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A REVIEW ON DODONAEA VISCOSA

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ABSTRACT

Dodonaea viscosa (L.) Jacq., a member of the Sapindaceae family, is an important medicinal shrub widely distributed in tropical and subtropical regions. It has been extensively used in traditional medicine for the treatment of fever, wounds, inflammation, rheumatism, gastrointestinal disorders, skin diseases, and various infections. The plant is rich in biologically active phytochemicals, including flavonoids, terpenoids, saponins, tannins, steroids, phenolic compounds, and essential oils, which contribute to its diverse pharmacological properties. Phytochemical evaluation using Soxhlet extraction and High-Performance Thin-Layer Chromatography (HPTLC) confirms the presence of several bioactive constituents, particularly flavonoids. Experimental studies have demonstrated significant antibacterial, antioxidant, anti-inflammatory, wound-healing, hepatoprotective, antidiabetic, antiulcer, anthelmintic, antidiarrheal, analgesic, anticonvulsant, and anticancer activities. Recent research also highlights the potential of *Dodonaea viscosa*-derived nanoparticles in enhancing therapeutic efficacy. Although substantial preclinical evidence supports its traditional use, further investigations, including toxicity evaluation, clinical trials, and isolation of active compounds, are required to establish its safety and therapeutic potential. Overall, *Dodonaea*

viscosa represents a promising source of novel phytopharmaceuticals and warrants continued research for future drug development.

MEDICINAL PLANTS

According to the World Health Organization, "a medicinal plant is any plant which, in one or more of its organs, contains substances that can be used for therapeutic purposes, or which are precursors for chemo-pharmaceutical semi synthesis".

Medicinal plants are presently in demand and their acceptance is increasing progressively. Undoubtedly, plants play an important role by providing essential services in ecosystems. Without plants, humans and other living organisms cannot live in a way living should be. Anyway, herbals especially medicinal herbs have constantly acted as an overall indicator of ecosystem health.[1]

Medicinal plants have undoubtedly been considered by human beings since ancient times. It can be said that before the history and since the early humans recognized and exploited the plants around them for use as fuel, clothing, shelter and food, they became aware of their properties more or less. Medicinal plants have been transformed into one of the oldest sciences in countries such as China, Greece, Egypt and India. In ancient Persia, plants were commonly used as a drug and disinfectant and aromatic agents.[2]

In fact, the use of medicinal plants for the treatment of diseases dates back to the history of human life, that is, since human beings have sought a tool in their environment to recover from a disease, the use of plants was their only choice of treatment.[3] More than a tenth of the plant species (over 50 000 species) are used in pharmaceutical and cosmetic products. However, the distribution of medicinal plants across the world is not uniform and medicinal herbs are mainly collected from the wildlife population.[4] Indeed, the demand for wildlife sources has increased by 8%-15% per year in Europe, North America and Asia in recent decades.[5] The term medicinal plant refers to a variety of plants that have medicinal properties. These plants are a rich source of compounds that can be used to develop drug synthesis.[6] The parts of medicinal plants that may be used are different types of seeds, root, leaf, fruit, skin, flowers or even the whole plant. The active compounds in most parts of the medicinal plants have direct or indirect therapeutic effects and are used as medicinal agents. In the body of these plants, certain materials are produced and stored that are referred to as active compounds (substances), which have physiological effects on the living organisms.[7]

Human is mainly dependent on raw plant materials in order to meet medical needs to maintain health and cure diseases.[8] Medicinal plants are used for treatment because they have certain properties, including synergistic actions. The constituents of the plant may interact with each other, and this interaction can be beneficial for both or adverse to either of them or eliminate the harmful effects of both. Plant-derived compounds can dramatically improve hard-to-treat illnesses, such as cancer. Plant components are also characterized by their ability to prevent the development of certain diseases. The toxicity and adverse effects of conventional and allopathic medicines have also been important factors in the sudden increase in population demands and increase in the number of herbal drugs manufactures as well as a reduction in the use of chemical drugs.[6]

HISTORY OF USE OF MEDICINAL HERBS

Determining the exact time of using plants as drug is very difficult. Evidence indicates that plants have been cultivated as drugs approximately 60 000 years ago.[9] Scripts about medicinal plants date back to almost 5000 years ago in India, China and Egypt, and at least 2500 years in Greece and Central Asia.[10] Since ancient times, people have sought to cure their own illness using nature. As the use of animals was initially instinctive, such instinctive use was also applied to plants.[11] Given the fact that at that time there was insufficient information about the causes of the disease, useful plants for treating them, and the ways of using them for such purpose, everything was empirical. Over time, the reasons for the use of certain medicinal plants for treatment of certain diseases were discovered; consequently, the use of medicinal plants gradually rejected the empirical framework and was limited to the facts. The earliest written evidence of the use of medicinal plants for preparation of drugs has been found on a Sumerian clay slab from Nagpur dating back to nearly 5000 years ago.[12] According to some inscriptions, Egyptians and Chinese who used plants as medicine since more than 27 centuries BC were among the earliest human beings who did so.[13] Ancient Greek people were also familiar with the medicinal properties of some medicinal plants, and Hippocrates, the founder of Greek medicine and Aristotle, pupil of Hippocrates, used medicinal plants for the treatment of diseases. After that, Theophrastus, a Greek scientist, founded the School of Medicinal Plants. Then, Pedanius Dioscorides (He lived in the first century AD), a physician and surgeon in the years 75-45 BC, wrote an encyclopaedia, called De Materia Medica, to describe 600 therapeutic medicinal plants in the form of a series of scientific studies on medicinal plants.[14,16]

FUTURE PROSPECTS OF MEDICINAL PLANTS

There is a promising future of medicinal plants as there are about half million plants around the world, and most of them are not investigated yet for their medical activities and their hidden potential of medical activities could be decisive in the treatment of present and future studies. In the development of human culture medicinal plants have played an essential role, for example religions and different ceremonies. Among the variety of modern medicines, many of them are produced indirectly from medicinal plants, for example aspirin. Many food crops have medicinal effects, for example garlic. Studying medicinal plants helps to understand plant toxicity and protect human and animals from natural poisons. The medicinal effects of plants are due to secondary metabolite production of the plants. Keeping this in consideration there have been increased waves of interest in the field of research in natural product chemistry. This interest can be due to several factors, including therapeutic needs, the remarkable diversity of both chemical structure and biological activities of naturally occurring secondary metabolites, the utility of novel bioactive natural compounds as biochemical probes, the development of novel and sensitive techniques to detect biologically active natural products, improved techniques to isolate, purify, and structurally characterize these active constituents, and advances in solving the demand for supply of complex natural products. The importance of traditional medicine has also recognized by World Health Organization (WHO) and has created strategies, guidelines and standards for botanical medicines. For the cultivation, processing of medicinal plants and the manufacture of herbal medicines agro-industrial technologies need to be applied. Medicinal plants are resources of new drugs and many of the modern medicines are produced indirectly from plants.[17]

USES

Many drugs used to treat diseases like infections, heart conditions, and cancer are derived from plants or their derivatives. For example, aspirin, one of the world's most widely used pain relievers, comes from the bark of willow trees.

Herbal medicine, also known as botanical medicine or phytotherapy, involves using different parts of plants (leaves, roots, flowers, etc.) for their medicinal properties. There are tribal communities worldwide, living in dispersed groups in various landscapes.[18] Their economic, cultural, and social patterns vary across regions. For example; in India, the tribal population comprises 8.6% of the total population.[19]

These indigenous people possess deep knowledge of using plants for medicinal purposes, with Southeast Asian traditional healers utilizing nearly 6500 plant species. Tribal plants and their traditional medicinal uses have dominated the modern pharmaceutical industry's documentation.[20]

These plants exhibit inherent antimicrobial properties, which can be further enhanced through Silver Nanoparticles (AgNPs) synthesis. They also hold promise as sources for developing anti-cancer and antibiological drugs with minimal or no adverse effects.[21]

Rauwolfia serpentina is used by tribes as an antidote to snakebite, while its reserpine is utilized to treat hypertension. Artemisia annua, known for treating fevers, led to the discovery of artemisinin, an antimalarial drug.[22]

The choice of plant materials for research should consider their freshness and unique properties.[23] Various forest plants have specific characteristics, such as Catharanthus roseus with vincristine, Annona squamosa with toxic compounds, and *Cleistanthus collinus* with *Cleistanthin*-B harmful to fish. The tribal population also cultivates millets with distinct nutritional and toxicological aspects. Gathering and digitizing tribal knowledge and conducting laboratory research with the expertise of scientists is essential.[24]

DODONAEA VISCOSA

Dodonaea viscosa Linn is a shrub belonging to the 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.[25]

Figure 1: *Dodonaea viscosa.*

Dodonaea viscosa 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.[26] Leaves and roots as a painkiller to soothe toothaches and headaches and a lotion made from unspecified plant parts to treat sprains, bruises, burns and wounds.[27] Digestive system disorders, including indigestion, ulcers, diarrhoea 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 flavour, and also as a tonic. A red dye is extracted from the fruit. In India seeds are used as fish poison.[28]

The chemical analysis of *Dodonaea viscosa* (Sapindaceae), revealed that the plant contained flavonoids, fixed oil and fat, steroids, phenolics, saponins, tannins, gums, mucilage, carbohydrates, reducing sugar, and trace elements.[29]

SYNONYMS[30]

- *Dodonaea & arabica* Hochst. & Steud.
- *Dodonaea eriocarpa* f.
- *Dodonaea candolleana* Blume.
- *Dodonaea candolleana* var.
- *Ptelea viscosa*.
- *Dodonaea spatulata* Sm.
- *Dodonaea ovata* Dum. Cours.
- *Dodonaea pallida* Miq.
- *Dodonaea pauca* Herrera.
- *Dodonaea paulinia* Herrera.

VERNACULAR NAMES[31]

Table 1: Vernacular names.

SL. NO.	LANGUAGE	VERNACULAR NAMES
1	English	Broadleaf hopbush, Florida hopbush, Giant hopbush, Sticky hopbush, Hopshrub
2	Malayalam	Unnataruvi, Vrali
3	Tamil	Valari, Virali
4	Hindi	Aliar
5	Sanskrit	Sanatta, Aliar
6	Telugu	Bandaru
7	Punjabi	Ban-mendru, Dhasera Dawaka-jhar

TAXONOMICAL CLASSIFICATION[32]

Table 2: Taxonomical Classification.

KINGDOM	Plantae
DIVISION	Spermatophyta
SUBDIVISION	Angiospermae
CLASS	Dicotyledonae
SUBCLASS	Magnoliales
ORDER	Sapindales
FAMILY	Sapindaceae
GENUS	Dodonaea
SPECIES	viscosa

BOTANICAL DESCRIPTION

HABIT[33]

Dioecious or monoecious multi stemmed shrub or single-stemmed small tree.

LEAVES[33]

Leaves alternate, simple; stipules absent; petiole very short, up to 2.5 mm long, or absent; blade oblanceolate or broadly to narrowly elliptical, 4–13 cm × 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 often indistinct pairs of lateral veins.

FLOWERS[33]

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, 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.

FRUITS[33]

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.

SEED[33]

Seeds subglobulose, 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.

STEM[33]

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.

INFLORESCENCE[33]

Inflorescence a loose thyrsoid panicle at the end of twigs.

Figure 2: Leaves.

Figure 3: Flowers.

Figure 4: Fruits.

Figure 5: Stem.

MORPHOLOGICAL CHARACTERISTICS[33]

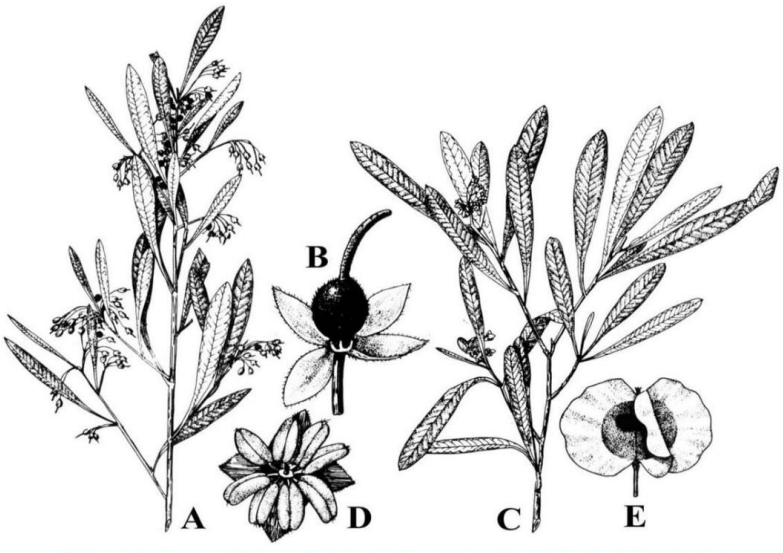


Figure 6: Morphological characteristics of *Dodonaea viscosa.*

A: Female branch; B: Female Flower; C: Male Branch; D: Male Flower; E: Fruit.

Table 3: Morphological characters.

Morphological characters of *Dodonaea viscosa*	
Flowers	Inflorescence panicled cymes, up to 7 cm long, terminal or axillary; flowers small, polygamous; pedicel up to 0.5 cm long.
Fruits	Capsule, membranous, compressed, with 3 wings.
Seeds	1-2, black.

MICROSCOPICAL STUDIES

MICROSCOPY OF LEAVES[34]

The leaf blade, on both the surface has abundant oil cavities, druse crystals and sessile multicellular glands in the form of small multicellular peltate scales. The leaves are hypostomatic and the epidermal cells on both the surfaces are polygonal without any undulations. Stomata are tetracytic with kidney shaped guard cells slightly projecting from the nearby unspecialized cells.

Lamina is bifacial and the adaxial epidermal cells are larger than the abaxial cells. Upper epidermal cells frequently modified into mucilaginous cells. Mesophyll tissue is highly chlorophyllated with square shaped palisade cells and 3-4 layered spongy tissue with reduced air spaces. Secretory cells filled with dark brown coloured secretions and druse crystals are present throughout the mesophyll tissue, in all the studied samples. Vein bundles are extended towards the upper and lower epidermis by collenchymatous tissue, making the bundle vertically transcurrent. Leaf margin having blunt end and slightly curved downwards. Midrib is slightly raised abaxially with ‘U’ shaped outline. Midrib bundles are closed and diagonal in appearance. Presence of druses and secretory cells throughout the midrib is a common feature in all the studied samples.

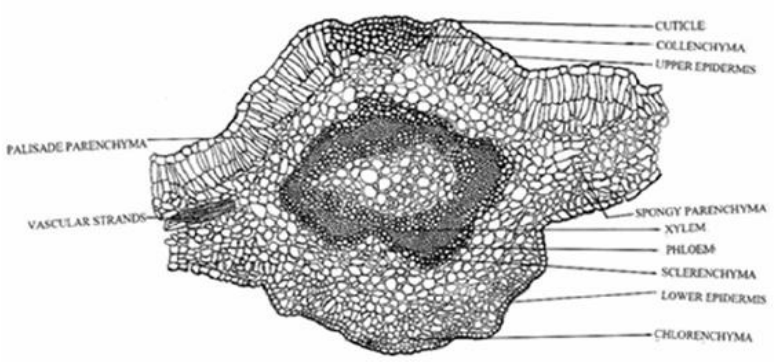


Figure 7: T S of leaf of *Dodonaea viscosa.*

Petiole is triangular in outline with two lateral wing like extensions. Peltate scales are present all over the petiolar surface. Petiole bundle is closed, triangular to omega shaped in outline and surrounded by sclerenchymatous sheath. Plenty of druses and secretory idioblastic cells are present throughout the ground tissue.

MICROSCOPY OF STEM[34]

In the transverse section, stem is terete in outline with growth boundaries marked by the presence of marginal parenchyma. Periderm is internal and originated from multilayered phellogen. In the Periderm tissue plenty of brownish yellow viscous secretion is present. A continuous wavy sclerenchymatous ring could be seen associated with the phelloderm. Vessel members are both solitary and grouped in radial multiplies of 2-4. Axial parenchyma is scanty paratracheal to vasicentric. Gum-like deposits present in some of the vessels. The tangential section reveals alternately arranged round shaped intervessel pits with slit like aperture, simple perforation pate, prismatic crystals in chambered axial parenchyma and the non-septate libriform fibers. Ray parenchyma composed of procumbent and sometimes square cells, infrequently with a marginal row of square cells.

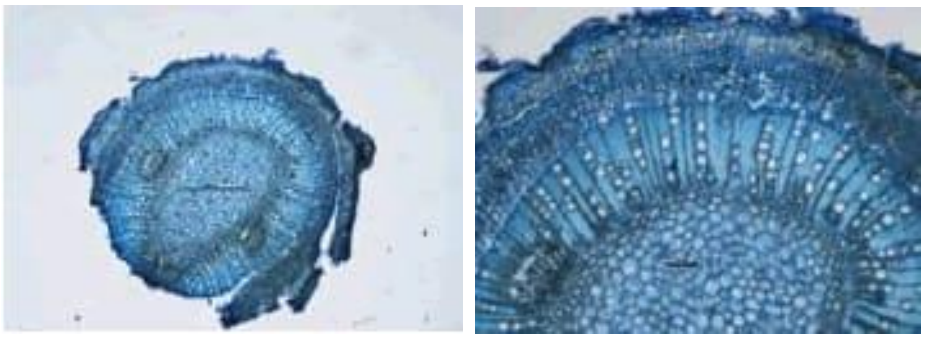


Figure 8: T S of stem of *Dodonaea viscosa.*

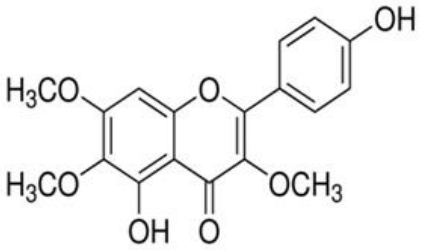
CHEMICAL CONSTITUENTS OF *DODONAEA VISCOSA*[32]

In general, the species contains di- and triterpenes, saponins, flavonoids, hautriwaic acid, viscosine and a complex mixture of other phenolic compounds. Previous chemical studies on this species resulted in the isolation and characterization of several flavonoids, diterpenoid acids, some biologically active saponins and plant acids a novel P-coumarin acid ester, essential oils, sterols and tannins from the aerial parts of *D. viscosa* and saponin esters from the seeds of *D. viscosa*.

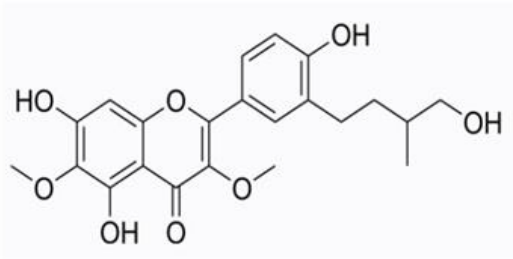
Flavonoids of *Dodonaea viscosa*

Table 4: Flavonoids of *Dodonaea viscosa.*

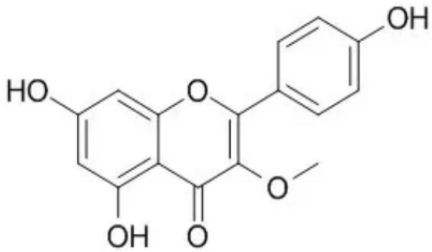
Common name	Chemical name
Aliarin	5,7,4’-trihydroxy-3’-3,6-dimethoxyflavone
Pinocembrin	5,7-dihydroxyflavone
Penduletin	5,4’-dihydroxy-3,6,7-trimethoxyflavone
Viscosol	3’-(γ, γ-dimethylallyl)-5,7-dihydroxy-3,6,4’-trimethoxyflavone
Sakuranetin	(S)-5,4’-dihydroxy-7-methoxyflavone
Isokaempferide	3,5,7,4’-tetrahydroxyl-3’- methoxyflavone
Ermanin	3,5,7,4’-tetrahydroxyl-3,4’-dimethoxyflavone
Cirsimaritin	5,4’-dihydroxy-6,7-dimethoxyflavone
Pectolinarigenin	5,7-dihydroxy-6,4’-dimethoxyflavone
Kaempferol7,4’-dimethylether	3,5-dihydroxy-7,4’-dimethoxyflavone
Kaempferol3,7,4’ trimethyl ether	5-hydroxy-3,7,4’-trimethoxyflavone
Santin	5,7-dihydroxy-3,6,4’,3’-tetramethoxyflavone
Acacetin7-methyl ether	5-hydroxy-7,4’-dimethoxyflavone
6-hydroxy kaempferol trimethyl ether	6-hydroxy-3,6,7-trimethoxyflavone
Kaempferol-3-methyl ether	5,7,4’-trihydroxy-3-methoxyflavone



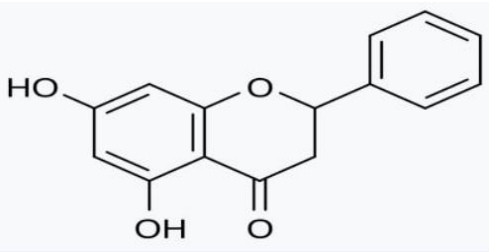
Aliarin



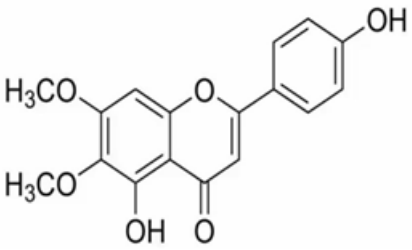
Penduletin



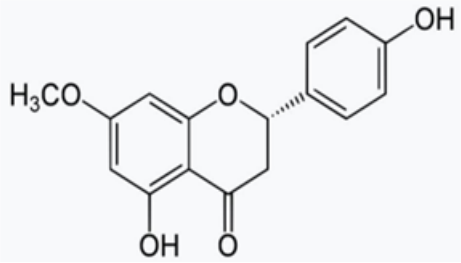
Pinocembrin



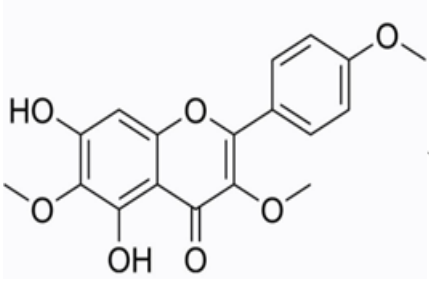
Isokaemferol



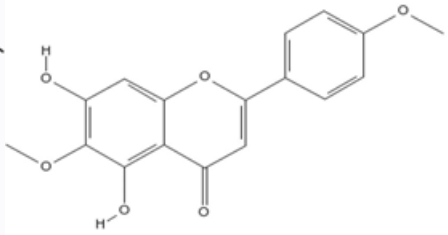
Cirsimaritin



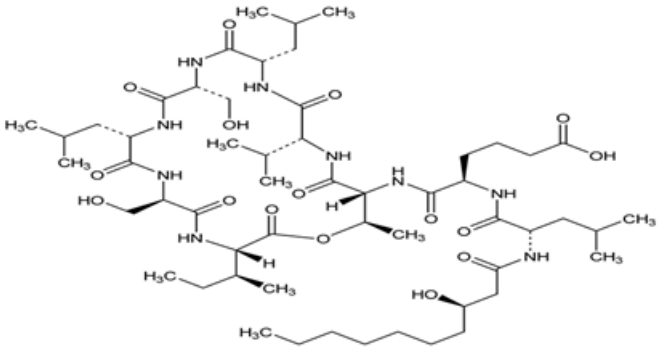
Sakuranetin



Santin



Pectolinarigenin



Viscosine

Figure 9: Flavonoids in *Dodonaea viscosa.*

TRADITIONAL USES OF *DODONAEA VISCOSA*[32]

- Antibacterial agent
- Wound healing property
- Anticancer agent
- Antioxidant agent
- Anti-inflammatory agent
- Anthelmintic agent
- Antidiabetic agent
- Antidiarrheal agent
- Antiulcer agent
- Analgesic and anticonvulsant agent

PHYTOCHEMICAL STUDIES[35,37]

The whole plant or organism serves as an active laboratory for the production of natural products from primary metabolites. Primary metabolites are the products of vital metabolic pathways such as respiratory chain, TCA cycle etc. Secondary metabolites are varieties of simple to sophisticated bizarre molecules. They are fascinating chemical molecules, very useful and of great importance in nature, as well as highly diversified in structures, properties, uses, chemistry etc.

Extraction

Soxhlet extraction is a piece of laboratory apparatus invented in 1879 by Franz von Soxhlet. It was originally designed for the extraction of a lipid from a solid material. Typically, Soxhlet extraction is used when the desired compound has a limited solubility in a solvent, and the impurity is insoluble in that solvent. It allows for unmonitored and unmanaged operation while efficiently recycling a small amount of solvent to dissolve a larger amount of material.

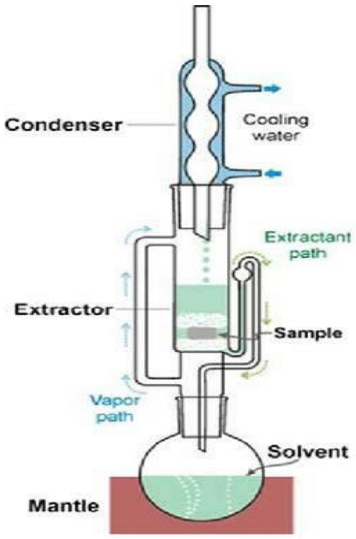


Figure 10: Soxhlet Apparatus.

OPERATION

The solvent is heated to reflux. The solvent vapour travels up a distillation arm, and floods into the chamber housing the thimble of solid. The condenser ensures that any solvent vapour cools, and drips back down into the chamber housing the solid material. The chamber containing the solid material slowly fills with warm solvent. Some of the desired compound dissolves in the warm solvent. When the Soxhlet chamber is almost full, the chamber is emptied by the siphon. The solvent is returned to the distillation flask. The thimble ensures

that the rapid motion of the solvent does not transport any solid material to the still pot. This cycle may be allowed to repeat many times, over hours or days.

During each cycle, a portion of the non‑volatile compound dissolves in the solvent. After many cycles the desired compound is concentrated in the distillation flask. The advantage of this system is that instead of many portions of warm solvent being passed through the sample, just one batch of solvent is recycled.

After extraction the solvent is removed, typically by means of a rotary evaporator. The extracted compound. The non‑soluble portion of the extracted solid remains in the thimble, and is usually discarded.

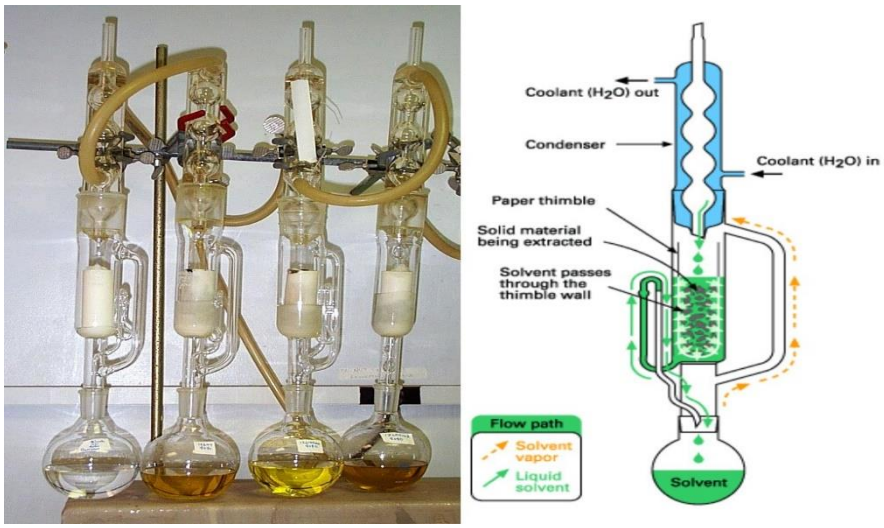


Figure 11: Working of Soxhlet Apparatus.

Procedure

The aerial parts of *Dodonaea viscosa* were collected, washed, shade-dried for 10–15 days, and ground into a coarse powder using a mechanical grinder. About 25 g of the powdered material was weighed and packed into a thimble made of Whatman No. 1 filter paper. The thimble was placed in the Soxhlet apparatus and 250 mL of methanol was added to the round bottom flask along with a few glass beads to prevent bumping. The extraction was carried out continuously at 65°C on a heating mantle for 8 hours until the solvent returning to the flask via the siphon tube became colourless, ensuring exhaustive extraction. The methanolic extract was filtered through cotton wool while still warm and evaporated to dryness under reduced pressure at 40–45°C using a rotary vacuum evaporator. The crude extract was transferred to a pre-weighed petri dish, dried in a desiccator, and the percentage yield was calculated. The

dried extract was stored in an airtight container at 4°C for further phytochemical and chromatographic studies.

High Performance Thin Layer Chromatography[38]

HPTLC is one sort of planar chromatography and the most advanced form of instrumental TLC, which is widely used as a cost-effective method for rapid analysis of sample mixture. In HPTLC sample application, chromatogram development, and detection are independent and widely used to standardize the methodology based on a validated method. The relative independence of sample application chromatogram development, and detection in time and location make possible the parallel analysis of many samples on the same plate. HPTLC is useful in the development of qualitative and quantitative evaluation techniques for the components present in any sample. It includes cutting-edge instruments controlled by a coordinated software programming, which ensures enhanced utility, reliability and reproducibility of the information produced. It is a flexible screening procedure with which both qualitative and quantitative analyses can be performed. HPTLC uses high-performance adsorbent layers (e.g., Silica gel with refined uniform particles, approximately 5µm in diameter, as compared to 12µm in TLC).

HPTLC Procedure[39]

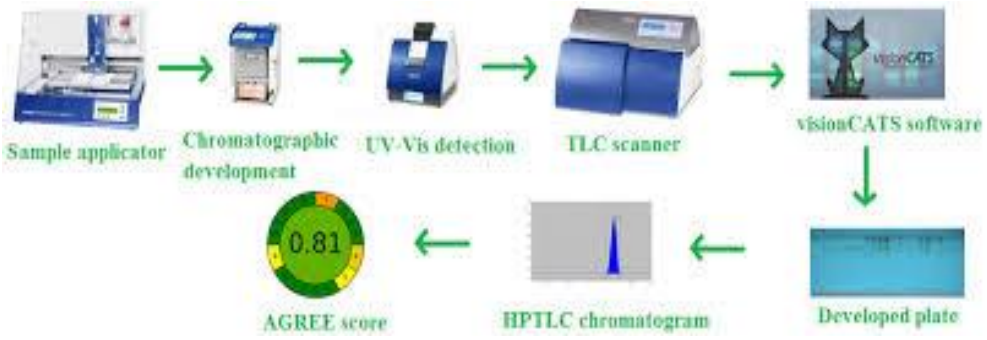


Figure 12: HPTLC.

High-Performance Thin-Layer Chromatography was performed on silica gel 60F254 (10 cm× 10 cm; 0.25 mm layer thickness; Merck). The extract was prepared in 10 ml volumetric flask by taking 250 mg of the extract and diluting with ethanol (25 mg/ml) and filtered using a 0.45 syringe filter from which 10 µl was subjected to HPTLC (CAMAG, Switzerland) analysis. The extract and standard samples were spotted on a silica gel 60F254 (Merck, Darmstadt, Germany) TLC plate. The plate was air-dried and then developed using the mobile phase Toluene: Ethyl acetate: Formic acid (5:4:0.2v/v) in a CAMAG Twin Trough glass chamber,

which was previously saturated with mobile phase vapor for twenty minutes. After developing, the plate was dried at 65°C for 2 minutes and then scanned using CAMAG Scanner 3 (CAMAG, Switzerland) at 254 and 365 nm using WinCATS 4 software.

PHYTOCHEMICAL ANALYSIS[40]

The ethanolic extract of *Dodonaea viscosa* were subjected to different chemical tests for the identification of various active phytoconstituents. The tests were as follows:

1. DRAGENDROFF'S TEST

About 1 ml of the extract was added with 1 ml of Dragendroff's reagent (potassium bismuth iodide solution). No orange-red precipitate indicates the absence of alkaloids.

2. ALKALINE REAGENT TEST

Few drops of dilute ammonia were added to a portion of the leaf extract and concentrated hydrochloric acid was also added. A yellow colouration indicated the presence of flavonoids.

3. TEST FOR STEROIDS

About 2 ml of acetic anhydride was added with 0.5 ml of extract of each sample with 2 ml of sulphuric acid. The colour changed from violet to blue or green in samples indicates the presence of steroids.

4. SALKOWSKI TEST

About 0.5 ml of the extract was added with 2 ml of chloroform and 3 ml of concentrated sulphuric acid was also carefully added to form layer. A reddish-brown colour at the interface indicates the presence of terpenoids.

5. TEST FOR SAPONINS

About 2 g of the powdered sample was boiled in 20 ml of distilled water in a water bath and filtered. 10 ml of the filtrate was mixed with 5 ml of distilled water and shaken vigorously until the formation of a stable foam. The foam was mixed with 3 drops of olive oil and again shaken vigorously, and observed for the formation of emulsion which indicate the presence of saponins.

6. TEST FOR TANNINS

a) LEAD ACETATE TEST

A little quantity of the test solution was mixed with basic lead acetate solution. Formation of white precipitate indicates the presence of tannins.

b) FERRIC CHLORIDE TEST

To the alcoholic extract few drops of ferric chloride solution was added. A bluish black colour was produced indicates the presence of tannins.

7. TEST FOR CARBOHYDRATES

About 2 ml of the extract was added with 1 ml of Barfoed's reagent and boiled. A reddish-brown precipitate is formed which indicates the presence of carbohydrates.

8. NINHYDRIN TEST

About 3 ml of test solution was added with 3 drops of 5% ninhydrin solution in a tube and heated in boiling water bath for 10 minutes. Formation of purple or bluish colour indicates the presence of amino acids.

9. LEGAL'S TEST

The extract when treated with pyridine and made alkaline by sodium nitro prusside solution, no pink to red colour is produced, which indicates the absence of glycosides.

Based on qualitative phytochemical tests, ethanolic extract of *Dodonaea viscosa* leaf contained several chemical compounds like flavonoids, steroids, terpenoids, saponins, tannins, carbohydrates, amino acids.

LITERATURE REVIEW

PHARMACOLOGICAL ACTIVITY OF DODONAEA VISCOSA PHYTOCHEMICAL PROFILING AND ANTIBACTERIAL ACTIVITY OF ETHANOLIC EXTRACT OF *DODONAEA VISCOSA*

Abdulrasheed H et al (2025)[41] Anti-bacterial analysis of the crude ethanolic extract sample of *Dodonaea viscosa* against Salmonella Typhi bacteria were conducted by serial dilution using DMSO as a polar solvent. 100 mg/ml, 50 mg/ml and 25 mg/ml W/V of the *D. viscosa* crude extract concentration were prepared and tested against Salmonella Typhi. The analysis was simultaneously conducted using two same medium (petri dishes containing 25 ml W/V solidified solution of nutrient broth each).

In both testing media, the highest concentrations of the extract demonstrated appreciable inhibitory effects against Salmonella Typhi (S. Typhi), while the lowest concentration showed no activity. Specifically, in the first medium, a 100 mg/mL extract produced a zone of inhibition measuring 12 mm, and 50 mg/mL yielded an 11 mm zone, whereas the 25 mg/mL

concentration was entirely ineffective. The second medium showed a slight enhancement: 100 mg/mL produced a 13 mm zone and 50 mg/mL a 12 mm zone, with 25 mg/mL again showing no observable inhibitory activity. Ciprofloxacin was included. The MIC of this research work for *Dodonaea viscosa* crude extract against Salmonella Typhi is 50 mg/ml.

WOUND HEALING PROPERTY

Subramanian S et al (2023)[42] The application of *D. viscosa* -derived products to assist in wound healing has been reported in alternative therapy, prompting investigation of this potential therapeutic benefit in laboratory-based in vivo studies using rats. Ethyl acetate flavonoid-rich fractions extracted from *D. viscosa* leaves were shown to significantly increase levels of hydroxyproline and hexosamine, important constituents of the extracellular matrix, improve collagen formation, and fasten epithelialization and vascularization of wounds, relative to control groups.

Nayeem N et al (2021)[43] In a separate but similar study using the same in vivo model and approach, *D. viscosa* extracts were found to perform similarly to the known and approved antibiotic nitrofurazone in preventing infection and accelerating wound healing. These findings warrant further investigations aimed at isolating the bioactive constituents with wound healing and antibiotic properties from the crude extracts of *D. viscosa*.

HEPATOPROTECTIVE ACTIVITY OF DODONAEA VISCOSA LEAF EXTRACT NANOPARTICLES AGAINST N-NITROSODIETHYLAMINE INDUCED TUMOUR INITIATION IN RAT LIVER: MODULATION OF APOPTOSIS AND SIGNALLING PATHWAYS

Alasmari A et al (2022)[44] AgNPs synthesized from ethanolic D. viscosa leaf extracts inhibited the development of tumours induced by N-nitrosodiethylamine in the liver of Wistar rats. Serum levels of enzymatic markers indicative of liver damage, alanine transaminase and aspartate aminotransferase, were significantly reduced, while albumin levels, a marker of less aggressive tumour progression, were reduced. While DNA damage was reduced in hepatic tissues of rats which received the DV-AgNPs, the apoptosis rate was increased. Overall, DV AgNPs exhibited protective effects against liver damage and significantly inhibited hepatocellular carcinoma progression in rats receiving *D. viscosa* extracts compared with controls.

ANTIOXIDANT ACTIVITY

Malik MN et al (2022)[45] In a study, through the use of the DPPH (2,2-diphenyl-1-picrylhydrazyl) free radical scavenging in vitro assay, stem and leaf extracts of *D. viscosa* were found to have strong antioxidant activities, which corroborated an earlier study where stem extracts of the plant showed strong scavenging activities.

Ali H et al (2014)[46] The administration of extracts from *D. viscosa*, both organic and aqueous, proved protective towards carbon tetrachloride (CCl_4)-induced hepatotoxicity in rats. CCl_4 is known to cause liver damage through the formation of ROS, and in that particular study, hautriwaic acid was suggested as the main *D. viscosa* derived protective compound identified via HPLC fingerprinting.

ANTI-INFLAMMATORY ACTIVITY

Ramkumar R et al (2019)[47] The carrageenan rat paw oedema model was used to demonstrate that hydroalcoholic (DVHA) and n-hexane (DVH) extracts from D. viscosa leaves were more effective compared with the anti-inflammatory drug indomethacin, in reducing inflammation.

Khan AZ et al (2013)[48] A potential mechanism mediating these anti-inflammatory effects was suggested to be through the action of the phytochemical viscosine. Using molecular docking simulations, viscosine was found to impair the activity of lipoxygenase, an enzyme responsible for generating pro-inflammatory mediators and implicated in inflammatory diseases. Another notable observation was the potent reduction of nitric oxide production, prostaglandin E2 and tumour necrosis factor-α in the culture medium of lipopolysaccharide-induced murine macrophages (RAW264.7), once again suggesting that extracts from *D. viscosa* possess significant anti-inflammatory activity.

Salinas-Sánchez DO et al (2012)[49] The study demonstrated that the DVHA and DVH extracts effectively suppressed carrageenan-induced inflammation in rats compared with control rats which either did not receive DV or received indomethacin. In another study, this time using mice ear oedema as a model to measure inflammation, a 64% reduction in ear oedema was observed in mice receiving *D. viscosa* dichloromethane extracts, compared with a 40% reduction in mice receiving indomethacin.

ANTHELMINTIC ACTIVITY OF AERIAL PARTS OF *DODONAEA VISCOSA* (L.) JACQ

R. Xavier Arulappa et al (2018)[50] The chloroform and ethanolic extract of aerial parts of *Dodonaea viscosa* was used for the evaluation of anthelmintic activity, on earth worms (8 ±1cm in length) washed with normal saline to remove all the extrageneous matter.

The times for paralysis and when death of the worms occurred are analysed. Both chloroform(10,25,50mg/ml) and ethanol(10,25,50mg/ml) extracts of *D. viscosa* aerial parts exhibited dose dependent and significant anthelmintic activity as compared with standard drug, albendazole. Chloroform extract required least time to causes paralysis and death of the earth worm followed when compared to the extracts from ethanol suggesting either higher concentrations of the compounds producing anthelmintic activity or more compounds with the activity.

ANTI-DIABETIC ACTIVITY OF *DODONAEA VISCOSA*(L) LEAF EXTRACTS

P. Muthukumran et al (2011)[51] Fasted rats were received aqueous ethanol and butanol extracts of *Dodonaea viscosa* leaves at a dose of 250 mg/kg body weight as a fine aqueous suspension orally. All the rats were given glucose (2 g/kg body weight, p.o)30min after administration of the drug. Blood samples were collected from the tail vein just prior to glucose administration and at 30 and 90 min after the glucose loading. Serum was separated and blood glucose levels were measured immediately by glucose-oxidase method.

Male wistar rats (180-200g) were made diabetic by a single i.p injection of 120mg/kg bodyweight of alloxan monohydrate in sterile normal saline. Five days later blood samples were drawn from tail vein and glucose levels were determined to confirm the development of diabetes(350mg/dl). A group of diabetic rats were given *Dodonaea viscosa* (L) aqueous ethanol, and butanol extracts at a dose of 250 mg/kg, orally. Other group received glibenclamide at dose of 10 mg/kg. Blood samples were collected from the tail vein just prior to and 1h,3h and 5h after drug administration.

The aqueous ethanol and butanol extracts have shown significant reduction in blood glucose levels in both glucose loaded and alloxan induced diabetic rats. The butanol extract produced maximum anti-diabetic activity and is higher than the hypoglycemic activity of glibenclamide in the diabetic rats.

ANTI-DIARRHEAL ACTIVITY OF *DODONAEA VISCOSA* ROOT EXTRACTS

Rajamanickam V et al (2010)[52] In a separate study, the anti-diarrheal activity of *D. viscosa* root extracts (alcohol and aqueous) was analysed in male albino mice fed castor oil to induce diarrhoea. Both alcohol and aqueous *D. viscosa* extracts significantly reduced diarrhoea episodes and stool weight in the mice in a dose-dependent manner, similar to what was observed in the groups receiving the anti-diarrheal drug, loperamide. Additionally, the *D. viscosa* extracts were found to be non-toxic to the mice at a dose of up to 2,000 mg/kg. No clinical signs of weakness or other adverse events were observed in the animals after *D. viscosa* treatment.

GASTROPROTECTIVE EFFECT OF *DODONAEA VISCOSA* ON VARIOUS EXPERIMENTAL ULCER MODELS

Arun M et al (2008)[53] Extracts from *D. viscosa* leaves were shown to have gastroprotective effects and protect against the development of ulcers in a rodent model. Pretreatment with *D. viscosa* hexane extracts blocked the formation of ethanol/indomethacin-induced gastric ulcer lesions in the Charles Wistar rats which displayed reduced gastric glutathione levels, inhibition in the accumulation of alkaline phosphatase and increased gastric pH. These effects were similar to those observed in rats treated with the proton-pump inhibitor drug, omeprazole.

STUDY OF ANALGESIC AND ANTICONVULSANT ACTIVITIES OF ETHANOLIC EXTRACTS OF *DODONAEA VISCOSA* JACQ. SEEDS

Krupanidhi AM et al (2006)[54] Ethanolic extract of the seeds of *Dodonaea viscosa* 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 writing 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.

CONCLUSION

Dodonaea viscosa Linn. is an evergreen woody perennial shrub, though it is a native plant of Australia, indigenous and widely distributed in temperate regions of India, Africa, Mexico, New Zealand, Northern Mariana Islands, Virgin Islands, Florida, Arizona, South America. It is commonly known as Hopbush or Sticky hopbush belongs to the family Sapindaceae. Its

various plant parts such as stem, leaves, seeds, roots, bark and aerial parts contain flavonoids such as aliarin, pinocembrin, penduletin, viscosol, sakuranetin, etc., steroids, terpenoids saponins, tannins, carbohydrates and amino acids. Preclinical studies demonstrate its broad spectrum of bioactivities, including antibacterial, wound healing, anticancer, antioxidant, anti-inflammatory, anthelmintic, antidiabetic, antidiarrheal, antiulcer, analgesic and anticonvulsant, which largely validate its traditional use in managing wounds, fever, rheumatism, and skin disorders.

Overall, *Dodonaea viscosa* holds considerable potential for drug discovery and phytopharmaceutical development, particularly for inflammatory and metabolic conditions. Integrating traditional knowledge with modern analytical and pharmacological approaches will be key to translating its medicinal value into evidence-based applications.

Further studies are required to isolate the possible phytoconstituents which may be responsible for the pharmacological activity and to explore the possible mechanism of action.

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