

DODONAEA VISCOSA LINN.-AN OVERVIEW

M.SANDHYA RANI*, PROF.RAO.S.PIPPALLA*, PROF KRISHNA MOHAN**

For author affiliations, see end of text

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ABSTRACT

Dodonaea viscosa Linn. is an evergreen woody perennial shrub, though it is a native plant of Australia, indigenous and wide spread throughout the tropics. In Traditional system of medicine, various plant parts such as stem, leaves, seeds, roots, bark and aerial parts are used as antibacterial, analgesic antiviral, anti-inflammatory, antiulcer and antioxidant. The present review is therefore an effort to give a detailed survey of the literature on its pharmacognosy, phytochemistry, traditional and pharmacological uses.

Keywords: Dodonaeaviscosa, Hopbush, Pulivailu, Bandedu, Herbal medicine, Pharmacognosy, Phytochemistry

INTRODUCTION:

Dodonaea viscosa Linn.-is a shrub belonging to family Sapindaceae. The centre of origin of *Dodonaea viscosa* is believed to be Australia, but it occurs throughout the tropics and subtropics, widely distributed in temperate regions of Australia, Africa, Mexico, New Zealand, India, Northern Mariana Islands, Virgin Islands, Florida, Arizona, South America and elsewhere. In addition to hop bush, it is also popularly called as Jamaica Switch Sorrel, hop seed bush, togovao, akeake (1). In Indian languages it is called as puli-vailu, gollapulledu, bandedu(Telugu),wilayatimehandi,janglianar(Hindi),bandare(Kannada),virali(Tamil),latchmi,pao rki(Marathi).(RDReddy flora)

The plant *Dodonaea viscosa* is a dioecious or monoecious multi stemmed shrub or single-stemmed small tree up to 7 m tall; bark blackish, of variable roughness, thin and exfoliating in long thin strips; twigs blackish or reddish-brown, glandular, developing vertical fissures, uppermost part of young branches greenish and prominently angled. Leaves alternate, simple; stipules absent; petiole very short, up to 2.5 mm long, or absent; blade oblanceolate or broadly to narrowly elliptical, (1–)4–13 cm × (0.5–)1.5–4 cm, narrowly cuneate at base, obtuse but minutely apiculate at apex, margins entire, both surfaces glabrous but glandular and coated (especially when young) with viscid glandular exudate, with a conspicuous midrib on both sides and 15–20(–30) often indistinct pairs of lateral veins. Inflorescence a loose thyrsoid panicle at the end of twigs. Flowers bisexual or unisexual, whitish to greenish-yellow; pedicel 8–15 mm long; sepals 3–4, free, 2–2.5 mm long; petals absent; stamens 7(–9), filaments very short, anthers oblong, up to 3 mm long in male flowers, up to 2 mm long in bisexual flowers and reduced to staminodes or completely lacking in female flowers; ovary superior, oblong in outline, flattened, 2–3-celled, strongly rudimentary in male flowers, style 2–3-lobed. Fruit a 2–3-winged papery capsule, 15–23 mm × 18–25 mm, white or straw-coloured to brown or purplish, dehiscent by splitting along 2–3 central septa, each cell 2-seeded. Seeds subglobose, more or less compressed, 3 mm in diameter, black. Seedling with epigeal germination; hypocotyls 8–16 mm long; cotyledons lanceolate, acute; epicotyl 0.5–1.5 cm long(2).The genus *Dodonaea* comprises about 60 species, which are almost all restricted to Australia, suggesting Australia is an

evolutionary centre of dispersal. In Australia, *Dodonaea viscosa* is described as having seven subspecies, which are largely geographically distinct. In tropical Africa, 2 varieties of *Dodonaea viscosa* are distinguished: the coastal var. *viscosa*, which has usually bisexual, whitish flowers, a strongly 2-lobed scar of fallen sepals beneath the fruit and not or only slightly compressed seeds, and the mainly inland var. *angustifolia* (L.f.) Benth., which has usually shorter and narrower leaves, usually unisexual, greenish-yellow flowers, a more or less annular scar of fallen sepals beneath the fruit and more compressed seeds(3).

Dodonaea viscosa tolerates sandy or rocky soils, salt spray, windy areas and drought conditions. It favors areas that receive full sun and is often cultivated in loamy or sandy soils(Florida).*Dodonaea viscosa* regenerates profusely by seed.(4).The seeds are desiccation tolerant and maintain high levels of viability for long periods when dry. Pre-treatment of the seed by scarification, nicking the seed coat, or with boiling water promotes germination. Rains must follow germination to ensure seedling survival. Plantations can be established by direct sowing or by using nursery-raised seedlings. Propagation by stem cuttings has been practiced successfully. It is capable of flowering and setting viable seed within three years of establishment. Flowering occurs almost all the year round throughout its geographical range, but most populations flower in spring and summer. Pollination is probably by wind, although bees have been observed to collect pollen. The fruits take 10–11 months to mature after flowering. They are broad winged, giving the impression of being dispersed by wind (5).

Dodonaea viscosa has many medicinal properties and has been used by native peoples from all regions where it is found. It is a traditional medicine worldwide, administered orally or as poultice to treat a great variety of ailments. Stem or leaf infusions are used to treat sore throats; root infusions to treat colds. The stems and leaves are used to treat fever, and seeds (in combination with those of other plants and coated in honey) to treat malaria. The stems are used as fumigants to treat rheumatism. The leaves are used to relieve itching, fevers swellings, aches and can be used as an antispasmodic agent(6) leaves and roots as a painkiller to soothe toothaches and headaches(7) and a lotion made from unspecified plant parts to treat sprains, bruises, burns and wounds. Digestive system disorders, including indigestion, ulcers, diarrhea and constipation are commonly treated in traditional medicine with an orally-administered decoction of either the

leaves or roots. Trachoma is treated with applications of leaf juice, and powdered leaves are given to expel roundworms. Pulverized roots are a component of anthelmintic preparations. The roots, either in decoction or fresh, are taken by women in East Africa to stimulate milk production after giving birth and to treat dysmenorrhoea and irregular menstruation. The flowers are used as a “home-brew “substitute to bestow a bitter flavor, and also as a tonic. A red dye is extracted from the fruit (1).In India seeds are used as fish poison (8)

PHYTO-CHEMISTRY:

The knowledge of individual chemical constituents of a medical plant is essential for optimizing extraction procedures, understanding pharmacological activity as well as potential toxicity. In general the species contains di- and triterpenes, saponins, flavonoids and a complex mixture of other phenolic compounds. It is that any therapeutic activity in the herb is associated with polyvalent pharmacological effects brought on by synergistic combination of several constituents rather than any single isolated one (9)

Ghilbert identified 23 flavones from seeds, bark, flowers and leaves of *D.viscosa*, characterized at c-3 and in almost 50% of cases , methoxylation at c-6(10).Many uses of herb by the indigenous people from various countries show remarkable similarities ,which in turn appear to correlate with the active constituents. Siddiqui’s 1988 review makes reference to eighteen flavonoids including glycosides of quercetin (eg.rutin) and isorhamnetin-these were isolated previously by Nair and Subramanian in 1975(11).Mata and co workers isolated sakuranetin from Mexican *D.viscosa* in 1991.Leucocynindns were reported by Sastry and Nayudamma in 1966.More recently Getie et al isolated relatively large concentrations of quercetin, kaempferol and isorhamnetin in *D.viscosa* crude leaf extract (12)

Previous chemical studies on this species resulted in the isolation and characterization of several flavonoids (13), diterpenoid acids (14,15),some biologically active saponins(16,8) and plant acids (17) a novel *P*-coumarin acid ester(18), essential oils(19),sterols(20,14) and tannins(17) from the aerial parts of *D.viscosa* and saponin esters from the seeds of *D.viscosa*(8).

Flavonoids of *Dodonaea viscosa* (21, 22, 23, 24, 25)

Common name	Chemical name	reference
Aliarin	5,7,4'-trihydroxy-3'- (3hydroxymet hylbutanol) 3,6- dimethoxyflavone	Sachdev & Kulshreshtha1983
pinocembrin	5,7-dihydroxyflavanone	Sachdev & Kulshreshtha1983
penduletin	5,4'-Dihydroxy-3,6,7- Trimethoxy flavone	Sachdev & Kulshreshtha1983
Viscosol	3'-(γ,γ -dimethyallyl)-5,7- dihydroxy-3,6,4'-trimethoxy flavone	Sachdev and Kulshreshtha,1986)
Sakuranetin	(S)-5,4'-dihydroxy-7- methoxyflavone	Mata et al.,1991)
Isokaempferide	3,5,7,4'-Tetrahydroxyl-3'- methoxyflavone	(Wollenweber, 1993)
Ermanin (Kaempferol 3,4'dimethylether)	3,5,7,4'-Tetrahydroxyl-3,4'- dimethoxyflavone	(Wollenweber, 1993)
	3,5,7,4'-Tetrahydroxy-7- methoxyflavone	(Wollenweber, 1993)

Cirsimaritin (Scutellarein 6,7-Dimethoxy flavone)	5, 4'-Dihydroxy-6,7- dimethoxyflavone	(Wollenweber, 1993)
Pectolinarigenin(Scutellarein 6,4'- Dimethoxy flavone)	5, 7 -Dihydroxy-6, 4'- dimethoxyflavone	(Wollenweber, 1993)
Kaempferol7,4'-dimethylether	3,5-Dihydroxy-7,4'- dimethoxyflavone	(Harborne,1999)
Kaempferol3,7,4'- trimethylether	5-Hydroxy-3,7,4'- trimethoxyflavone	Harborne & Baxter 1999
Santin	5,7-dihydroxy - 3,6,4'3'tetramethoxy flavone(trimethoxy flavone)	Sachdev &Kulshreshtha1983 Harborne &Baxter 1999
Acacetin7- methyl ether	5 hydroxy -7,4'- dimethoxyflavone	(Abdel-Mogiset al. , 2001)
6 Hydroxy kaempferol – trimethyl ether (Penduletin?)	6 Hydroxy– 3,6,7 trimethoxy flavone	Wollenweber & Roitman2007
Kaempferol3 – methyl ether	5,7,4'Trihydroxy-3- methoxyflavone	Wollenweber& Roitman2007

Essential oils and extracts obtained from the leaves exhibited antibacterial and hypotensive activities. Aqueous and alcoholic extracts were found to exhibit cardiac depressant and coronary-constricting properties, and slight antihelmintic activity. A saponin mixture from the seeds has been shown to have phagocytosis enhancing, analgesic and molluscicidal (including against the schistosomiasis-transferring snail *Biomphalaria glabrata*) properties. The use of the seeds as a fishpoison is supported by the presence of triterpene, saponins.

A number of 3-methoxy flavones derived from quercetin and kaempferol in the seeds, bark, inflorescences and leaves exhibited pronounced antiviral activity and were active in tissue cultures against polio-, rhino- and picorna-viruses. Spasmolytic activity could arise from the presence of some diterpenes, sakuranetin, quercetin and rutin in the seeds, bark, inflorescences and leaves. A chloroform-methanol extract from aerial parts was found to inhibit the spontaneous contraction of the intestinal smooth muscle of isolated rat and guinea-pig ileum in a concentration-dependent manner. This could explain the use of *Dodonaea viscosa* preparations to alleviate gastrointestinal disorders. The isolated coumarin fraxetin has attracted some attention as an anti-oxidant, and it displayed analgesic properties in tests with mice. In addition, various extracts of *Dodonaea viscosa* showed insecticidal activity against the cotton leaf worm *Spodoptera littoralis*. (26, 27)

PHARMACOLOGY

a) Antimicrobial

The antimicrobial activity of aqueous, methanol, ethanol and ethyl acetate leaf extracts of *Dodonaea viscosa* var. *angustifolia*, were tested against *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Candida albicans* and *Mycobacterium smegmalis*. Better activity was observed in the liquid dilution assay with all extracts, the ethanolic and methanolic extracts of *D. viscosa* showed good inhibition against *S. aureus*, *M. smegmalis* with minimum inhibitory concentration (MIC) value of 2.5 mg/ml and 1.25 mg/ml respectively in the bioassay. In disc diffusion study ethanolic extract of *D. viscosa* showed inhibition against *Candida albicans*. (27, 28, 29)

b) Antibacterial

The crude ethanolic extract and n-hexane, dichloromethane, ethyl acetate, n-butanol and aqueous fractions of *D.viscosa* were analyzed for antibacterial potential against four Gram positive bacteria: *Bacillus subtilis*, *Bacillus aereus*, *Micrococcus lutes*, *staphylococcus aureus*, and three Gram negative bacteria: *Escherichia coli*, *Salmonella typhi*, and *Pseudomonas aeruginosa*. Preliminary screening showed inhibition against *Staphylococcus aureus*, *Micrococcus luteus*, *Escherichia coli* and *Pseudomonas aeruginosa*. The thin layer chromatograms of fractions showed inhibition zone at different R_f values against *Bacillus subtilis*, *Micrococcus luteus*, *Escherichia coli*, *Salmonella typhi* and *Pseudomonas aeruginosa* indicating the presence of antibacterial components.

D.viscosa fractions showed good activity against *B. subtilis*, with prominent inhibition zones for the n-hexane (two zones of inhibition), ethyl acetate (one zone of inhibition) and n-butanol (one zone inhibition) extracts. Minimum inhibition concentrations (MICs) of the crude fractions were found to be within the range of 5-20.0mg/mL. The high levels of MICs of the fractions are attributable to the facts that the active components present that serve as growth promoters for the bacteria, thereby, necessitating the presence of high amount of the fraction to inhibit the growth. The n-hexane fraction found to show higher bactericidal potential as compared to the ethyl acetate and n-butanol fractions (30)

c) Antiulcer

Preliminary phytopharmacological investigations of *Dodonaea viscosa* leaves revealed the presence of flavonoids, tannins, sterols, bitter principles, phenols and saponins and showed promising antiulcer activity. Among the conducted bioactivity –guided fraction studies of *D.viscosa* using various experimental gastric ulcer models, ethyl acetate extract exhibited higher ulcerative lesion index, Increased serum calcium level and Decreased alkaline phosphatase activity in all experimental models. Hexane extract at a dose 500mg/kg exhibited 90% and 92% protection against ethanol induced and indomethacin induced gastric lesions respectively and also inhibited acid secretion to prevent ulcer aggravation.(31,32)

d) Wound healing

Ethanol extract of dried leaves showed potent wound healing activity in excised and incised wound model in rats. In excision model, 10% extract treated wounds were found to have faster rate of wound contraction and epithelization. Suspension and ointment of ethanol extract produced a significant response in wound models like breaking strength of skin, granuloma and wound contraction and also found to overcome the anti-healing properties of dexamethasone.(33)

e) Antioxidant

All the extracts are able to reduce peroxidation, however hot water extracts have the most potent antioxidant capacity in both the spectrophotometer and micro plate methods, despite containing low flavonoid levels. In the assay of spectrophotometer, antioxidant activities are expressed as percentage inhibition of control rate of oxidation i.e. %oxidation. The hot water extracts showed 95% inhibition at 4%, 92% inhibition at 2% and the result came from the 4% ethanol extract, which produced a mean inhibition rate of 96%. In micro plate assay hot water extracts showed highest inhibition rate (82%) at 5mg/ml (34). The methanolic extract of *D.viscosa* showed a high effective free radical scavenging in the DPPH assay and exhibited remarkable antioxidant (50%) effect at low concentration of 50µg/ml. This extract exhibited 94.29% and 92.45% radical scavenging activity at a dose of 500µg and 1000µg/ml respectively; hence provide prophylaxis against various diseases like heart diseases, arteriosclerosis and cancers. (27, 35)

f) Anti-inflammatory

The extracts of the *D.viscosa* were found to show effective against inflammation, inhibiting 30% to 60% of edema. 50% of ethanol extract in the dose of 1000mg/kg exhibited maximum 56.67% anti-inflammatory effects with carragenan induced edema in the hind paw of rats equivalent to inhibition by 100mg/ml of phenyl butazone (66%) given intra-peritoneally. Even the water extracts in the dose of 100mg/kg exhibited significant anti-inflammatory activity within carragenan induced rat paw edema method. (36, 37, 38)

g) Analgesic and Antipyretic activity

Ethanollic extract of the seeds of *Dodonaea viscosa*, upon preliminary photochemical screening, showed the presence of alkaloids, saponins and carbohydrates. The extract showed significant CNS depressant activity at the dose level of 30 mg/kg, when compared with morphine sulphate, diazepam and phenytoin as standard drugs. Significant analgesic and anticonvulsant activities were also observed at the same dose. In vivo analgesic activity was demonstrated in the mouse acetic acid-induced writhing test and hot plate method. Water extract of *D. angustifolia* (50–200 mg/kg, i.p.) dose dependently and significantly inhibited the writhes induced by 2% acetic acid. It shows antipyretic activity in the rat (LP-induced rectal temperature increase) at a concentration of 100.0mg/kg.

h) Other activities

Application of leaf decoction of *D.viscosa* for tooth ache has been tested on patients by an herbal physician and hence used as a mouth wash(41) and was found to show anti fungal activity on *Candida albicans* from HIV infected patients (42), (41). *D.viscosa* yet to be reported for its anti malarial use as traditionally the fresh leaf infusion was used for malaria (43).

CONCLUSION

In recent years ethno medicinal studies received much attention on natural resources to light the numerous medicines, especially of plant origin which needs evaluation on modern scientific lines such as phytochemical analysis, pharmacological and clinical trials. The reported phytochemical and pharmacological studies on this plant support its traditional uses and may prove to be useful for clinical evaluation and development of drugs.

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CURRENT AUTHOR ADDRESSES:

*Department of Pharmacognosy

The Vignan Institute of Pharmaceutical Science

Deshmukhi, Nalgonda, A.P, India

**Centre for Pharmaceutical Sciences, JNTU Institute of Science and Technology, kukatpally, Hyderabad-85