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A REVIEW ON PHARMACOGNOSTIC STUDY AND PHARMACOLOGICAL ACTIVITY OF THE PLANT CARISSA CARANDAS

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Abstract:

Carissa carandas is a member of the family Apocynaceae, and there have been numerous studies about its pharmacognostic properties and pharmacological activities. Ethnobotanically, it has been of significance, being used traditionally in managing ailments such as digestive disorders, infections, and inflammatory conditions. A detailed review of its pharmacognostic aspects provides important information on the macro- and microscopic features, physicochemical parameters, and phytochemical profile to standardize and control the quality of herbal formulations derived from this plant. Carissa carandas contains alkaloids, flavonoids, tannins, and saponins. These phytoconstituents are responsible for the pharmacological activities of this plant. Different research studies have shown that the plant possesses various types of biological activities, including antioxidant, antimicrobial, anti-inflammatory, antidiabetic, hepatoprotective, and neuroprotective activities. It may also help prevent oxidative stress-related disorders and metabolic syndromes. This review aims to provide a comprehensive analysis of the pharmacognostic and pharmacological attributes of Carissa carandas, emphasizing its potential as a source for developing novel therapeutic agents.

Keywords: Carissa carandas, pharmacognostic properties, phytoconstituents, hepatoprotective, and neuroprotective

1. Introduction

Carissa carandas, commonly known as Karonda, is a perennial, spiny, evergreen shrub or small tree that belongs to the family Apocynaceae. It is widely distributed across tropical and subtropical regions, including India, Sri Lanka, Nepal, Bangladesh, and Southeast Asia, and has also been introduced in parts of Africa and the Americas. Traditionally, this plant has held a prominent place in ethnomedicine due to its ability to thrive in harsh climatic conditions and its rich repository of phytochemicals, which have been utilized for various therapeutic applications. In traditional systems of medicine, the plant has been used for its fruit, leaves, roots, and stems, which serve as remedies for numerous ailments.These include gastrointestinal disturbances, anemia, infections, wounds, fevers, and even more chronic conditions like diabetes and cardiovascular diseases.(Singh, Bajpai and Mishra, 2020)(Zoghebi, Sabei and Safhi, 2024) The plant is also valued for its economic significance, as its fruits are edible and are often used in culinary applications such as pickles, jams, and beverages. The sour taste and nutritional benefits of the fruits have led to their popularity as a functional food.(Rajapandi et al., 2024) Apart from its culinary uses, the medicinal potential of Carissa carandas is being extensively researched in modern pharmacology, making it an important candidate for developing new natural remedies. Its ability to grow in arid and semi-arid conditions, along with its resilience to drought and poor soils, makes it an ideal species for cultivation in regions where other crops fail to thrive.(Patathananone et al., 2024)

From a pharmacognostic point of view, Carissa carandas is distinguished by its distinct morphological and anatomical features to be used for identification and standardization. The plant can easily be identified by its shiny, elliptic, or ovate leaves with spiny branches that are characteristic of the genus. The fruits are initially green but mature into very dark purplish to black colored ones rich in bioactive compounds. These are responsible for the numerous pharmacological activities of the plant. Analyses done macro- and microscopic alongside the physicochemical studies that helped set it firmly based upon its assurance quality and the true origin, quality of its product in herb.(Itankar et al., 2011)

In plant, biochemistry and phytochemically, treasure-house for producing variety of such pharmacologically useful compounds which encompasses alkaloids flavonoids terpenoids like saponin and tannin phenol derivatives like salicylic phenolic acids besides a range of glycoside including those formed within its internal stress, induced or endogenous basis. For example, while carissone and carindone are recognized with antimicrobial as well

as anticancer activity, its flavonoid content like quercetin and rutin add to its value as an antioxidant and anti-inflammatory agent. Hence, its high amount of phytochemicals emphasize its potential usage as a multispectrum medicinal herb, starting with antioxidant and antibacterial treatment towards anti-inflammatory, hepatoprotective, or even anticancer therapy.(Siddiqui et al., 2003a) (Plants et al., 2016)

Various pharmacological analyses on Carissa carandas offer scientific proof and validation of these traditional applications and uses. Studies have proved the plant is helpful in oxidative stress, microbial infection, inflammation conditions, metabolic disorder, and neurodegenerative disease management.(Fadhli et al., 2024) Fruits and leaves extracts have especially exhibited very significant antioxidant activities. Antioxidants remove free radicals to stop their further generation in order to reduce the cell/tissue injury from the reactive oxidant. The plant has been found to possess potential in regulating blood glucose levels, lowering cholesterol, protecting the liver from toxic damage, and enhancing cardiovascular health. All these findings correlate with its traditional use as a natural remedy for lifestyle-related and chronic diseases.(Galipalli et al., 2015a)(Plants et al., 2016)

The ethnomedicinal importance of Carissa carandas is rooted deep in ancient medical practices, particularly in Ayurveda, Siddha, and Unani systems of medicine. Various parts of the plant are combined in decoctions, infusions, and poultices to treat a broad spectrum of health issues in these traditional practices. For example, the root bark is a vermifuge as well as used for treating biliousness; the fruits are consumed to address digestive disturbances and anemia. The juice extracted from the fruits is applied topically for its antiseptic and wound-healing properties, which shows the multifaceted applications of the plant in primary healthcare.(Siddiqui et al., 2003b) In light of the renewed interest in natural remedies and plant-based therapies around the world, Carissa carandas has become a promising candidate for pharmaceutical development. The increasing incidence of chronic diseases, coupled with the limitations of synthetic drugs such as side effects and drug resistance, has led to a renewed focus on medicinal plants as sources of safer and more effective therapeutics. In this context, the scientific investigation of Carissa carandas is critical to uncover its full potential and expand its applications in modern medicine.(Plants et al., 2016)(Plants et al.,2016)

In addition, the ecological importance of the plant cannot be overlooked. Carissa carandas plays an essential role in facilitating biodiversity since the plant creates and provides shelter, food, and sustenance to multiple species of birds and insects. It has capabilities to thrive under degraded soil, tolerates different harsh conditions for the

environment, and thus provides for ecological restoration project resources. Supporting sustainable agriculture comes through with income generation opportunities within rural communities working on farming, processing, or even preparing a product using carandas.(Bano et al., 2020)

Recent advances in biotechnology and analytical techniques have provided new avenues to explore the pharmacological potential of Carissa carandas. Techniques like high-performance liquid chromatography, gas chromatography-mass spectrometry, and nuclear magnetic resonance spectroscopy are being employed to identify and quantify the bioactive compounds present in the plant. These advancements are crucial for standardizing its extracts and ensuring consistency in therapeutic efficacy. Moreover, studies related to the molecular mechanisms underlying its pharmacological effects have revealed that it has a potential role in modulating critical signaling pathways in inflammation, oxidative stress, and metabolic regulation. (Sarkar et al., 2018)

2. Pharmacognostical Profiling

Pharmacognostic studies have significant importance for the identification, authentication, and quality assurance of medicinal plants. It involves elaborate examination of the macroscopic, microscopic, and physicochemical parameters to put forth a thorough profile of the plant. Under the following points is an exhaustive study of pharmacognostic characters of Carissa carandas in detail:(MAHIYA SURESH, 2014)(Rai and Misra, 2005)(Yadav, Vishwakarma and Jain, 2019)

Figure 1:- Leaves, Flowers and Fruits of a fully grow *Carissa carandas*

Macroscopic Characters

Macroscopic examination determines the observable physical characteristics of the plant, its morphology, habitat, and growth patterns. This is the first step in the identification and differentiation of *Carissa carandas* with others.

Plant Description

Carissa carandas is a shrub, spiny, evergreen, perennial that grows to 2–4 m in height. It is widely spread in the tropics and subtropics and functions well in arid and semiarid climates. This plant is drought-resistant and can grow in poor soils; hence, it is a mandatory component of an agroforestry system on degraded lands.

Leaves

The leaves of *Carissa carandas* are opposite, ovate to oblong, and have a smooth, glossy texture. Each leaf is 3–7 cm in length and 1.5–3.5 cm in width. Dark green coloration is indicative of high chlorophyll content, which supports photosynthesis under arid conditions. The leaf base is rounded and the apex is pointed with a sharp midrib running along it length.

Flowers

Flowers are small, tubular, and white, and they have a sweet fragrance. They grow in clusters and are bisexual, so crosspollination is ensured. The flowering occurs throughout the year, though in spring and early summer, the flowers bloom at their peak time. The flowers have five lobes, and the structure helps in identifying the species.

Fruits

The fruits are globular to ellipsoidal berries. In size, it is about 1-2 cm in diameter. At initial stages, green in color. As maturity arrives, pink and purple change over to black colors. Sour, juicy with lots of organic acid content, is the flavor description of these fruits. Each fruit holds 4 to 8 seeds, oblong in shape but small and fleshy in pulp. Good source of all vitamins, minerals, and antioxidants

Roots-Bark:

The roots are pretty long and fibrous with deep extensions that penetrate the soil when the flora tries to reach water in arid environments. The root bark is dark brown and rough, having a characteristic aromatic odour. The root system plays a significant role in traditional medicine. It was used for its antimicrobial as well as vermifuge properties.(Pino, Marbot and Vászquez, 2004)

Microscopic Characteristics

Such microscopic studies provide detailed information regarding the internal structures of the plant tissues. This is important for the identification of powdered or processed plant materials.

Leaf Anatomy

Epidermis: The epidermis is single layered. Epidermal cells are polygonal with a smooth outer wall. That outer wall possesses a thick cuticle to minimize water loss.

Stomata: The paracytic stomata are evident in these leaves, which is an important attribute of the family Apocynaceae.

These stomata control gas exchange and loss of water vapor.

Mesophyll: The mesophyll tissue is made up of palisade and spongy parenchyma cells. The palisade cells are compact and are highly chloroplastous. The spongy cells are loosely arranged to allow diffusion of gases.

Vascular Bundles: The vascular system is developed, comprising collateral vascular bundles. Xylem is lignified, and phloem is surrounded by a layer of parenchymatous cells.

Stem Anatomy

Epidermis: A single-layered epidermis covers the stem, which bears multicellular trichomes.

Cortex: The cortex is made of parenchyma cells and has an oil gland and a massive calcium oxalate crystal.

Vascular Bundles: The vascular bundle is arranged in a ring with lignified xylem, and prominent secondary growth leads to a very thick woody stem.

Fruit Anatomy

Pericarp: Pericarp has three layers which include exocarp, mesocarp, and endocarp. The exocarp is thin and shining, whereas mesocarp is fleshy and rich in phytochemicals.

Seeds: A hard seed coat protects the seeds, containing sclerenchyma cells inside. The cotyledons have storage proteins and lipids in abundance.

3. Physicochemical Parameters

Physicochemical studies do provide great critical information regarding the purity, stability, and quality of the plant material. These parameters are very important for the standardization of herbal drugs. (Weerawatanakorn and Pan, 2017)

Moisture Content

Low moisture content is an important indication of the stability of the plant material. High moisture content leads to microbial contamination and degradation of bioactive compounds. C. carandas leaves and fruits moisture content is usually less than 10% with long shelf lives

Ash Values

Ash values show the existence of inorganic residues like silica, carbonates, and oxides.

Total Ash: It is the total inorganic content.

Acid-Insoluble Ash: It shows the existence of insoluble impurities like silica.

Water-Soluble Ash: It is the soluble salts, which can be used as nutrients.

Extractive Values (Plants *et al.*, 2016)

Extractive values are the estimation of the solubility of active constituents in various solvents. Alcoholic Extractive Value: It shows the concentration of alcohol-soluble compounds like flavonoids and alkaloids.

Water Extractive Value: Indicates the soluble water-soluble constituents including tannins and saponins.

Impurities: Measurement of impurities like soil, stones, and other plant residues is done for high purity. Minimum contamination is assured through strict quality control measures.

4. Phytochemical Evaluation

Phytochemical screening is the analysis of secondary metabolites responsible for the pharmacological activity of a plant.

Alkaloids

Alkaloids such as carissone and carindone possess antimicrobial, antifungal, and cytotoxic properties. They are obtained from the roots, leaves, and fruits of the plant.

Flavonoids

Flavonoids like quercetin, rutin, and catechins are antioxidants that scavenge free radicals. They also possess anti-inflammatory and cardioprotective properties.

Phenolic Compounds

Phenolics give the plant antioxidant and antimicrobial activities, including gallic acid and caffeic acid. These two substances play a major role in providing cells with defense against oxidative breakdown.

Saponins

Saponins possess surfactant activities and have antimicrobial, anti-inflammatory, and immunomodulatory effects. They are mostly present in the fruits and seeds.

Tannins

Tannins are astringent agents that provide wound healing and possess antimicrobial activity. They are rich in the bark and unripe fruits.

Triterpenoids

Triterpenoids such as lupeol and ursolic acid exhibit hepatoprotective, anti-inflammatory, and antitumor properties.

Table 1:- A detail plant profiling of *Carissa carandas*

Aspect	**Details**
Botanical Name	*Carissa carandas*
Family	Apocynaceae
Common Names	Karonda (India), Natal plum, Bengal currant, Christ's thorn
Plant Type	Evergreen, spiny shrub or small tree
Height	2–4 meters
Habitat	Tropical and subtropical regions; thrives in arid, semi-arid, and degraded soils
Distribution	India, Sri Lanka, Nepal, Southeast Asia, East Africa; introduced in parts of the Americas
Stem (Macroscopic)	Woody, spiny branches with a rough, dark brown bark
Leaves (Macroscopic)	Opposite, ovate to oblong, glossy green
Flowers (Macroscopic)	White, tubular, fragrant
Fruits (Macroscopic)	Green to purple-black berries

5. Previous founds major chemical constitutes in *Carissa carandas*

Carissone and Carindone (Alkaloids)

Found in the roots and leaves, these alkaloids have shown potent antimicrobial activity against Gram-positive and Gram-negative bacteria.(Hameed *et al.*, 2021)

Their cytotoxic effects make them candidates for anticancer research.

Quercetin and Rutin (Flavonoids)

These well-known flavonoids exhibit strong antioxidant properties, reducing oxidative stress and preventing cell damage.

They also contribute to the plant's cardioprotective and neuroprotective effects.

Ursolic Acid and Lupeol (Triterpenoids)(Siddiqui *et al.*, 2003a)

These compounds are responsible for anti-inflammatory and hepatoprotective activities.

Lupeol is also reported to suppress tumor growth and enhance skin health.

Gallic Acid and Caffeic Acid (Phenolics)

These phenolic acids possess antimicrobial and antioxidant properties and are helpful in controlling infections and oxidative stress.(Bano *et al.*, 2020)

Beta-Sitosterol (Steroids)

Beta-sitosterol present in leaves and roots reduces cholesterol and has anti-inflammatory properties.

Anthocyanins (Cyanidin and Delphinidin)(Siddiqui *et al.*, 2003b)

The pigments of the fruits, besides providing them with color, also provide antioxidant and anti-inflammatory properties.

Essential Oils (Linalool and Geraniol)

These volatile organic compounds are found within the leaves and fruits. Antimicrobial in nature, relaxing, and worth their value due to these uses.(Plants *et al.*, 2016)

Saponins and Tannins

These provide the plant's antimicrobial/astringent and wound healing attributes, preventing further infection.

Table 2:- Name of Previous found chemical constituent in *Carissa carandas*

Compound Class	**Specific Compounds**	**Plant Part(s)**	**Pharmacological Activities**
Alkaloids	Carissone, Carindone	Roots, leaves, fruits	Antimicrobial, antifungal, cytotoxic
Flavonoids	Quercetin, Rutin, Catechins	Leaves, fruits	Antioxidant, anti-inflammatory, cardioprotective, neuroprotective
Phenolic Compounds	Gallic acid, Caffeic acid, Chlorogenic acid	Fruits, leaves,	Antioxidant, antimicrobial, anti-

			roots	inflammatory
Triterpenoids	Lupeol, Ursolic acid		Leaves, stems, fruits	Hepatoprotective, anti-inflammatory, antitumor
Saponins	Specific saponins (not fully characterized)		Fruits, seeds	Antimicrobial, anti-inflammatory, immunomodulatory
Steroids	β-Sitosterol		Leaves, roots	Anti-inflammatory, cholesterol-lowering, antioxidant
Tannins	Ellagic acid, Tannic acid		Fruits, bark	Astringent, antimicrobial, antioxidant
Essential Oils	Linalool, Geraniol, α-Terpineol	Leaves, fruits	Antimicrobial, anti-inflammatory, soothing	
Fatty Acids	Oleic acid, Linoleic acid	Seeds	Nutritional, cardioprotective	
Glycosides	Cardiac glycosides	Roots, fruits	Cardioprotective, mild sedative	
Carotenoids	β-Carotene, Lycopene	Fruits	Antioxidant, anti-aging, protection against oxidative stress	
Anthocyanins	Cyanidin, Delphinidin	Fruits	Antioxidant, anti-inflammatory, protection against oxidative damage	

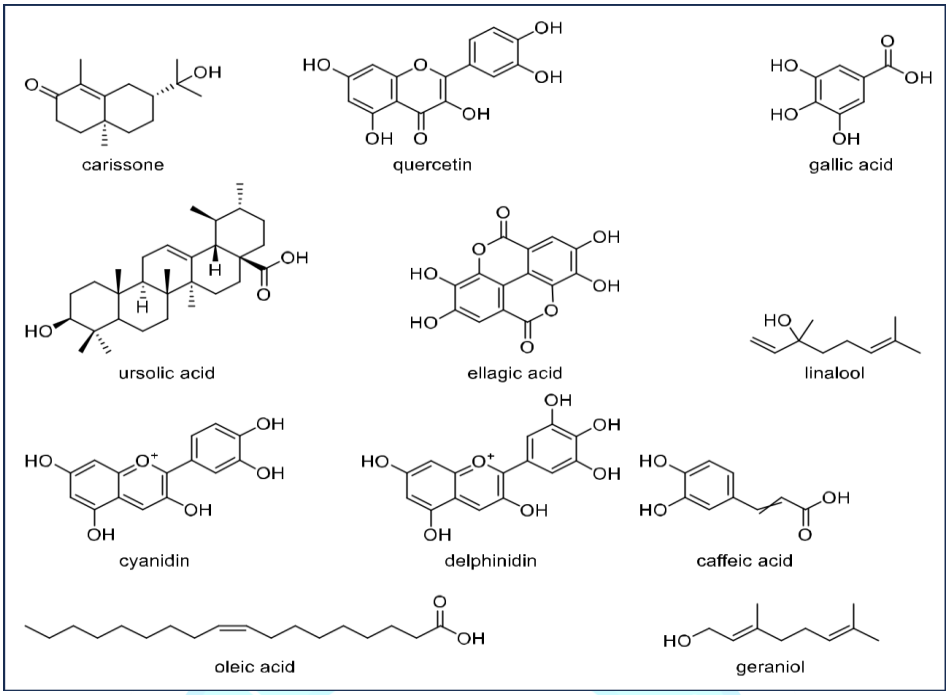

Figure 2:- Previous isolated chemical constituent isolated from *Carissa carandas*

6. Ethnopharmacological Relevance of Carissa carandas

Its large-scale presence also occupies an esteemed niche in Ayurveda, Unani, Siddha systems, and in a host of indigenous folk medicinal activities. Different components of the carandas, in its fruits, leaves, root, and even bark, it treats so much and varies and encompasses an amplitude of conditions towards a comprehensive multifaceted role of therapeutical values to which its value in its richly nutritional product. Ripened fruits are eaten raw or preserved as pickles, jams, and chutneys that are said to improve digestion, cure anemia, and break fever. (Galipalli *et al.*, 2015b)

High in fiber and iron, the fruits are ideal for digestive health and treatment of iron deficiency anemia. The fruit juice is also consumed as a healthy beverage that purifies and activates the immune system. The leaves of *Carissa carandas* are commonly applied topically and used in herbal decoctions. Crushed leaves have been used topically on wounds, ulcers, and boils because of their antiseptic and astringent properties that encourage wound healing and prevent infection.

(Sumbul and Ahmed, 2012) Decoctions of the leaves are used in the treatment of diarrhea and dysentery. Their anti-inflammatory property also makes them effective in reducing swelling and pain resulting from insect bites and minor injuries. The roots and root bark of *Carissa*

carandas play a special role in traditional medicine. They are widely used as a vermifuge to remove intestinal worms and to treat respiratory diseases such as cough and colds. The root bark is also applied to cure fever, biliousness, and skin infections. Traditional healers prepare paste or poults for treating spots and inflammation from the roots. The plant's bark, which is bitter, is used in such herbal preparations to purify the blood and to improve function in the liver. The usage of the plant across cultures highly projects its significance in the treatment of most health conditions in the rural and deprived communities. It is readily available and sustainable medicine, especially in areas devoid of modern health facilities. The plant's importance is further emphasized by the fact that it is used for rituals and it forms an important part of food preparation, serving to bridge the much stretched lines between medicinal and nutritional uses.(Dhatwalia *et al.*, 2021)(Plants *et al.*, 2016)

7. Pharmacological Activities of Carissa carandas

The pharmacological potential of *Carissa carandas* has been extensively studied and validated in preclinical and experimental models. The therapeutic effects of this plant are attributed to its diverse phytochemical constituents, including alkaloids, flavonoids, phenolics, saponins, and triterpenoids. Below is an expanded account of the key pharmacological activities of *Carissa carandas*:(Prakash *et al.*, 2011)(Anupama, Madhumitha and Rajesh, 2014)

Antioxidant Activity

Oxidative stress is a major factor in the progression of chronic diseases, including cardiovascular, neurological, and metabolic disorders. *Carissa carandas* exhibits significant antioxidant activity due to its rich content of phenolics, flavonoids, and carotenoids.

Mechanism: The antioxidants in the plant scavenge reactive oxygen species (ROS), reduce lipid peroxidation, and enhance endogenous antioxidant enzyme levels such as superoxide dismutase (SOD) and catalase.(Plants *et al.*, 2016)

Antimicrobial Activity

The plant exhibits broad-spectrum antimicrobial properties against Gram-positive, Gram-negative bacteria, and certain

fungi, which is primarily due to its alkaloids, phenolics, and essential oils.(Siddiqi *et al.*, 2011)

Bacteria: *Carissa carandas* extracts have shown activity against *Escherichia coli*, *Staphylococcus aureus*,
Bacillus subtilis, and *Pseudomonas aeruginosa*.

Fungi: Antifungal effects have been observed against *Candida albicans* and *Aspergillus niger*.

Mechanism: The plant's bioactive compounds disrupt microbial cell walls and inhibit enzyme systems
essential for microbial survival.

Anti-inflammatory Activity

Inflammation is a pathological response involved in various chronic diseases. *Carissa carandas* shows antiinflammatory
effects by modulating pro-inflammatory mediators and enzymes.

Mechanism: The flavonoids and triterpenoids in the plant inhibit the activity of cyclooxygenase (COX)
enzymes, reducing the synthesis of prostaglandins and other inflammatory mediators.(Devmurari *et al.*, 2009)

Antidiabetic Activity

The plant has shown promise in managing diabetes by regulating glucose metabolism and enhancing insulin sensitivity.

Mechanism: The bioactive compounds in *C. carandas* inhibit alpha-glucosidase and alpha-amylase enzymes,
which delays carbohydrate digestion and glucose absorption in the intestine.(Singh and Uppal, 2015)(Elya *etal.*, 2012)

Hepatoprotective Activity

The hepatoprotective effects of *Carissa carandas* are attributed to its ability to prevent oxidative damage and restore
liver function.

Mechanism: The antioxidant properties of the plant reduce lipid peroxidation in liver cells and enhance the
activity of protective enzymes such as glutathione peroxidase.(El-desoky *et al.*, 2018)

Cardioprotective Activity

Cardiovascular diseases, including atherosclerosis and hyperlipidemia, are mitigated by the lipid-lowering and
antioxidant properties of *Carissa carandas*.

Mechanism: The plant's flavonoids reduce LDL cholesterol levels, enhance HDL cholesterol levels, and
improve vascular function by reducing oxidative stress in endothelial cells.

Neuroprotective Activity

The neuroprotective effects of *Carissa carandas* are particularly important for managing neurodegenerative diseases
such as Alzheimer's and Parkinson's.

Mechanism: The plant's flavonoids and anthocyanins reduce oxidative stress in neuronal tissues and inhibit
acetylcholinesterase, an enzyme linked to Alzheimer's disease.(Singh and Uppal, 2015)(Neimkhum *et al.*,
2021)

Anticancer Activity

Preliminary studies suggest that *Carissa carandas* may have anticancer potential due to its cytotoxic effects on tumor
cells.

Mechanism: The alkaloids and triterpenoids in the plant induce apoptosis (programmed cell death) in cancer
cells by activating caspases and disrupting mitochondrial function.

Cell Line Studies: Extracts of *C. carandas* have shown cytotoxic effects against human breast cancer and
colon cancer cell lines.(Hameed *et al.*, 2021)(Sumbul and Ahmed, 2012)(Singh and Uppal, 2015)

Wound-Healing Activity

The wound-healing properties of *Carissa carandas* are linked to its astringent, antimicrobial, and anti-inflammatory
properties.

Mechanism: The tannins and saponins in the plant promote wound contraction and epithelialization while
preventing infection.

Animal Studies: Topical application of *C. carandas* leaf extract has been shown to accelerate wound healing
in excision wound models.

Antiulcer Activity

The plant demonstrates antiulcer properties by reducing gastric acid secretion and protecting the gastric mucosa.

Mechanism: Flavonoids and phenolics in the plant strengthen the gastric lining and inhibit the action of pepsin,
reducing the risk of ulcers.

Animal Studies: Extracts of *C. carandas* significantly reduced ulcer formation in pylorus-ligated and aspirininduced
gastric ulcer models.

Antipyretic and Analgesic Activity

The plant has been traditionally used to reduce fever and alleviate pain.

Mechanism: The antipyretic effects are mediated by the inhibition of prostaglandin synthesis, while the
analgesic effects involve modulation of pain receptors and central nervous system pathways.

Studies: Ethanolic extracts of the leaves and roots have demonstrated significant antipyretic and analgesic
effects in experimental fever and pain models.

Immunomodulatory Activity

The plant enhances immune function, making it effective in managing infections and improving overall health.

Mechanism: Saponins and flavonoids stimulate the production of cytokines and enhance macrophage activity.

Table 3: Summary Table of Pharmacological Activities

Activity	Key Compounds	Mechanism of Action
Antioxidant	Phenolics, flavonoids	Scavenges ROS and enhances antioxidant enzymes
Antimicrobial	Alkaloids, phenolics	Disrupts microbial membranes and inhibits enzymes
Anti-	Flavonoids,	Inhibits COX enzymes and reduces inflammatory

inflammatory	triterpenoids	mediators
Antidiabetic	Flavonoids, saponins	Inhibits alpha-glucosidase and enhances insulin sensitivity
Hepatoprotective	Flavonoids, phenolics	Reduces lipid peroxidation and protects liver cells
Cardioprotective	Flavonoids, carotenoids	Reduces LDL, enhances HDL, and improves vascular function
Neuroprotective	Anthocyanins, flavonoids	Reduces oxidative stress and inhibits acetylcholinesterase
Anticancer	Alkaloids, triterpenoids	Induces apoptosis and inhibits tumor cell proliferation
Wound Healing	Tannins, saponins	Promotes contraction and epithelialization
Antiulcer	Flavonoids, phenolics	Protects gastric mucosa and inhibits acid secretion

8. Conclusion

Carissa carandas is a multi-relevance medicinal plant that has gained great importance in the fields of pharmacognosy, phytochemistry, pharmacology, and ethnopharmacology. This article focuses on its traditional importance and modern significance based on different medicinal systems from diverse cultures across the globe. Bioactive compounds of the plant such as alkaloids, flavonoids, phenolics, saponins, and triterpenoids contribute to various pharmacological effects such as antioxidant, antimicrobial, anti-inflammatory, antidiabetic, hepatoprotective, and neuroprotective. Pharmacognostic studies have given detailed information about its macroscopic, microscopic, and physicochemical characteristics, thus ensuring its identification and standardization in herbal medicine. The plant's role in traditional healthcare systems for managing ailments like digestive disorders, skin infections, and respiratory conditions underscores its utility as a natural remedy. Its adaptability to harsh climates and its nutritional and medicinal versatility make it an ecologically and economically valuable resource. But significant progress has already been made towards understanding its applications in therapy. Further research would be required for its incorporation into modern pharmaceutical practice, which could include clinical trials and the isolation of individual bioactive compounds.

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