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Biological Morphology and Ethano-Pharmocological Importance of Calotropis Species-A Review

Navdeep Ranjan*, Sushil Kumar Singh and Chandrawati Kumari

Department of Biotechnology, A.N. College, Patna, (Magadh University), Bihar, India
**Corresponding author*

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A B S T R A C T

Calotropis a medicinal plant of family Asclepiadaceae has been utilized in Ayurveda, Unani, Siddha and many other traditional systems to cure diseases. There are two common species of *Calotropis* viz. *Calotropis gigantean* (Linn.) R.Br. and *Calotropis procera* (Ait.) R.Br. *Calotropis gigantea* called Swetarka and *Calotropis procera* called Raktarka. Secondary metabolites of *Calotropis* have well known pharmaceutical and therapeutic applications. Chemical constituents of plants such as alkoloids, steroid, terpenoids, resin, glycosides, carbohydrates, etc are reported in Ayurvedic literature. This present review enumerates the morphology and ethno pharmacology utilization of *C. procera and C. gigantea* for the treatment of various human ailments. This plant has been known to possesses antibacterial activity, anti- inflammatory activity, schizontocidal activity, anti larvicidal activity, antioxidant activity, skin disease, jaundice, leucoderma, eczema, ulcer, piles, dysentery, dropsy, ring worm, removing thorn from body, elephantiasis and leprosy and other miscellaneous activities.

Introduction

As stated by Acharya Charak (6th century to 2nd century) that there is nothing in this world which cannot be used as medicine after proper purification, formulation and given in appropriate doses. A poison after proper purification if given in appropriate doses, can act as a medicine. *Calotropis* also called as *Arka*, is an example of plant having both therapeutic and toxicological properties. According to Ayurveda, action of a drug depends upon seven factors viz. *dravya, rasa, guna, veerya, vipaka, prabhav* and *karma* while active ingredient present in body is solely responsible for its effect and side effect according to modern science, this is the basic difference in the pharmacological principle of both the sciences. Modern science uses the single active principle in the form of medicine while Ayurveda advocate use of effective part of the plant as a whole.

Medicinal plants are used from the ancient time to cure the diseases and it is the sources of different drugs formulation in all systems of medicine. The allopathic, Ayurvedic and Unani medicines were obtained by plant resources, the presently available drugs, either directly in the extract form or in the modified synthetic form. Naturally, plants have the ability to synthesize natural products which are beneficial for us known as phytoconstituents that are used to perform biological functions. *Calotropis* species is used in several traditional medicine and

folklore systems to cure various ailments as reported in the Hindu literature. It is widely used in the Indian traditional medicinal system as well as in Arabic, Unani and Sudanese systems. It is also reported widely in various folklore preparations and ethno-medicines, the plant posses many secondary metabolites. The secondary metabolites are biologically active and structurally unique compounds which may be useful for generation of new medicines. Secondary metabolites of *Calotropis* have well known pharmaceutical and therapeutic applications. Chemical constituents of plants such as Alkoloids, Steroid, Terpenoids, Resin, Glycosides, Carbohydrates, Aluminum, Iron, Magnesium, and Sodium are reported in Ayurvedic literature. These chemicals are reported to be Analgesic, Resilient, Anti-inflammatory, Schizontocidal Activity (P. Sharma *et al.*, 1999), Emetic, Expectorant, Stomachic, Digestive, Laxative and Depurative. Further, these phytoconstituents are also reported potentially active for the treatment of several diseases such as Skin disease, Jaundice (Jan *et al.*, 2009), leucoderma, eczema, ulcer, piles, dysentery (Khan *et al.*, 2009), dropsy, ring worm (Kuta, 2008) and removing thorn from body (Rai *et al.*, (2000). *Calotrois* root bark is very largely used as a treatment for elephantiasis and leprosy. The latex is as potent as standard anti-inflammatory drug phenylbutazone (PBZ) in inhibiting inflammatory response induced by various inflammagens in acute and chronic models of inflammation.

Preferred Scientific Name: *Calotropis procera*
Calotropis gigentia
Preferred Common Name: Akwan, Arka, Madar in India

Systematic classification

Table.1 Systematic classification of *Calotropis procera* given by three taxonomists

Classification	Bentham and Hooker	Engler and Prantl	Hutchinson
Kingdom	Plantae	Plantae	Plantae
Class	Dicotyledones	Dicotyledones	Dicotyledones
Division	Gamopetalae	Sympetalae	Lignosae
Order	Gentianales	Asclepiadaceae	Asclepiadaceae
Family	Asclepiadaceae	Asclepiadaceae	Asclepiadaceae
Genus	Calotropis	Calotropis	Calotropis
Species	Procera	Procera	procera

Table.2 Systematic classification *of Calotropis gigentea* given by three taxonomists

Classification	Bentham and Hooker	Engler and Prantl	Hutchinson
Kingdom	Plantae	Plantae	Plantae
Class	Dicotyledones	Dicotyledones	Dicotyledones
Division	Gamopetalae	Sympetalae	Lignosae
Order	Gentianales	Asclepiadaceae	Asclepiadaceae
Family	Asclepiadaceae	Asclepiadaceae	Asclepiadaceae
Genus	Calotropis	Calotropis	Calotropis
Species	Gigentia	Gigentia	gigentia

Table.3 International name

England	Calotrope, calotropis, dead Sea fruit, desert wick, giant milkweed, swallow-wort, mudar fibre, rubber bush, rubber tree, sodom apple.
Arabic	Dead sea plant, debaj, usher, oshar, kisher
Malaysia	Remiga, rembega, kemengu
German	Wahre mudarpflanzer, gomeiner
Philippines	Kapal-kapal (Tagalog)
Spanish	Bomba, algodón extranjero, cazuela
Indonesia	Bidhuri (Sundanese, Madurese), sidaguri (Javanese), rubik (Aceh)
Chinese	Bai hua niu jiao gua
Somali	Boah, bo'ah
French	Faux arbre de soie, mercure vegetal
Turkish	Ipekag
Thailand	Po thuean, paan thuean (northern), rak (central).
Laos	Kok may, dok kap, dok hak
Persian	Kharak
Vietnam	B[oot]ng b[oot]ng, l[as] hen, nam t[it]b[at]
Nigeria	Tumfafia
Pakistan	Ak

Table.4 National name

Sanskrit	Arka, Ganarupa, Mandara,Vasuka, Svetapushpa, Sadapushpa, Alarka, Pratapass
Hindi	Aak, Madar
Bengali	Aakna
Urdu	Madar, aak
Punjabi	AK
Marathi	Rui, mandara
Kannada	Ekka
Tamil	Erukku
Telugu	Jilledi Puvvu
Malyalam	Neela Eukku

Table.5 National distribution

Country	**Ditribution**	**Origin**	**Invasive**	**Natural**
India	Present	Native	Invasive	Natural

Table.6 International distribution

Country	**Distribution**	**Origin**	**Invasive**	**Natural**
Afghanistan	Present	Native	Invasive	Natural
China	Present	Introduced	Invasive	Natural
USA	Present	Introduced	Invasive	Natural
Bangladesh	Present	Native	Invasive	Natural
Mexico	Present	Introduced	Invasive	Natural
Brazil	Present	Introduced	Invasive	Natural
Pakistan	Present	Native	Invasive	Natural

Table.7 Etano- pharmacological importance of *Calotropis* species

Sl.No.	Pharmacological Importance	Plant parts used
1.	Antibacterial activity	Leaf, Flower, Root or Whole plant
2.	Antiviral activity	Leaf, or Whole plant
3.	Antifertility and emmenagogue	Leaf, Flower, Root, Latex OR Whole plant
4.	Anti-inflammatory activity	Leaf, Latex
5.	Anti tumor activity	Leaf, Flower, Root, Latex or Whole plant
6.	Anti-diarrheal and anti dyssentry activities	Leaf, Flower, Root,
7.	Anti cancer activity	Leaf, Flower, Root,
8.	Asthma	Flower
9.	Anxiety and pain	Leaf, Flower, Root,
10.	Abortifacient	Leaf, Flower, Latex
11.	Analgesic and Antinociceptive activity	Leaf, Root,
12.	Cytotoxic activity	Leaf, Flower, Root,
13.	CNS activity	Leaf
14.	Cold	Leaf
15.	Cytostatic activity	Flower, Root,
16.	Dyspepsia	Leaf, Flower, Root, Latex
17.	Diabetes mellitus	Leaf, Flower, Root,
18.	Eczema	,Latex
19.	Expectorant	Leaf, Flower
20.	Elephantiasis of the legs and scrotum	Leaf, Flower, Root,
21.	Fever	Leaf, Flower, Root, Latex OR Whole plant
22.	Free radical Scavenging activity	Leaf, Flower, Root, Latex OR Whole plant
23.	Fibrinolytic activities	Leaf, Flower, Root, Latex OR Whole plant
24.	Healing the ulcers and blotches	Leaf, Flower, Latex OR
25.	Indigestion	Leaf
26.	Jaundice	Leaf,
27.	Leprosy	Latex
28.	Liver injuries as well as on oxidative stress	Leaf, Flower, Root,
29.	Mental disorders	Flower,
30.	Piles	Latex
31.	Pregnancy interceptive activity	Leaf, Flower, Root, Latex or Whole plant
32.	Removing anemia	Leaf, Flower, Root, Latex or Whole plant
33.	Rheumatism	Leaf
34.	Ringworm of the scalp	Leaf, Flower, Root, Latex
35.	Secondary syphilis	Leaf, Flower, Latex
36.	Skin diseases	Leaf, Flower, Root, Latex
37.	TB	Leaf, Flower, Root,
38.	Uterus stimulant	Leaf, Flower,
39.	Vermicidal activity	Leaf, Flower, Root, Latex
40.	Worms	Leaf, Flower, Root,
41.	Wound healing	Leaf, Flower, Root,

(sources)

Distribution

Calotropis is native to tropical Africa and Asia and introduced to the Southern United States and Brazil (Crothers *et al*., 1998). It is naturalized in Australia, many Pacific islands, Mexico, Central and South America and the Caribbean islands.

The Fresh leaves are used in treatment of Rheumatoid, Arthritis and Healing of wounds (Patil *et al*., 2009). The pungent latex extracted from the leaf and flowers of *C. procera* is processed and used in the commercial preparation of eye tonic (Vohra, 2004; Henrich *et al*., 2004; Gurib-Fakim, 2005; Bruneton, 1999).

Morphology

Calotropis species is a shrub with thick twisted branches, the young ones bluntly quadrangular, bark ash colored, covered with a minute white woolly down (Ahirwar *et al.*, 2007). The species can be differentiated by the floral characterstics. *Calotropis gigantea* bears corolla lobes which are spreading, uniformly coloured, pure lavender to white, coronal scales narrow truncate shorter than the staminal column with pubescent back, apex entire. Whereas the corolla lobes of *Calotropis procera* are erect while pink or purple spotted on the corolla lobes, corona scales equal or longer than the staminal column, glaburous on back apex bifid, auricles wanting (Raman Sehgal *et al.*, 2005).

Habit

An upright shrub or small tree usually growing 1-4 m tall.

Habitat

It is drought-resistant, salt-tolerant species, grows in poor soils, found along roadsides, railway tracts watercourses, river side and coastal dunes, and is often prevalent in disturbed areas. Found mostly in semi-arid and arid inland areas, as well as in the drier parts of tropical and sub-tropical regions.

Somatic chromosomes: 2n=22

Karyotypic formulae

Calotropis procera Br. = mi6+sm6+sto+to=2n=22

Calotropis gigantea Br.=mi6+sm6+sto+to=2n=22

Chromosomal Formulae

Calotropis procera Br. = A6+B4+C6+D4+E2+Fo=2n=22

Calotropis gigantea Br = A2+B io+C6+Do+E4+Fo=2n=22

Root: Taproot, approximately 3000-4000 mm deep.

Stems

Approximately 2000-4000 mm tall, erect, branched, glabrous, woody below and herbaceous above, tomentose, solid, cylindrical. Branched from the base at times and branched higher up, Waxy, Copious milky sap exuded when injured.

Leaves

Oval, broad and flat in opposite pairs, thick and hairless apart from a basal tuft, leaves are arranged at higher angles. Waxy Grey-green to blue green with indented bases. None-petiole. Blade – Thick, egg shaped. Approx 50- 150 mm long x 40-100 mm wide, tip pointed. Notched at the base where it clasps the stem. Stiff tuft of hairs at the base of the midrib.

Inflorescence

Cymose, umbellate cyme, dense, multiflowered, umbellate, peducled, cymes, arising from the nodes and appearing axillary or terminal.

Flower head

In groups (umbels) of up to 15 flowers in the upper leaf axils, outer flowers develop first and inner ones don't develop fully.

Flowers

Approx 25 mm wide, scented and white with a deep purple blotch at the base of each petal, Waxy texture, Bracts - Deep purple bracts between the petals and stamens, (5) lobed, 20-30 mm wide, Scented. No milky sap. Petals - Deep purple bracts between the petals and stamens, tubular, five (5) lobed. 20-30 mm wide. Stamens – five (5) united with the stigma to form gynostegium, each stamen is represented by two pollinia with their retinaculae. Anther is bilocular and with a hyaline outgrowth of the connective that covers the stigmatic disc at the periphery; appendaged. It appendages are apical. Unisexual flowers absent.

Pollination

Each anther sac contains a pollinium. There are five pollinaria, each consisting of paired pollinia from adjacent anthers jointed by translator arms to a corpusculum located just above the slit or opening of the stigmatic chamber.

The stigmatic chambers are beaklike, due to raised anther flaps (wings). Anther flaps are hard, straight and enclose the stigmatic chamber tightly. Each pollinium is a flat wing-like body, narrow at its base close to the translator and wide at the apex. It has no external appendages and no pellucid margin.

Calyx

Sepal five (5), Polysepalous, five (5) lobed, shortly united at the base, glabrescent, quincuncial aestivation.

Corolla

Petals five (5), gamopetalous, five (5) lobed, twisted aestivation, Petals, gamopetalous, pink or whitish with purple spots, lobes spreading, inferior, twisted aestivation.

Androcium

Stamens five (5), gynandrous, anther dithecous, coherent, Five (5) stamens, filaments connate in a fleshy staminal tube around the ovary, the apex of the staminal tube united with the much-dilated stigmatic head to which the anthers are also coherent, forming the pentagonal gynostegium; anthers short, broad tipped with inflexed membranous flaps, bi-celled, the pollen grains of each cell aglutinated into sac like pollinium; the pollinia of each anther are united together by means of short stalks or caudicles to a distinct dark coloured dot-like structure, the corpusculum, which lies at the angle of the gynostegium, thus forming a translator apparatus.

Gynoecium

Bicarpellary, apocarpus, styles are united at their apex, peltate stigma with five (5) lateral stigmatic surfaces. Anthers adnate to the stigma forming a gynostegium. 2 carpels (bicarpellary), syncarpous; the pistil free below and fused above; two distinct ovaries end in two styles forming a pentangular stigmatic head to the sides of which the anthers are coherent; ovary superior, unilocular, many ovules, marginal placentation. Placentation axile. Ovules 30–50 per locule (‘many’).

Fruit

Long and balloon like. Follicle (bladdery pod). Grey-green. 70-125 mm long and almost as wide. Rounded at the base. Tip pointed. Numerous (400- 600) seeds are released when the ripe pod bursts. A simple, fleshy, inflated, subglobose to obliquely ovoid follicle up to 10 cm or more in diameter.

Seeds

Brown, Flattened, Tuft of long, white, silky hairs at top. Many, small, flat, obovate, 6x5 mm, compressed with silky white pappus, 3 cm or more long, Mainly, broadly ovate, flat tomentose with tuft of silky hairs.

Physiology

Salt tolerant, root stocks tolerate fire and drought.

Reproduction

Plants hermaphrodite, plants homostylous. Reproduces usually by seed and sometimes by suckers.

Flowering times

July to October mainly but can flower at any time of year. Fruit mainly ripens from November to February.

Life cycle

Seed germinates from October to December with tropical rain and it makes rapid growth in the wet season. Flowers occur in August to October when the plant is probably two years old. Flowers stay open for 10-12 days. Fruit is set from September to November and has many seeds. They ripen from November to February then burst to release seeds. New growth and suckering is stimulated by the break of each season in October to December.

Seed biology and germination

Prefers to germinate in light conditions and seed germination is inhibited in shaded conditions. Seed normally germinates in favorable conditions. Good germination takes place when temperature alters at 40/20 degrees Celcius and 36/21 degrees Celcius.

Vegetative propagules

Crowns and roots form suckers. Broken stems may take root and regenerate.

Propagation and management

The seeds freely float in the air and natural regeneration is very common. Vegetative propagation through stem and root cutting is very useful in large scale multiplication of the superior genotypes. *Calotropis* has been cultivated in South America and on the Caribbean Islands for the production of fibres at a spacing of 1-1.5m.When cultivated annualy yields of up to 500kg/ha are expected.

A single harvest per season is preferable to a double or triple harvest; a single harvest would result in a net saving of energy input both on the form and in the processing plant.

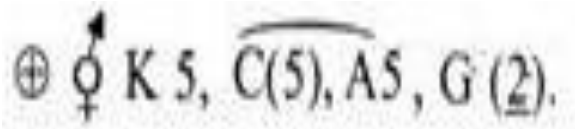
It is well suited for intensive energy farming in arid or semi-arid regions where frost is not a limiting factor.

Population dynamics and dispersal

In 5 years one WA infestation grew from 20ha to over 5000ha. Seeds are spread by wind and water or mud attaching to passing animals and vehicles. Localised spread is from suckering of the roots and crowns and seedling recruitment.

Earthmoving equipment is a major means of spreading rootstocks and seeds.

Floral formula



Floral diagram

Dehisence

The atrichomatous wall of ovary in *Calotropis procera* becomes highly pubescent in the young fruit, but scabrous in the mature fruit. The single layered epicarp develops from the outer epidermis of the ovary wall. The mesocarp which develops form the mesodermis is distinguished into outer, middle and inner zones. The central mesocarp breaks up in the course of fruit development and disintegrates to form large air chambers. The 2-3 layered lignified endocarp develops from the inner epidermis as well as from the inner mesodermis layers of the ground tissue and shows a 'parquetry pattern' of cell arrangement in surface view.

Ethano- pharmacological importance of *Calotropis*

Calotropis procera is commonly used in India both orally and topically for various joints and gastrointestinal complaints. It has highly economic importancs in pharmacology as well as other industry. Some of the medicinal importance of the plant has been mentioned in table 7.

In conclusion, both the species of *Calotropis* having many curative principles and other economic values, it grows in all types of soils and environmental conditions, requiring no cultivation practices. The plants are a rich source of phytoconstituents. A large number of synthetic compounds are available but due to their environmental pollution and adverse effect on the human body there use is restricted. To find the safe, effective, and environmental friendly agent from a plant source, *Calotropis* is a plant that may present as effective one. The literature on *Calotropis* suggests a huge biological potential of this plant. The present study may be useful to provide morphological information with regard to its identification and in accordance to carry out further research on its use in the treatment of various diseases and secondary metabolites will be useful for development of novel drugs to treat many human diseases in the modern era of globalization and intellectual property right regime after proper islotation, purification and formulation.

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