

## *Diplocyclos palmatus* (L.) JEFFRY: PHYTOCHEMICAL AND PHARMACOLOGICAL EVIDENCE SUPPORTING ITS THERAPEUTIC POTENTIAL

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### ABSTRACT

Conventional medical systems offer a valuable starting base for bioactive compounds of medicinal plants. Shivalingi *Diplocyclos palmatus* (L.) Jeffry is a seasonal climber in the family Cucurbitaceae that is popular in folk medicine for treating inflammatory disorders, diabetes, pain, arthritis, and neurological conditions. Recent scientific research has attempted to support these ethnomedicinal arguments by using pharmacological and phytochemical research. *D. palmatus* has a wide spectrum of bioactivities, including antidiabetic, anti-inflammatory, analgesic, anti-arthritis, anticonvulsant, and cytotoxic effects, as demonstrated by experiments. Qualitative phytochemical screening has shown the presence of a set of secondary metabolites, di- and triterpenoids, alkaloids, flavonoids, saponins, tannins, phenolic compounds, anthraquinone derivatives, and cardiac glycosides, which are known to play a part in a variety of therapeutic actions. These bioactive compounds can be used to explain the traditional uses of the plant scientifically. This paper reiterates the importance of more sophisticated methods of analysis, mechanistic studies, and thorough safety evaluation in order to advance the study of the therapeutic potential of *D. palmatus*. In general, Shivalingi is one of the potential candidates in the field of future pharmacological research and the development of phytopharmaceuticals.

**Keywords:** *Diplocyclos palmatus*, Shivalingi, Folklore, Pharmacological, Phytochemical.

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### INTRODUCTION

India constitutes the richest source of biological diversity in the world. Nowadays, utilisation of natural resources and Vedic knowledge is increasing enormously. Various tribal communities use wild medicinal resources in their endemic system of treatment of diseases.<sup>1</sup> Traditional medicine practitioners described the therapeutic effectiveness of native plants for many disorders.<sup>2</sup> *Diplocyclos palmatus* Linn. is a less-known restorative ethnomedicinal plant with diversified medicinal values.<sup>3</sup> Because its seed resembles a lingam, it is known as Shivalingi and native bryony or striped cucumber.<sup>4</sup> The term "Lollipop climber" comes from the ripening fruit's red hue and longitudinal white striations, which resemble lollipops.<sup>5</sup> The classical Ayurvedic writings of Rajanighantu and Nighantu Ratnakara have depicted it.<sup>6</sup> In Āyurveda, the plants "*Cayaponia laciniosa* (L.) C. Jeffrey" and "*Diplocyclos palmatus* (L.) C. Jeffrey (F: Cucurbitaceae)" are referred to by the name Śivaliṅgī. Morphologically, the two plants are identical but vary in the physical parameters of the leaves and seeds. Renner and Pandey described *Cayaponialaciniosa* (L.) C. Jeffrey as an indigenous plant of Jamaica, not spotted in India, and *Diplocyclos palmatus* (L.) C. Jeffrey is a well spread plant throughout Hindustan, Druk Yul, China, Nepal, Ceylon, Pakistan, South Japan, Philippines, Siam, Republic of Indonesia, Peninsular Malaysia, Papua New Guinea, NE Australia.<sup>7</sup> Genus name was acquired from the Grecian words diploos meaning "double" and kyklos denoting "a circle, ring"; referring to the cirri; and specific epithet was coined from the Italic word palmatus suggesting 'with 5 or additional veins emerging from one point (commonly on divided leaves), hand-like, palm shaped'.<sup>8-10</sup>

### Ethnobotany

In tribal societies and customs, Shivalingi plays a pivotal role and is utilised in numerous natural rejuvenating practices. In India, the plant is generally known as Shivalingi and Gargumaru. In Patalkot Valley, the tribes of Gond and Bharia venerate the plant. As stated by these tribes, this plant is a support

for the nulliparous folks. The tribals state that the seeds act as a vitalising agent to improve sperm calibre and libido. Furthermore, it improves physical and psychological health and enhances youthfulness in aged persons. Seeds of this herb are recommended by Bhumkas of Harra-Ka-Chhar town in Patalkot for conceiving male children. In Gaildubba, traditional practitioners mix seeds of Shivlingi with Tulsi leaves (*Ocimum basilicum*) in Gur and give them to the female who is not thinking about a baby for any reason. In Chhattisgarh, tribals use leaves as an ingredient in a special preparation along with Bengal gram flour as a tonic.<sup>3</sup> Bhils tribe of Ratlam District of Madhya Pradesh used the seeds of sivalingi, Rai (*Brassicainigra* (L.) K. Koch and Urad (*Vignamungo* (L.) Hepper is an amulet because they believe the seeds possess the power to ward off evil spirits, and they tie the amulet around the neck of the children to protect them from evil spirits.<sup>11</sup> Traditionally, uses include as an aphrodisiac and pro-fertility compound, as an effective supplement for treating various ailments like inflammation, icterus, and pyrexia. It was described in ancient texts as an Ayurvedic formulation named 'Strirativallabhupugpak' used to enhance libido and as a restorative.<sup>12</sup> In Chhattisgarh, Traditional practitioners of Gulgul village suggest women consume three to four seeds a day in a fasting state for 1-2 months to have a male child.<sup>13,14</sup> The combination of Shivlingi seeds with dry ginger, Piper nigrum, Putrajivi, vata root bark (*Ficus bengalensis*), and dairy is a potent contraceptive.<sup>15</sup> Shivlingi seeds were proved to be abortifacient when mixed with the same quantity of Ashwagandha roots and taken with sugar and dairy (Bhawda Amalad).<sup>16</sup> Native inhabitants in the Porbandar region frequently utilise it as a hypoglycemic herb. According to sources, the herb has long been utilised in the Khammam District of Andhra Pradesh, India, to treat icterus. In Kenya, roots are used as an antivenin and leaves and fruits as a stomachache cure. In Siam, fruits and stems are used as expectorants and laxatives, respectively. In Nepal, seeds are used to lower fever. Raw fruits and twigs are occasionally consumed in Southeast Asia.<sup>17</sup>

### Taxonomy<sup>18,19</sup>

Kingdom: Plantae; Subkingdom: Tracheobionta; Infrakingdom: Streptophyta; Class: Magnoliopsida; Sub-Class: Rosidae; Super Order: Violanae; Order: Cucurbitales; Family: Cucurbitaceae; Subfamily: Cucurbitoideae; Genus: *Diplocyclos*; Species: *palmatus*; Synonyms: *Bryoniapalmata* L; *Bryonopsis laciniosa* var. *walker*i Chakrav; *Diplocyclos palmatus* var. *walker*i (Chakrav). Babu.

### Synonyms<sup>2,16</sup>

*Diplocyclos palmatus* (L.) C. Jeffrey subsp. *palmatus*  
*Diplocyclos palmatus* subsp. *palmatus*  
*Bryonopsis laciniosa* var. typical Domin  
*Bryonopsis laciniosa* Naudin (L.)  
*Bryonopsis laciniosa* (L.) Naudin var. *laciniosa*  
*Bryonopsis erythrocarpa* (F. Muell.) Naudin  
*Bryonopsis laciniosa* var. *erythrocarpa* (F. Muell.) Naudin *Bryonia laciniosa* L.  
*Bryonia palmata* L  
*Zehneria erythrocarpa* F. Muell  
*Trichosanthes muelleri* Cogn

### Common names<sup>17, 20-24</sup>

|                    |                                                                                                                                                    |
|--------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| English            | – Native Bryony, Red Striped Cucumber, Striped cucumber, Marble vine<br>Lollipop climber                                                           |
| Gujarati           | – Sivalongi                                                                                                                                        |
| Hindi              | – Bonkakra, Bankakra, Putloguli, Isvaralingi                                                                                                       |
| Carnatic           | – Panchaguriya, Lingatomdeballi, Lingatondeballi. Śivaliṅgī,                                                                                       |
| Mahaalinganaballi, | Lingakonde Balli, Maaninganaballi, Angathondeballi.                                                                                                |
| Tamil              | – Sivalingakkay, Shivalingakkay, Aiviralkkovai, Aivirali, Iyviri, Iyveli                                                                           |
| Malayalam          | – Sivalingakkaya, Sivavalli, Kakkakothi, Iyiviralkkova, Aiviralkkova, Naiunnikkai,<br>Nehomemka, Namakai, Pambukodi, Neyyunni, Neyyuruni, Neysatti |
| Maharashtri        | – Shivlinge, Mahadevi, Kavdoli                                                                                                                     |
| Konkani            | – Karta                                                                                                                                            |

|             |                                                                     |
|-------------|---------------------------------------------------------------------|
| Indo-Aryan  | – Lingaja, Putrada, Apashtambhini, Linguini, Chitrphala, Shivavalli |
| Trilinga    | – Lingadonda                                                        |
| Gadhawala   | – Put-loguli                                                        |
| Nepali      | –Shaavaa, Shivalingii, Ghurmilahara, Ghuru                          |
| Tulu        | – lingatonde                                                        |
| Thai        | – Khikalai                                                          |
| Sinhalese   | – Pasengilla                                                        |
| Swedish     | – Polkagrisreva, Rödbryonreva                                       |
| Kinyarwanda | – Ichongosho                                                        |
| Dutch       | – Kerstklimmer                                                      |
| Japanese    | – “Okinawa suzumeuri, Okinawa suzumeuri, Okinawa suzumeuri”         |
| Irula       | – Vanasurakodi, Surakodi                                            |
| Chinese     | – Shuanglungua, Du gua                                              |
| Korean      | – Jeon cho                                                          |

### Distribution

Its natural habitat is tropical forests and xeric forest habitats. The ethnic distribution of the plant species is: Tropical and subtropical Asia, Tropical & S. Africa, S. Arabian Peninsula. The plant is indigenous to Cambodia, China, Bangladesh, Burundi, Chad, Southeast, Congo, East Himalaya, Assam, Ethiopia, Gulf of Guinea Is., Hainan, India, Jawa, Kenya, KwaZulu-Natal, Laos, Lesser Sunda Is., Maluku, Malaya, Mozambique, Myanmar, Namibia, Nansei-shoto, New Guinea, New Caledonia, New South Wales, Nepal, Norfolk Island., Northern Territory, Pakistan, Oman, Philippines, Queensland, Rwanda, Solomon Island., Sudan, Taiwan, Sri Lanka, Sulawesi, Sumatera, Tanzania, Uganda, Thailand, Vietnam, Vanuatu, West Himalaya, Zaïre, Zimbabwe, Yemen but is absent in most of West Africa and Somalia.<sup>25</sup>

### Medicinal Uses

Tables-1 and 2 show medicinal uses and traditional uses of the plant *Diplocyclos palmatus*, respectively.

Table-1: Medicinal Uses of the Plant *Diplocyclos palmatus*

| Medicinal use/s                                                                                              | Ref.                   |
|--------------------------------------------------------------------------------------------------------------|------------------------|
| Female infertility                                                                                           | 26,27,28,2,29          |
| Aphrodisiac, Pro-fertility compound                                                                          | 3, 29, 30, 5           |
| Jaundice, Inflammation and Fever                                                                             | 6, 31                  |
| Anti-inflammatory                                                                                            | 30, 31, 32, 33, 29, 34 |
| Antimalarial, Anti-inflammatory, Anti-ulcer, virustatic and antihyperglycemic agent                          | 37                     |
| Snake-bite                                                                                                   | 32, 30,33, 5,36        |
| Asthma                                                                                                       | 33                     |
| Eaten as a vegetable                                                                                         | 29                     |
| Febrifuge                                                                                                    | 29, 37                 |
| Laxative, Expectorant, Reproductive medicine, Impotency, Infertility in Females, Leucorrhea.                 | 29                     |
| Cough suppressant, Deflatulent, Arthritis, Asthma, Dermatitis, Snakebite.                                    | 29                     |
| Anodyne, Gynaecological, Anti-venom, Antimicrobial, Dermatophytic infections, Anticonvulsant, Anti-arthritis | 29, 38, 33, 39, 37     |
| Stomach Ache, External abscess                                                                               | 5                      |
| Diarrhoea                                                                                                    | 5                      |
| Restorative, Skin disease, Thermogenic, Anti-inflammatory, tongue paralysis, Snake bite                      | 34                     |
| Antitumor and Antioxidant                                                                                    | 40, 34                 |
| Anti hyperlipidemic                                                                                          | 34, 37, 41             |
| Antimicrobial                                                                                                | 35, 34                 |
| Jaundice                                                                                                     | 42, 34                 |
| Antidiabetics                                                                                                | 43, 34                 |
| Anthelmintic                                                                                                 | 44, 34                 |
| Sex selection drug                                                                                           | 33, 34                 |

|                                                                                                           |                |
|-----------------------------------------------------------------------------------------------------------|----------------|
| Cytotoxicity                                                                                              | 45, 34         |
| Anti-arthritis activity                                                                                   | 46, 34         |
| “Gynaecological, asthma medication, antiepileptic, antidote, Anti-inflammatory, antioxidant and anabolic” | 47, 48, 49, 45 |
| Inflammations and General debility                                                                        | 3, 50          |
| Acrid, Anti-inflammatory, and Tonic                                                                       | 3              |
| Sterility                                                                                                 | 51, 3, 50      |
| Reduce inflammation, Anti-fungal, Antimicrobial, Anodyne, hypolipidemic, Spermatogenesis, Febrifuge       | 3              |
| Improve Sexual behavior, General tonic                                                                    | 13             |
| Adenitis                                                                                                  | 1              |

Table-2: Traditional Uses of the Plant *Diplocyclos palmatus*

| Traditional Use in/as                                                                                                                                                                  | Part                   |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------|
| Anti-venom                                                                                                                                                                             | roots                  |
| Stomach-ache                                                                                                                                                                           | fruits and leaves      |
| Expectorant                                                                                                                                                                            | stems                  |
| Laxative                                                                                                                                                                               | fruits                 |
| Febrifuge                                                                                                                                                                              | seeds                  |
| Anti-inflammatory                                                                                                                                                                      | Leaves                 |
| Cephalalgia, Fever, Colic pain, Splenomegaly, Tongue Paralysis, Dementia, Convulsions                                                                                                  | Various parts of plant |
| Reproductive medicine                                                                                                                                                                  | Fruits                 |
| Conception                                                                                                                                                                             | Seeds                  |
| Snake-bite                                                                                                                                                                             | Entire plant           |
| Asthma                                                                                                                                                                                 | Roots                  |
| Aphrodisiac, increasing Sperm count                                                                                                                                                    | Seeds                  |
| Fevers                                                                                                                                                                                 | Leaves and the seeds   |
| Lymph node inflammation, Fever, Carbuncles, Asthma, Bronchitis, Cholera, Colic, Cough, Dementia, Fertility, Cephalalgia, Consumption, megalosplen, paralysis, Tuberculosis, snakebite. | Whole plant            |
| Constipation                                                                                                                                                                           | Entire plant           |
| Antivenin                                                                                                                                                                              | Roots                  |
| Stomach-ache                                                                                                                                                                           | Fruits and leaves      |
| Expectorant                                                                                                                                                                            | stems                  |
| Diabetes                                                                                                                                                                               | seeds                  |
| Ear ache                                                                                                                                                                               | Fruits                 |
| Splenomegaly                                                                                                                                                                           | Fruit                  |
| Veterinary medicine                                                                                                                                                                    | Plant                  |
| Eye infection                                                                                                                                                                          | Leaves                 |
| Foaming at mouth and Paralysis of tongue                                                                                                                                               | Plant                  |
| Syphilis                                                                                                                                                                               | Plant                  |
| Wounds                                                                                                                                                                                 | Fruit                  |

**Ayurvedic Health Benefits<sup>1, 17</sup>**

Various components of the plant *Diplocyclos palmatus* are used in various ways and combinations in Ayurveda. Table-3 summarises the medicinal properties of the plant according to Ayurveda.

Table-3: Ayurveda health benefits of *Diplocyclos palmatus*

| Health benefits                     | Form of Usage                                                                                                        |
|-------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| Blocked Fallopian Tubes             | Every morning, take 1 teaspoonful of powdered seeds with warm water on an empty stomach. Duration: 2 to 3 months.    |
| Impotency                           | Powder the seeds of Putrajeevak and Shivlingi separately. Half teaspoon of each, taken twice a day for three months. |
| Increasing conception possibilities | Take the Seeds with milk.                                                                                            |
| Oligospermia                        | powdered seeds                                                                                                       |

|                                                            |                                                                                 |
|------------------------------------------------------------|---------------------------------------------------------------------------------|
| Pregnancy                                                  | Small pills were made with seeds and jaggery. Two pills twice a day for 15 days |
| Gastric distress                                           | Crush the Leaves and blend the juice with milk.                                 |
| Burn                                                       | Decoction of the plant is applied topically to the burnt area.                  |
| Sores, Boil                                                | Whole plant made into a paste and applied topically.                            |
| Cough, diabetes, flatulence                                | Blended Leaf juice with sugar or honey                                          |
| Febrifuge                                                  | Paste is made from seeds. Consume 2 gm twice for 5 days.                        |
| Inflammation                                               | Leaves are tied on the affected part of the body.                               |
| Respiratory problems, asthma                               | Consume the coconut oil-fried leaves.                                           |
| Lumbago                                                    | Take Tender twigs and fry with onion.                                           |
| Cookery                                                    | Cooked leaves are eaten as a vegetable.                                         |
| Animal bite                                                | Leaf juice is applied to scorpion stings. Used in the treatment of snakebite.   |
| Conception                                                 | One seed with a spoonful of animal ghee                                         |
| Galactorrhea, Fluor albus, strengthen pelvic floor muscles | One seed with a spoonful of animal ghee                                         |
| Ear ache                                                   | Fruit juice is poured in the ear.                                               |
| Wounds                                                     | Warm poultice of fruit pulp is tied on the wound.                               |

### Morphology<sup>2,5,6,12, 52, 53,54</sup>

*Diplocyclos palmatus* is a seasonal vine. Aerial parts of the herb are depicted in Fig.-1. Tap Root system with subsidiary roots and many radicular hairs. From the nodes of vines, Fibrous roots arise. The stems of the perennial climber are hairless and grow up to 6m long and a diameter not exceeding 2 cm, thickened when they are old, and dotted white on the ridges. Membranous Leaves measuring 10-15 cm in length and expansive, green in colour. Upper surface is *rough or scaly*, and the lower surface is paler and smooth. Leaves are broadly ovate, petiolate, cordate base, and hairless. Petioles measure about 2.5-7.5 cm in length, striated, and slim. Deeply palmately lobed leaf blade with five major lobes. Lobes are lanceolate to elliptic, hairless; usually, lateral lobes are shallowly bi-lobed with a subserrate margin and a sharp, pointed to subacuminate apex; midrib once in a while subserrate. Leaves emit an unpleasant odour when crushed. Tendrils 2- branched and leaf-opposed. The flowering season is August-October. They are small and greenish yellow in colour. Usually, 2-8 staminate and pistillate flowers in the same leaf axil. The staminate flower is larger than the female. The female flowers are borne in fascicles, and the male flowers are present solitarily. Staminate flowers are stalkless with small clusters of 3-6, 20 mm diameter. The length of the inflorescence stalk is 5-20 mm, filiform and smooth. The floral cup length is 3-4 mm long, with glabrous sepals, lobe length 2 mm, inflated bases, spreading lobes, subulate teeth. White, cream-pale or greenish yellow coloured corolla of 6 - 9 mm in length and 2.5 - 5 mm broad lobes, unified below, dense hairs on the inner surface. Length of Anthers and filaments are 3-4 mm and 2 mm, pubescent at base. 2 biloculate and 1 uniloculate anthers, and microsporangia are bent and contorted. Floral Formula of Male flower: + ♂ K (5) C (5) A 3. Female flowers are pedicellate, Solitary or few, or numerous peduncles, 15 mm diameter. Calyx lobes 2 mm long, inflated bases, spreading lobes. Corolla 8 mm long, 3 mm broad, united below, densely hairy on the inner surface. The ovary is ellipsoidal in outline, deep green in colour with longitudinal rows of white markings, length 4.5–5 mm, 2.5–3.5 mm wide, length of the receptacle-tube is 1.5–2.5 mm, flared above. Three staminodes, each 3 mm long, compactly pubescent. Style is 3 mm in length and splits into 3 branches or a pistil head. Floral Formula of Female Flower: + ♀ K(5) C(5) G(3). Fruiting occurs during September and October. Fruit is a solitary ovoid-round berry, or found in clusters of two to five, 2-3 cm in diameter, bluish-green coloured with eight vertical white streaks. The ripened fruit is red in colour with vertical white stripes and seems to be a lollipop, hence the common name, lollipop climber, due to the presence of the red colour. The number of seeds is about six to ten in a fruit. Compressed Seeds, 6-8 mm in length, 3 mm in width, yellowish cocoa coloured, usually encircled by a prominent raised band, shaped irregularly, vaguely appearing as teardrops or bird skulls. Seedlings have elliptical Cotyledons, 20-26 mm long, 10-15 mm broad, 2 mm long petioles, lengthy radicle (0.8 mm), straight, small, and more slender than the cotyledons.

Small recurved trichomes or spines cover the petioles and stem above the cotyledons. A rudimentary pair of true leaves has trifoliate, toothed margins. An unpleasant odour is observed when the leaves are crushed at the tenth stage. The germination period is 8 to 42 days.

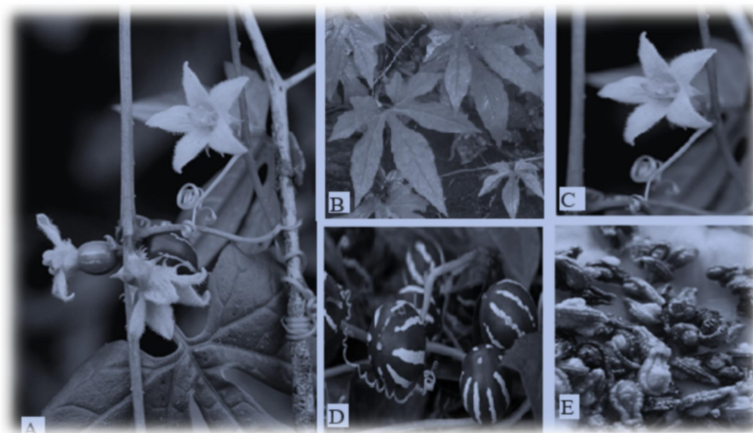


Fig.-1: *Diplocyclos palmatus* Plant. A. Twig, B. Leaves, C. Flower, D. Fruits, E. Seeds

## Microscopy

### Leaf

The transverse section of the leaf,<sup>55</sup> (Fig.-2a), shows a dorsiventral nature. In the Lamina region, multicellular and uniseriate covering trichomes are present. Elongated palisade cells and calcium oxalate crystals are found in the Mesophyll region. In the midrib region, beneath the adaxial epidermis and over the abaxial epidermis, closely packed collenchyma cells are found. Collenchymatous tissue is two- to three-layered in the upper part & three- to four-layered in the lower part. The remaining tissue in the midrib region is composed of loosely packed parenchymatous cells with vascular bundles. A few trichomes,<sup>56</sup> with flattened bases are seen.

### Stem

The cross section of the stem,<sup>57</sup> (Fig.-2b) shows the epidermis, cortex, vascular bundles, and pith. The epidermis was covered with a thick cuticle. The cortex was composed of thin-walled parenchymatous cells and lignified fibres. The vascular bundle consists of xylem and phloem. The pith region was composed of thin-walled lignified polygonal parenchyma containing calcium oxalate crystals.

### Fruit

The T.S. of the fruit,<sup>11</sup> (Fig.-2c), is orbicular in outline. The wide fleshy portion occupies the major area in the centre and is divided by placental portions into various compartments. Three are prominent, with two seeds on parietal placentation. The pericarp is made up of thick-walled cells covered with thick cuticles. Below the pericarp, three to six rows of small, thick-walled hypodermis are present. The mesocarp is composed of thin-walled parenchymatous cells with a compact arrangement. Starch grains and oil globules are seen in the parenchymatous cells of the mesocarp. The mesocarp is traversed by only helical xylem vessels and long, narrow secretory ducts.

### Seed

Transverse section of the seed,<sup>11</sup> (Fig.-2d), is oval in outline with two broad wing-like structures. Highly lignified multi-layered palisade-like parenchymatous cells constitute the outermost layer of the Testa. The centre of the cells is occupied by small pits in some cells. Below this outer layer of the Testa, unevenly thickened, collapsed rows of pigmented cells are present. The pigment layer is followed by a row of small-sized palisade rows of thickened parenchymatous cells and a narrow layer of brown-colored perisperm embedded with vascular strands at lateral edges. Vascular bundles are of the bicollateral type. Wide endosperm with parenchymatous cells containing droplets of fixed oil, starch grains, and aleurone grains.

### Powder Microscopy<sup>55</sup>

The leaf and stem powder is green in colour, odourless, and has a sweet to characteristic taste. Prismatic calcium oxalate crystals and stomata are seen in a chloral hydrate mount. Vascular bundles and lignified fibres were observed when the powder was stained with phloroglucinol and Conc.HCl. Trichomes were observed in a glycerin mount. Parenchyma, oil globules, aleurone grains, and palisade cells of the Testa are seen in the seed powder (Fig.-2e).

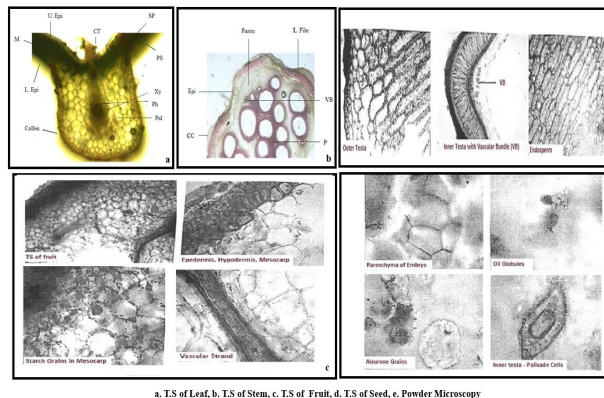


Fig.-2: Transverse Section of *Diplocyclos palmatus*

### Phytochemical Review

Qualitative bioactive analysis of the leaves and seeds showed the presence of various secondary metabolites like flavonoids, glycosides, cardiac glycosides, di- and triterpenoids, tannins, saponins, phenols, steroids, and alkaloids. Alkaloids were found in methyl alcohol and hydrous extracts; flavonoids in hydrous extract only; tannins in chloroform and ethyl acetate extracts; saponins in aqueous and methanol extracts; cardiac glycosides in aqueous, methanol and chloroform extracts; terpenoids (di and tri) in chloroform and ethyl acetate extracts; phenols only in aqueous extract; steroids in aqueous, methanol, ethyl acetate and chloroform extracts.<sup>58</sup> Compounds reported from Chloroform extract of *Diplocyclos palmatus* leaves are Phenol, Propanedioic acid, Dodecanoic acid, 4-Piperidinepropanoic acid, Pyrrolidine-5-one, 2-Pyrrolidine, Pyrrolidine-5-one, 4-Piperidinepropanoic acid, L-Proline, Propanedioic acid, 3-Oxo-4-phenylbutyronitrile, 3,5-bis(1,1-dimethyl)phenol, Benzeneacetic acid, Dodecanoic acid, 1-Nonadecne, 2(4H)-Benzofuranone, 1-Pentadecanol, Octadecane, Heptadecane, Heneicosane, 1,2-Benzenedicarboxylic acid, Docosane, Hexadecenoic acid, Di-n-octyl phthalate. Compounds reported from the alcoholic extract of leaves are 2-Pyrrolidinone, L-Glutamic acid, Levoglutamide, 3,7,11,15-Tetramethyl-2-hexadecen, Hexadecenoic acid, Dotriacontane, Tetracontane. Compounds reported from the aqueous extract of leaves are 1,3-dimethylbenzene, 3-Eicosyne, 10-Methyl-11-tetradecen-1-ol acetate, Tetracosane.<sup>55</sup> Phytoconstituents Bryonin and Fatty acid are reported from the whole Plant; Chlorogenic, acid, Gallic acid, and Protocatechuic acid from Fruits; Punicic acid from seed oil. The major active phytoconstituents are (Bryonin), punicic acid (fatty acid), glucomannan (soluble dietary fibre), and goniiothalamine (*styryllactone*) (Fig.-3).<sup>60</sup>

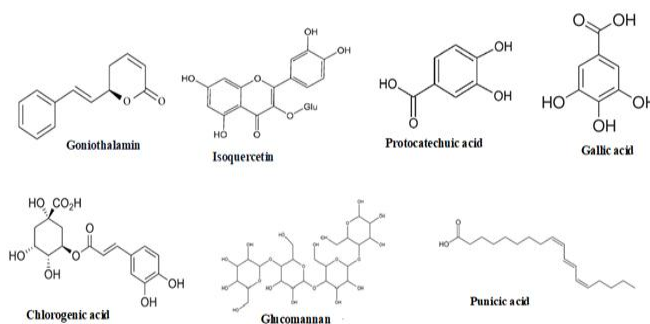


Fig.-3: Active Phytoconstituents of the Plant *Diplocyclos palmatus*

### Physicochemical Evaluation

Physicochemical properties like moisture content, ash, and extractive values and the phytoconstituents from various parts are summarised in Table-4.

Table-4: Physicochemical Evaluation Parameters of the Plant *Diplocyclos palmatus*

| Parameter                | Aerial parts <sup>57</sup>                                                    | Seeds <sup>61</sup>                                                   | Leaves <sup>55</sup>                                                             |
|--------------------------|-------------------------------------------------------------------------------|-----------------------------------------------------------------------|----------------------------------------------------------------------------------|
| Total ash                | 12.14%                                                                        | 9.6%                                                                  | 2.76%                                                                            |
| Acid-insoluble ash       | 0.8%                                                                          | 0.250%                                                                | 1.68%                                                                            |
| Water-soluble ash        | 3.6%                                                                          | 10.27%                                                                | 1.36%                                                                            |
| Moisture content         | 8.9%                                                                          | 3%                                                                    | 3.45%                                                                            |
| Ethanol extractive value | 18.85%                                                                        | 1%                                                                    | 3.01%                                                                            |
| Phytochemicals present   | Steroids, Terpenoids, Phytosterols, Proteins, Flavonoids, Saponins, Alkaloids | Alkaloids, Flavonoids, Triterpenoids, Saponins, Steroids and Proteins | Carbohydrates, Saponins, Steroids, Flavonoids, Tannins, Anthraquinone glycosides |

### Pharmacological Review

*Diplocyclos palmatus* has an extensive history of being used as an adjuvant for a different ailment and with a myriad of medicinal properties. Various research studies provided the scientific data for validating the claimed folklore uses. Reported Pharmacological activities of the ethnomedicinal plant, Shivlingi, are summarised in Table-5.

Table-5: Reported Pharmacological Activities of the Plant *Diplocyclos palmatus*

| Pharmacological activity              | Part/ extract                                                                       | Reference |
|---------------------------------------|-------------------------------------------------------------------------------------|-----------|
| Analgesic and anti-arthritis activity | Ethanol extract from seeds                                                          | 33        |
| Anti-asthmatic activity               | 70% alcoholic extract                                                               | 62        |
| Anticonvulsant activity               | 70% alcoholic extract, Chloroform extract                                           | 62        |
| Anti-diabetic activity                | Methanolic seed extract                                                             | 35        |
| Anti-inflammatory activity            | Ethanol extract of seeds, Chloroform extract                                        | 33, 6     |
| Anti-microbial activity               | Ethanol extracts of leaf and stem parts                                             | 2         |
| Antioxidant activity                  | Methanolic Fruit extract, aqueous leaf extract, Ethanol extracts of different parts | 6, 29, 40 |
| Anti-proliferative effects            | Seed extracts                                                                       | 62        |
| Antivenom and antidote activity       | Leaves paste                                                                        | 2         |
| Antimicrobial and analgesic activity  | Ethanol extract of fruits                                                           | 5         |
| Anodyne                               | 70% ethyl alcohol extract of aerial parts                                           | 6         |
| Antithrombotic activity               | Ethanol extract                                                                     | 31        |

### CONCLUSION

*Diplocyclos palmatus* (L.) Jeffry, which is also referred to as Shivalingi, is a wonderful botanical that is firmly embedded in Ayurveda and folk traditions. Although there have been reports of possible toxicity of some plant parts, available experimental studies have shown a broad spectrum of therapeutic actions, such as anti-inflammatory, antioxidant, analgesic, antidiabetic, antipyretic, anticancer, and reproductive health-promoting effects. Such therapeutic factors highlight the ethnomedicinal value and warrant further scientific attention. The variety of bioactivities of *D. palmatus* can probably be explained by the high phytochemical content, with the focus on the potential to produce new bioactive compounds. Further studies on bioactivity-based isolation of marker molecules, mechanistic pharmacology and rigorous toxicological analysis are necessary to promote safety and efficacy. These studies will not only enhance the scientific establishment of its traditional utilisation, but will also aid in the creation of standardised and evidence-based phytopharmaceuticals. All in all, *D. palmatus* can be a very promising source of medicine, but its treatment needs to be backed by thorough preclinical and clinical trials.

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## CONFLICTS OF INTEREST

The authors declare that there is no conflict of interest.

## AUTHOR CONTRIBUTIONS

The present work is related to *SDG-3: Good Health and Well-being*. All the authors contributed significantly to this manuscript, participated in reviewing/editing and approved the final draft for publication. The research profile of the authors can be verified from their ORCID ids, given below:

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