

## Dodonea Viscosa Linn: Its Medicinal, Pharmacological and Phytochemical Properties

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**ABSTRACT:** Herbal medicine is the oldest form of health care known to mankind. Herbal medicines have great importance in maintaining the health of every person. Demands of Herbal medicines are increasing in both developed and developing countries due to growing recognition of natural plants being lesser or of no side effect, easily available in surrounding place with low cost. Different parts of the plant have different active constituents and these active constituents may vary in their extent of activity and concentration. Most of active principles are existing in leaves, flower, fruit, bark, root and seeds of the plant. Certain herbs have become popular over the last twenty years, but herbal medicine is still poorly understood by the public, medical practitioners and the media. Nigeria is not left behind most of the world in this endeavor of utilizing herbal medicine. *Dodonea viscosa* is often used traditionally to treat many diseases like fever, cold, malaria, rheumatism, aches, toothaches, headaches, indigestion, ulcers, diarrhea, constipation, dysmenorrheal and irregular menstruation. The plant is reported to contain alkaloids, flavonoids, saponins, tannins, steroids, triterpenoids, phytosterols and volatile oil. This review was aimed at describing the medicinal uses, phytochemical components and other important aspects of the plant.

**KEYWORDS:** Antimicrobial, Antioxidant, Antidiabetic, Anti-inflammatory, *Dodonea Viscosa*.

### 1 INTRODUCTION

Many drugs commonly used today are of herbal origin. Indeed, about 25% of the prescription drugs dispensed in the United States contain at least one active ingredient derived from plant material [1]. Some are made from plant extracts; others are synthesized to mimic a natural plant compound. Undisputedly, the history of herbology is inextricably intertwined with that of modern medicine. Many drugs listed as conventional medications were originally derived from plants. Salicylic acid; a precursor of aspirin, was originally derived from white willow bark and the meadowsweet plant. Cinchona bark is the source of malaria – fighting quinine. Vincristine, used to treat certain types of cancer, comes from periwinkle [1]. The opium poppy yields morphine, codeine, and paregoric, a treatment for diarrhea laudanum, a tincture of opium poppy, was the favored tranquilizer in Victorian times. Even today, morphine – the most important alkaloid of the opium poppy – remains the standard against which new synthetic pain relievers is measured [1]. Hence, this review was aimed to provide the research studies done on the plant *Dodonea viscosa* to reveal its application in the pharmaceutical products and processes.

### 2 ETHNOMEDICINAL USES OF DODONEA VISCOSA (L)

*Dodonea viscosa* (L): Commonly known as pribet (Hausa) has many medicinal properties and has been used by native peoples from all regions where it is found. It is traditional medicine worldwide, administered orally or as poultice to treat great variety of ailments ([2]-[3]). The stems and leaves are used to treat fever and seeds in sore throat; root infusion to treat cold, and seeds (in combination with those of other plants and coated in honey) to treat malaria. The stems are used

fumigants to treat rheumatism ([2]-[3]). The leaves are used to relieve itching, fevers, swellings, aches and can be used as antispasmodic agent [4], leaves and roots as painkiller to soothe toothaches and headaches [5], and lotion made from unspecified plant parts to treat sprains, bruises, burns and wounds. Digestive system disorders, including indigestion, diarrhea and constipation are commonly treated in traditional medicine with an orally administered decoction of either leaves or roots ([2]-[3]). Trachoma is treated with applications of leaf juice, and powdered leaves are given to expel roundworms ([2]-[3]). 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 ([2]-[3]). The flowers are used as a "home – brew" substitute to bestow a bitter flavor, and also as tonic. A red dye is extracted from the fruit [6]. In India seeds are used as fish poison [7].

This evergreen shrub or small tree is widely diffused and in Jamaica is known as switch-sorrell [8]. According to Bennett it is called 'Apri' in Tahiti and fillets of it were once used for binding round the heads and wrist of victors after a battle. In India *D. viscosa* does not appear to be described by Sanskrit writers, but amongst the people, it has a certain amount of reputation as a febrifuge. It is believed that the powdered leaves applied over a wound will heal without leaving a white scar. The powder is used in burns and scalds. The leaf is said to be useful in rheumatism and to possess febrifugal properties. It is used in snake bite. For this purpose the leaves are also given internally. In South Africa the plant is used for many diseases, but particularly for stomach disorders [9]. In Madagascar, the bitter leaves are used as a febrifuge; the wood in decoration as an astringent bath or fermentation. In La Reunion an infusion of leaves is used as a sudorific, a popular panacea for gout and rheumatism. In Peru the leaves are chewed, as a stimulant. The leaves are not an antidote to snake, and are useless in the symptomatic treatment of snake bite [9].

#### **PROFILE OF PLANT**

*Dodonea viscosa* Linn

English name

Native name (Hausa) Pribet

Classification

Kingdom Plantae

Division Spermatophyte

Sub-Division Angiospermae

Class Dicotyledonae

Sub-class Magnoliales

Order Sapindales

Family Sapindaceae

Genus *Dodonea*

Species *viscosa*

#### **DISTRIBUTION**

*D. viscosa* Linn-is a shrub of flowering plant in the soapberry family, Sapindaceae, that has cosmopolitan distribution. The centre of origin 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, Virginia Islands, Florida, Arizona, South America and elsewhere [3].

#### **DESCRIPTION**

The plant *D. viscosa* is a dioecious or monoecious multi stemmed shrub or single stemmed small tree up to 7m tall; blackish, of variable roughness, thin and exfoliating in long thin strip; twigs blacks 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 2.5mm long, or absent; blade oblanceolates or broadly to narrowly elliptical, 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 exudates, with a conspicuous midrib on both sides and 15-20 often indistinct pairs of lateral veins [3]. *Dodonea viscosa* flowers are inconspicuous, with no petals. These flowers occur during spring and summer and are less than a centimeter in size. The plants are dioecious; i.e. the flowers are male or female and usually on separate plants [10]. The pollen is wind dispersed. However, fertilization does not need to occur for capsules to mature. Fertilized capsules can take up to 11 months to mature with unfertilized capsules maturing faster. Over this time the will change colour from a green or cream colour through to a brilliant red. These winged capsules are only produced on female or bisexual flowers and are approximately 2cm<sup>2</sup> in size [10].

The seven sub-species of *Dodonea viscosa* are *D. viscosa* subsp. *angustifolia*, *D. viscosa* subsp. *angustissima*, *D. viscosa* subsp. *burmanniana*, *D. viscosa* subsp. *cuneata*, *D. viscosa* subsp. *mucronata*, *D. viscosa* subsp. *spatulata* and *D. viscosa* subsp. *viscosa*. These sub-species each have a distinct habitat and can handle varying degrees of drought. The major differences of the sub-species are in distribution, form and leaf characteristics. It is best to plant the sub-species found in the local area; this species will have adapted to these particular environmental conditions [11]. As an example, *D. viscosa* subsp. *mucronata* is mainly found in central Australia but also has populations in Western Australia, Queensland and New South Wales. It naturally occurs in arid regions, particularly in rocky areas. *D. viscosa* subsp. *mucronata* grows well in rocky or sandy soils. *D. viscosa* subsp. *muronata* is an erect to spreading shrub growing from 1.5 to 4 metres tall. The leaves are sticky leathery. The foliage is evergreen, with the leaf shape usually spatulate (spoon-shaped). In general, *D. viscosa* is an extremely hardy species and is able to resprout from the base. The stand-out horticultural features of this species is the brilliant colour of the capsules. Other desirable features include its successful use as a hedge due to the dense habit. There is also a popular non-native form with purple foliage, referred to as *Dodonea 'purpurea'* [11].

*D. viscosa* can be easily propagated from cuttings and seeds. Cuttings are often preferred to guarantee a female plant with the colourful capsules. The optimum cutting material is young growth that has just firmed. It is best to then use a rooting hormone. Straight perlite may be used as the medium or as a mixture with peat or coconut fibre [10]. If seeds are used for propagation a treatment of soaking in very hot water prior to sowing will assist germination. This species prefers well-drained soils and requires a well-lit area. It can tolerate part shade but the capsules will not be as spectacular in colour if shaded. This species can tolerate dry conditions and can also handle some frost. Little maintenance is necessary. However, regular tip pruning will promote growth and branching. Scale may be an issue due to the viscous leaves. If this is the case, an application of white oil is an effective remedy [10].

**NAMING MEANING:** *Dodonea*- named after a Flemish botanist of the 16<sup>th</sup> Century, Rembert Dodoens. *Viscosa*- from the Latin term *viscosus* meaning sticky.

### 3 PHARMACOLOGICAL PROPERTIES

#### ANTIBACTERIAL PROPERTIES

The essential oil from *Dodonea viscosa* has been found to exhibit antibacterial activity and effectively inhibit *Staphylococcus albus* [12]. The alcoholic extract of *D. viscosa* exhibits antibacterial properties [13]. The antibacterial activity of *D. viscosa* was investigated among some Yemeni traditional medicinal plants [14], it was found that *D. viscosa* was one of the most active plants tested. The essential oil from *Dodonea viscosa* was tested for antimicrobial activity against seven Gram positive and three Gram negative bacteria by the zone inhibition method. The oil showed effective antibacterial activity against *S. aureus* and was not inhibitory to *micrococcus flavus* and *sarcina lutea* [15]. The crude extract of *Dodonea viscosa* has inhibitory effects against *Staphylococcus aureus*, *Streptococcus pyogenes* and *Corynebacterium diphtheriae*. But has no activity against *Escherichia coli* and *Pseudomonas aeruginosa*, thereby suggesting potential against notable Gram positive organisms [16].

According to [17] the *Vibrio cholerae* was controlled by all parts of *Dodonea viscosa* extracted through all the three types of solvent used. Maximum zone of inhibition was recorded by the methanol extract of stem against the bacteria. Similarly, the bacteria *Bacillus subtilis* was controlled by all the extracts except that of methanol extract of root. The root extract of the weed showed no efficacy against the bacteria, *Escherichia coli* and *Proteus mirabilis*. The ethanolic extract of *Dodonea viscosa* inhibited the growth of micro-organisms like *S. aureus*, *Streptococcus agalactiae*, *Agrobacterium tumefaciens*, *Erwinia carotovora* at the studied concentration, but *P. aeruginosa* and *E. coli* showed resistance to this extract at a concentration of 2.5mg/ml [18]. The leaf extracts of *Dodonea viscosa* showed antibacterial activity against *E. faecalis*, *E. coli*, *S. aureus* and *P. aeruginosa*, and the MIC was as low as 0.02mg/ml [19]. The aqueous boiled, aqueous infusion, ethanol and methanol extract of *Dodonea viscosa* plant shows antibacterial activity against *S. aureus*, *P. aeruginosa* and *Mycobacterium smegmatis* [20]. The ethanolic extract of *D. viscosa* leaf has anti-bacterial effect against *Salmonella species* and *Aeromonas hydrophila* [21].

#### **ANTIFUNGAL PROPERTIES**

The in vitro antifungal activity of some selected medicinal plant (*Adhatoda zeylanica*, *Azadirachta indica*, *Capparis decidua*, *Dodonea viscosa* and *Salvadora oleoides*) against *Alternaria solani*, *Rhizoctonia solani* and *Macrophomina phaseolina*, overall, *Dodonea viscosa* appeared significantly the most effective and suppressed the radial mycelial growth of the *Alternaria solani* and *Rhizoctonia solani* [22]. The methanol extract of leaf of the plant showed maximum activity against the fungi, *Curvularia lunata* and *Fusarium oxysporum* [17]. The methanol extract of root of *Dodonea viscosa* plant showed maximum activity against the fungus, *Aspergillus flavus* [23]. Similarly, it was the methanolic extract of stem of the plant which showed maximum activity against the fungus, *Penicillium citrinum*. However no significant level of activity was recorded against the fungus *Aspergillus niger* by any of the extracts studied. Antifungal activity of solvent extracts of leaves and shoot of *Dodonea viscosa* Jacq have been determined against fungi, *Aspergillus niger*, *Aspergillus flavus*, *Paecilomyces varioti*, *Microsporum gypseum*, and *Trichophyton rubrum* causing skin diseases. All crude extracts were found to be effective against tested fungi. However chloroform has strong inhibition activity against fungi as compared to ethanol, methanol, ethylacetate and aqueous extracts. The aqueous boiled, aqueous infusion, ethanol and methanol extract of *Dodonea viscosa* plant shows antifungal effect against *C. albicans*. While the yeast *Candida albicans*, Conidiophore *Aspergillus fumigatus* and dermatophyte *Trichophyton rubrum* were not inhibited [20]. More recently antifungal activity of *Dodonea viscosa* against 40 *C. albicans* isolates was reported [24]. It was reported that *C. albicans* shows resistance to *D. viscosa* extract at a concentration of 2.5mg/ml [18].

#### **ANTIVIRAL PROPERTIES**

Coxsackie virus B3 and influenza A virus were inhibited by *D. viscosa*, demonstrating the antiviral potential [16].

#### **ANTHELMINTIC PROPERTIES**

Both the extracts (aqueous and alcoholic) of *D. viscosa* possess slight anthelmintic activity [13].

#### **ANTI-INFLAMMATORY PROPERTIES**

According to [25] the aqueous and ethanolic extracts of *D. viscosa* has anti-inflammatory activity by testing the paw edema of rats when they received 600 and 800 mg/kg, respectively, inhibiting edema in 83.56% after 30 minutes and 55.98% after one hour. The ethanol extract of leaves of *D. viscosa* administered orally, inhibited the formation of granuloma tissue in rats, confirming anti-inflammatory activity [26]. The anti-inflammatory effect of the dichlorometane extract of *D. viscosa* was tested at doses of 3 mg/ear on a TPA-induced edema model, where it displayed a significant inhibition of 97.8% of the edema [27]. *Dodonea viscosa* has also shown anti – inflammatory effects in the experimental animals [28].

#### **ANTI-OXIDANT PROPERTIES**

Data from *in vitro* models of various structurally different flavonoids demonstrate antioxidant efficacy in relation for many conditions of oxidative stress. According [29] the extract of *D. viscosa* leaves exhibits antioxidant activity by the method of capture of the radical 2, 2 diphenyl picryl hydrazine (DPPH), and were attributed to flavonoids such as kaempferol isolated from the sample, which confirms the reasons for use in the treatment of infections in traditional medicine. The antioxidant activity of *D. viscosa* was investigated among some Yemeni traditional medicinal plants [14], it was found that *D. viscosa* was one of the most active plants that showed high free radical scavenging activity. *In vivo* analgesic activity was demonstrated in the mouse (acetic acid-induced writhing test and hot plate method) and antipyretic activity in the rat (LP-induced rectal temperature increase) [30]. The polar fraction of *D. viscosa* has potent antioxidant activity in STZ-induced diabetic rats [31]. The leaf extracts of *Dodonea viscosa* also had some antioxidant activities, as demonstrated by free radicals scavenging effect on DPPH [19].

#### **ANTIDIABATIC PROPERTIES**

The aqueous, ethanol and butanol extracts have shown significant reduction in blood glucose levels in both glucose loaded and alloxan induced diabetic rats [32]. The butanol extract produced maximum anti-diabetic activity and is higher than the hypoglycemic activity of glibenclamide in the diabetic rats [32]. The polar fraction of *D. viscosa* has potent antidiabetic and hypolipidaemic activity in STZ-induced diabetic rats [31].

### LARVICIDAL PROPERTIES

The aqueous extract of *Dodonea viscosa* leaf showed 100 % lethality against the larvae at the concentration of 1 %. Similarly aqueous extract of *Dodonea viscosa* root showed 100 % lethality of larvae at the concentration of 1.5 %. The methanol extract of stem of *Dodonea viscosa* at the concentration of 2 % showed 100 % lethality of larvae [17].

### MOLLUSCIDAL PROPERTIES

A mixture of saponins ester consisting of Dodonosides A and B isolated from the seeds of the plant exerts antiexudative, phagocytosis-enhancing the molluscidal activity [7].

### SPASMOlytic PROPERTIES

The aqueous and alcoholic extracts of the leaves of this plant exhibits Cardio-inhibitory and coronary constricting properties and spasmolytic activity on smooth muscles and intestine. The alcoholic extract is more effective than aqueous extract in counteracting the spasms induced by BaCl<sub>2</sub>, histamine acid and phosphate, and acetyl choline [13].

### ANTI-DIARRHEAL PROPERTIES

The alcohol and aqueous extracts of *D. viscosa* root significantly reduced diarrhea in mice with reduction in weight of stools [33].

## 4 PHYTOCHEMISTRY OF *DODONEA VIScosa* (L)

Knowledge of individual chemical constituents of a medicinal plant is essential for optimizing extraction procedures, understanding pharmacological activity as well as potential toxicity and interaction with pharmaceutical drugs. The species in question has been subjected to numerous analytical studies over the last 40years-however most of these were conducted outside Nigeria. *D. viscosa* flowers harvested in India were analyzed for the presence of some phytochemical components [34]. In their analysis of flowers harvested in Libya [35], concentrated on the composition of volatile oil and sterols. In general the species contains di and triterpenes, saponins, flavonoids and a complex mixture of other phenolic compounds. It is likely that any therapeutic activity in the herb is associated with polyvant pharmacological effects brought on by the synergistic combination of several constituents rather than any single isolated one [36].

A comprehensive review of the chemistry of the *Dodonea* genus, with particular emphasis on *D. viscosa* was carried out [34]. However there are few references to subspecies. He identified 23-flavones from seeds, bark, flower and leaves of *D. viscosa*, characterized by oxygenation at C-3 and, in almost 50% of cases, methoxylation at C-6 [37]. A review of the chemistry and pharmacology of the species was done [38]. It was observed that many uses of the herb by indigenous people from various countries show remarkable similarities, which in turn appear to correlates with the known active constituents [37]. The major investigation of flavonoids was conducted by [39], who isolated eight compounds, providing UV,MS and HNMR data for these flavonoid [39]. A research review makes reference to eighteen flavonoids including glycosides of quercetin (e.g. rutin) and isorhamnetin-these were isolated previously by [38]. Sukuranetin, and 6-hydroxykaempferyl-3, 7-diameyethyl ether were isolated from Mexican *D. viscosa* [40]. These compounds had not previously been found in *D. Viscosa*. Leucocyanidins were reported by [41] and [34]. The methanolic extract of *D. viscosa* contains bioactive compounds like flavonoids, terpenoids, tannins, and volatile oil [14]. The ethanolic extract of *D. viscosa* leaf contains photochemical like alkaloids, flavonoids, saponins, steroids, triterpenoids and phytosterols [21]. Tannins, saponins, flavonoids and terpenoids were detected from the aqueous extract of all the plant parts [17], [42], also reported the presence of flavonoids, terpenoids, tannins and steroids. Four flavonoids were isolated from dichloromethane fraction of crude *Dodonea viscosa* leaf extracts like ( 5-hydroxyl-3,7,4-trimethoxyflavone, 5,7-dihydroxy-3,6,4-trimethoxyflavone, 3,6-dimethoxy-5,7,4- trihydroxyflavone, 4-O-methylkaempferol ) [19].

## 5 CONCLUSION

The fact that the plant possesses many medicinal, traditional, and pharmacological uses makes it a very useful plant, and the extracts could be useful in therapeutic treatment, but this has to be substantiated by in vivo experiment.

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