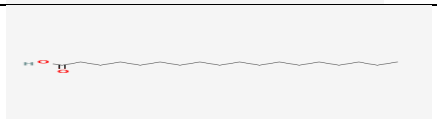
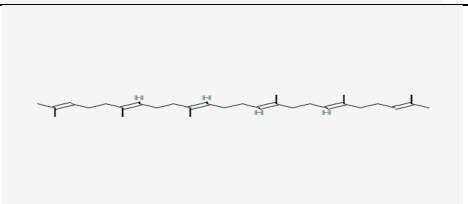
Analgesic

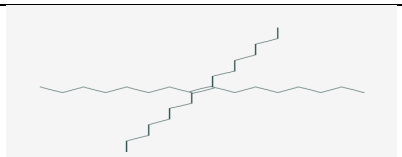
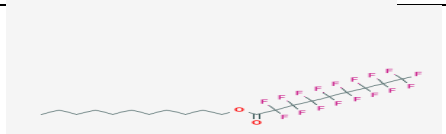
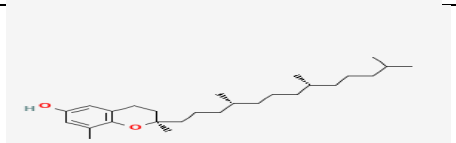
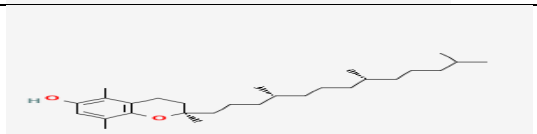
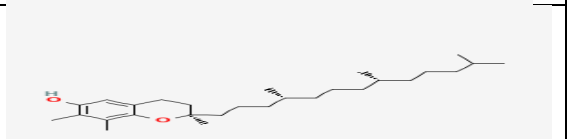
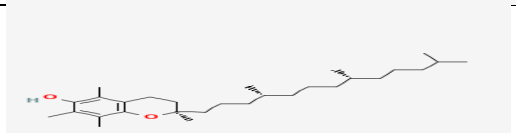
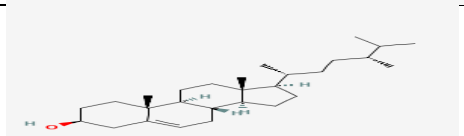
Analgesic activity of ethanolic extract of fruits of the plant was performed by tail clip, tail immersion, and radiant heat method by using albino mice. It showed analgesic activity and it was impressive results when compared to the standard aspirin and control [45].

Wild Edible Plant

Unripe fruit used as vegetable and ripened red fruit sweet in taste. It is a good source of protein, sugar and starch [54].

Table 5: GC-MS Profile of *D. palmatus* Leaf Extract: Compounds and Structures

Chemical formula	Chemical compounds	Chemical structure
$C_6H_{14}O_6$	Hexitol	
$C_6H_8O_4$	2,3-Dihydro-3,5-dihydroxy-6-methyl-4H-pyran-4-one	
$C_{14}H_{22}O$	Phenol, 2,4-bis(1,1-dimethylethyl)	
$C_{11}H_{14}O_3$	Benzoic acid, 4-ethoxy-, ethyl ester	
$C_{12}H_{16}O_3$	Benzene, 1,2,4-trimethoxy-5-(1-propenyl)-, (Z)-	
$C_7H_{14}O_6$	Methyl. beta-d-galactopyranoside	
$C_{17}H_{34}O_2$	Hexadecanoic acid	
$C_{15}H_{30}O_2$	Pentadecanoic acid	
$C_{16}H_{26}$	Ocis,cis,cis-7,10,13-Hexadecatrienal	
$C_{18}H_{36}O_2$	Octadecanoic acid	
$C_{21}H_{40}O_2$	4,8,12,16-Tetramethylheptadecan-4-olide	
$C_{30}H_{50}$	Squalene	

$C_{30}H_{60}$	8-Hexadecene, 8,9-diheptyl	
$C_{20}H_{23}F_{17}O_2$	Heptadecafluorononanoic acid, undecyl ester	
$C_{27}H_{46}O_2$	2H-1-Benzopyran-6-ol, 3,4-dihydro-2,8-dimethyl-2-(4,8,12-trimethyltridecyl)	
$C_{28}H_{48}O_2$	beta-Tocopherol	
$C_{28}H_{48}O_2$	gamma-Tocopherol	
$C_{29}H_{50}O_2$	Vitamin E	
$C_{28}H_{48}O$	Ergost-5-en-3-ol	

Ethnoveterinary uses

Fruit paste; Unripe fruits, seeds; Leaves or fruits crushed+butter mil; Kill pest10; Fever14,21 Ccolitis1; unripe or ripe fruits are native remedy for the treatment of fever and seeds are use in treatment of colitis [55]. Leaves or fruits crushed in butter milk and given to cure ephemeral fever [56].

Antioxidant potential

Antioxidant potential of *D. palmatus* fruits through combined in-vitro and in-silico methods have been reported through combined in-vitro and in-silco methods. In-vitro assays revealed strong antioxidant activity against various free radicals, with the highest potency observed hydroxyl free radicals (IC50 = 476.76 µg/ mL), followed by nitric oxide radicals (IC50 = 509.06 µg/mL), DPPH•(IC50 = 601.88 µg/mL), ABTS•+ (IC50 = 709.37 µg/mL) and FRAP (IC50 = 1141.76 µg/mL). Network pharmacology analysis highlighted the multi-targeted protective mechanism of *D. palmatus* fruits against oxidative stress [57].

Anti-fungal activity

Plant extracts were used to test in-vitro anti-fungal assay against *Candida albicans* at different concentrations such as 10 µg/ml, 30 µg/ml, and 50 µg/ml. for these different concentrations of the chloroform and ethanolic leaf extract were evaluated. Upon comparison to the standard (Luliconazole) and marketed standard (Terbinafine), effective antifungal activity was demonstrated by the ethanolic extracts. It was evident from the results that, as the concentration increased, the antifungal efficacy also increased [58].

Anti-inflammatory activity

Hydro-alcoholic extract of roots of *D. palmatus* was tested for its anti-inflammatory activity. The anti-inflammatory activity was evaluated using acute inflammatory models viz. carrageenan induced paw oedema. Oral administration of the extract at the doses 100 and 200 mg/kg exhibited dose dependent and significant anti-inflammatory activity. Anti-inflammatory screening was compared with standard drug diplofenac [59].

Extraction methods

Response surface methodology (RSM) with Box-Behnken design (BBM) was studied to optimize the production of cucurbitacins. RSM has been proved to be good in the optimization of cucurbitacins production in this finding. In the same experiment various extraction methods viz. CSE, MAE, UAE and SBAE are evaluated for their extraction efficiency to maximize the recovery of cucurbitacins. CSE and BAE are conventional methods used for extraction of terpenes, phenols and other antioxidant compounds. Following results were

found in terms of decreasing order of extraction efficiency SBAE>CSE>MAE>UAE. Antioxidant activity was also tested using various extraction methods. Findings suggest dependency of antioxidant potential on extraction method. Highest DPPH, ABTS and phosphomolybdate activities were recorded from SBAE, MAE and UAE respectively. MAE and UAE were efficient to extract the inhibitors of enzymes alpha amylase and alpha glucosidase [60].

Anticancer activity

D. palmatus fruit extract also tested against breast and colon cancer cell lines MCF-7 and HT-29 by SRB (sulphorhodamine B) assay. It revealed that *Diplocyclos palmatus* fruit exhibited promising anticancer activity [60].

Micropropagation, acclimatization and Genetic fidelity

Nodal explants from mother plant were grown on MS basal media along with plants growth regulators such as cytokines alone or in combination with auxins for shoot growth. Maximum shoots with maximum shoot length were produced after six weeks on MS media containing benzylamine purine 5.0 µM and 1-naphthaleneacetic acid 2.0 µM. Micro shoots show well root growth on a low nutrient medium of ½ MS +1.0 µM IBA showing maximum roots of 11/micro shoot. Scanning electron microscope of the leaves of acclimatized plant indicated the adaptation of plantlets to natural as confirmed by the formation of natural stomata. DNA based molecular markers such as RAPD and ISSR were used to check genetic uniformity [53].

Anti-Quorum sensing activity

Virulence factor production regulated by quorum sensing was effectively inhibited by *Diplocyclos palmatus* methanolic leaf extract (DPME) in *Serratia marcescens.* In addition to this biofilm formation reported in *Serratia marcescens* when treated with DPME. Presence of tocopherols and phytol active compounds revealed in docking study, confirmed for their anti-QS activity against *Serratia marcescens.* Further, the docking study revealed that the presence of active compounds, namely tocopherols and phytol, DPME exhibited its anti-QS activity against *S. marcescens* [61].

Protective effect against UV-A induced photoaging in model Caenorhabditis elegans

UV-A induced ROS stress was extensively reduced by DPME, thereby extended the life span in UV-A photoaged *C. elegans*. Further, qPCR study testified the up-regulation of daf-16, clec-60, clec-87 and col-19 genes which supported the improvement of the lifespan, healthspan, collagen production in UV-A photoaged *C. elegans* [61].

Neuroprotective effect

DPM and DCM extracts showed neuroprotective effect on Aβ induced Alzheimer's disease in mice due to presence of AchE and antioxidant activity. These two extracts reduced behavioral and biochemical abnormalities in dose dependent way. Moreover, high dose of DPM resulted in better results in improving AD [62].

Heavy metal absorption

Activated carbon prepared from the biomass of *Diplocyclos palmatus* (L.) C. Jeffrey was found to be effective in removing lead ions from the synthetic waste water. Removal of Pb^{2+} was studied by batch method and various experimental parameters namely contact time, effect of temperature, effect of pH, effect of Pb^{2+} and effect of matrix were also studied. This study has postulated great potential of plants residues, as low-cost heavy metal absorbed absorbent [63]. Ni^{2+} removal from polluted water was tested by using seeds of *Diplocyclos palmatus* as an adsorbent. Batch adsorption method was used and conc. of Ni measured using an UV-Vis spectrophotometry [64].

Wastewater remediation

Photocatalytic dye degradation of methylene blue under sunlight irradiation was used for the waste water polluted with chemical dyes. Cobalt oxide (Co_3O_4) nano-particles synthesized from the fruit extract of *Diplocyclos palmatus* by the co-precipitation technique and advanced oxidation process that degrade pollutants of higher concentration in a non-threatening manner was observed [65].

Spermoderm Pattern

Spermoderm pattern, an important taxonomic character refers to the pattern present on the seed coats. As seed characters are only slightly influenced by environmental conditions, great diversity in seeds structures provides an important taxonomic parameter for the classification of species and families. Spermoderm of *Diplocyclos palmatus* was studied and showed reticulate pattern [66].

Host of Papaya Ringspot Virus (PRSV)

Papaya Ringspot Virus poses a great threat to papaya globally. Studies have led the conclusion that *Diplocyclos palmatus* is a potent host of papaya ringspot virus. Further it was found that sap of *Diplocyclos palmatus* was able to induce symptoms in papaya seedlings. This was confirmed by various confirmatory tests such as reciprocal inoculation, aphid transmission, reciprocal aphid transmission, indicator host, serology *etc.* [67].

Insecticidal activity

Goniothalamin, one of the important phytochemicals present in the said plant found to be potent mosquito larvicide. Data clearly showed that upon increasing exposure time, LC_{50} values decrease indicating its potent larvicidal activity against *Culex quinquefasicatus.*

Role in infertility

Specifically known for its seeds "shivlingi" used in infertility in ethnobotanical studies, experiments related to this has been also reported. Histology of the liver showed no toxicity at the administered dose in either of the male and female mice groups in both experiments. Further extensive research along with a proper screening of phytosteroids of the methanol extract of the seeds of these two medicinal plants are needed for the declaration and formulation of fertility drugs from these two medicinal plants to provide hope for thousands of individuals dealing with reproductive and infertility issues. Methanolic seeds extracts and normal saline were used to see their role on reproductive physiology of albino mice. In account of the methanolic seeds extract it was observed that histology of testis exhibited increased number of sertoli cells, leydig cells with more sperm count and vascularization, increased spermatozoa, while histology of uterus showed enhanced expansion of uterine lumen with many epithelial glands. In case of histology of ovary, considerable increase in the number of follicles been reported towards the Graafian follicle with increases vascularization. In ME treated mice, estrus phase (heat phase) got prolonged. Researchers highlighted the presence of phytochemicals, specifically flavonoids in methanolic seeds extract, may be responsible for these observations [68]. In line of another scientific evidences of shivlingi seeds used in infertility, another remarkable work was use of super critical fluid extracted shivlingi seed oil (SLSO) in reproductive fecundity of zebrafish model of N-ethyl-N-nitrosourea induced infertility. In astonishing results, both male and female zebrafish who were orally fed with the pellets infused with SLSO showed a dose dependent increase in fecundity and fertility rates. Chemical characterization of the SLSO revealed linoleic (47.80%) and linolenic acid (28.9%) with trace amounts of stigmasterol and beta sitosterol [69].

Market value

Shivlingi seeds are sold to treat infertility. It is available online under the names "Divya Shivlingi Beej", "Brij Booti Shivlingi Beej", "Sri Satymev Shivlingi Beej", "Herbaveda- Shivlingi Beej" *etc*. price ranges between rupees 230 to 370 for 100 gms. Most of these give botanical description as *Bryonopsis laciniosa.*

Gaps in current knowledge

On reviewing comprehensively, certain gaps like the taxonomic status of the plant, habit, in studies were found. Most of the taxonomic studies have mentioned related plant as *Bryonopsis laciniosa*. However, some studies have given clearance for "shivlingi" plant, important of which is "Establishing the correct botanical identity of Shivlingi plant in India: A critical analysis based on various literatures" by Balkrishna A et al [1]. In contrary to this study, in a remarkable experimental study named "Super-critical fluid extract of *Bryonopsis laciniosa* (Shivlingi) seeds restores fertility in zebrafish models through revival of cytological and anatomical features" by Balkrishna A et al [69] contrasted the earlier study. In view of it, can be concluded that besides literatures like that of Jeffrey "Further Notes on Cucurbitaceae: V: The Cucurbitaceae of the Indian Subcontinent" published in Kew Bulletin, 1980"; "The cucurbitaceae of India: Accepted names, synonyms, geographic distribution, and Information on images and DNA sequences" by Renner SS et al [3] published in Photo Keys, erroneous use of scientific name for this plant still prevailed. Present review go with the preceding two checklists and accepted the correct name of shivlingi plant as *Diplocyclos palmatus* (L.) Jeffrey. Habit of the plant by observation has been confirmed to be perennial.

CONCLUSION AND FUTHER SCOPE

Misapplied and erroneous scientific name can lead to multiple problems like misleading search results, unreliable datasets. Hence, it is very important to have correct scientific names for the plants. Many important compounds have been isolated such as catechins, caffeic acid, quercetin, gallic acid. These compounds have various pharmacological properties, can be processed in potential drug making. *Diplocyclos palmatus* is used for various ethnobotanical uses. This plant majorly known for its uses to treat infertility. There are many studies culminating to its ethnobotanical uses to treat infertility, but scientific basis of such claims is rare. However, one study pertaining to SLSO activity in fertility improvement in zebra fish has built a foundation for further such studies. Most importantly, further scientific investigation of different aspects of concerned plant on human reproductive health. Further, isolation of chemical compounds responsible for such activities might result in novel strings of information that could lead to the development of drugs. Ethanolic fraction is found to be good antimicrobial substance. Ethnoveterinary uses have also been reported in tribal people. Many reports suggesting the antioxidant potential, one of them is by accessing multi-targeted protective mechanism of *D. palmatus* fruits against oxidative stress. DPM and DCM extracts have shown neuroprotective effect in Alzheimer disease. One study revealed *D. palmatus* fruit extract found to be against breast and colon cancer cell lines MCF-7 and HT-29. Results were similar to the standard adriamycin anticancerous activity activity, which give an aspiring future scope. Goniothalamin, a potent mosquito inhibitor as reported in a study shows good larvicidal activity justifying its role in ethno-botanical insecticidal activities. However, more scientific studies are required in this area.

From all these observations, it can be concluded that *D. palmatus* is an important medicinal plant that can be explored for effective drug development. However, scientific studies of these claims are few, and should be validated by further research. Regardless of all researches, claiming ethno-medicinal and traditional uses, the plant needs more attention for detailed scientific evaluation. In addition to this, structural, functional characterization of isolated compounds, and standardization of extracts with major bioactive compounds are required to make sure its use to cure infertility, antimalarial and anticancer activity. Well-structured studies to prove scientific basis for the use of the plant in fever, skin infection, against animal bite, rheumatism, and asthma will help in utilizing traditional knowledge for the benefit of mankind. Furthermore, use of correct scientific name, and revised conservation status are pre-requisite for relevant, authentic scientific studies and population conservation of this plant. Without valid scientific name nothing reproducible research could be conducted in terms of plants striking medicinal properties, most profound of which is in reproductive related aspects.

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Authors contributions

This review paper was written by Nidhi Thakur. The manuscript was reviewed and necessary inputs and suggestions were provided by Prof. Richa Puri.

Conflict of interest

The authors declared no conflict of interest.

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