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Carissa carandas (Karonda): Pharmacognostic Profile, Phytochemistry and Pharmacological Activities

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Abstract

Carissa carandas L. (family Apocynaceae), commonly known as Karonda, is a traditional medicinal plant widely distributed in tropical and subtropical regions of Asia, especially India. It has long been used in Ayurveda and folk medicine for treating anemia, diabetes, inflammation, gastrointestinal disorders, and infectious diseases. The plant contains diverse phytochemicals such as flavonoids, phenolics, terpenoids, alkaloids, and vitamins, which contribute to its pharmacological potential. Recent studies have highlighted antioxidant, antimicrobial, antidiabetic, anticancer, hepatoprotective, and cardioprotective activities of the plant. This review summarizes pharmacognostic features, phytochemical composition, and pharmacological properties of Carissa carandas, emphasizing its therapeutic importance and future research prospects.

Keywords: Carissa Carandas, Karonda, Pharmacognosy, Phytochemistry, Medicinal Plants, Bioactive Compounds, Antioxidant Activity, Antidiabetic Activity, Antimicrobial Activity, Anti-Inflammatory Activity

1. Introduction

Carissa carandas L., commonly known as Karonda, Bengal currant, or Christ's thorn, is an evergreen shrub belonging to the family Apocynaceae. It is widely distributed in tropical and subtropical regions, particularly in India, Sri Lanka, Bangladesh, Southeast Asia, and parts of Africa. The plant grows well in arid and semi-arid climates, making it an important horticultural and medicinal species in many developing countries. Karonda is valued not only for its edible fruits but also for its traditional medicinal applications. The fruits are commonly consumed fresh, pickled, or processed into jams, jellies, syrups, and beverages, while different parts of the plant—including roots, leaves, bark, and latex—are extensively used in traditional medicine systems such as Ayurveda and folk medicine.

Historically, Carissa carandas has been used to treat a wide range of ailments, including anemia, digestive disorders, skin diseases, fever, diabetes, and inflammatory conditions. The fruits are considered rich in vitamin C, iron, calcium, and antioxidants, making them beneficial for nutritional supplementation and prevention of micronutrient deficiencies. Traditional healers have also utilized the plant for its antimicrobial, anti-inflammatory, and cardiotonic properties. These ethnomedicinal uses have attracted scientific interest, prompting detailed pharmacognostic, phytochemical, and pharmacological investigations to validate its therapeutic potential.

Pharmacognostically, Carissa carandas is characterized as a thorny shrub with glossy, opposite leaves, fragrant white flowers, and small berry-like fruits that turn from green to red and eventually dark purple upon ripening. The plant exudes a milky latex when injured, which is typical of members of the Apocynaceae family. Microscopic evaluation reveals diagnostic features such as calcium oxalate crystals, laticifers, thick cuticle, and characteristic stomatal patterns. These pharmacognostic characteristics are important for authentication, quality control, and standardization of herbal formulations containing Karonda. Proper identification helps prevent adulteration and ensures consistency in therapeutic efficacy.

Phytochemical studies have revealed a rich diversity of bioactive compounds present in Carissa carandas. Major phytoconstituents include flavonoids, phenolic acids, tannins, alkaloids, terpenoids, glycosides, saponins, and vitamins. These compounds are known for their antioxidant, anti-inflammatory, antimicrobial, antidiabetic, hepatoprotective, and cardioprotective activities. The presence of phenolic compounds and flavonoids contributes significantly to its antioxidant potential, which helps neutralize free radicals and reduce oxidative stress—a major factor associated with chronic diseases, aging, and cancer development. Terpenoids and alkaloids also play an important role in antimicrobial and anti-inflammatory responses, supporting the traditional medicinal use of the plant.

Recent pharmacological research has demonstrated several therapeutic properties of Carissa carandas. Experimental studies have reported antioxidant activity due to its high phenolic content, antidiabetic effects through improved glucose metabolism, antimicrobial activity against bacterial and fungal pathogens, and anti-inflammatory effects linked to inhibition of inflammatory mediators. Additionally, hepatoprotective and cardioprotective activities have been observed in experimental models, suggesting potential benefits in liver disorders and cardiovascular diseases. Some preliminary studies have also explored anticancer potential, indicating cytotoxic effects against certain cancer cell lines; however, clinical validation remains limited.

In addition to its medicinal importance, Carissa carandas has gained attention as a functional food and nutraceutical resource. Its fruits contain essential vitamins, minerals, organic acids, and antioxidants that contribute to overall health. Increasing consumer awareness about natural products, herbal medicine, and plant-based nutrition has further stimulated research into Karonda's health benefits. Advances in extraction technologies, phytochemical analysis, and pharmacological testing have improved understanding of its bioactive constituents and therapeutic mechanisms. Moreover, interest in sustainable agriculture and natural healthcare solutions has encouraged the cultivation and utilization of this hardy plant species.

Despite the promising pharmacological potential of Carissa carandas, several challenges remain. Standardization of extracts, identification of active principles, detailed toxicological studies, and well-designed clinical trials are necessary to establish its safety and efficacy conclusively. Variability in phytochemical composition due to geographical, environmental, and processing factors also requires attention. Addressing these issues will help translate traditional knowledge into scientifically validated therapeutic applications.

Overall, Carissa carandas represents an important medicinal plant with significant pharmacognostic, phytochemical, and pharmacological relevance. Its diverse therapeutic properties, nutritional value, and adaptability to harsh climatic conditions make it a valuable resource for herbal medicine, nutraceutical development, and pharmaceutical research.

Continued interdisciplinary investigations integrating pharmacognosy, phytochemistry, pharmacology, and clinical studies are essential to fully explore its therapeutic potential and promote its use in evidence-based healthcare systems.

2. Pharmacognostic Profile of Carissa carandas

2.1 Macroscopic Characteristics

Figure 1: Carissa carandas leaves and fruit

Carissa carandas L., commonly known as Karonda, is an evergreen thorny shrub belonging to the family Apocynaceae. It is widely distributed in tropical and subtropical regions of India and other Asian countries. The plant exhibits several distinct macroscopic features that are important for identification, authentication, and pharmacognostic evaluation.

The shrub typically grows to a height of about 2–4 meters and possesses numerous rigid, sharp thorns arising from branches, which act as protective adaptations. The bark is grayish to brown and exudes a characteristic milky latex when injured, a common trait in many members of the Apocynaceae family. This latex contains various bioactive compounds and serves as a diagnostic feature during crude drug identification.

Leaves are simple, opposite, oval to elliptic in shape, and leathery in texture. They generally measure about 3–7 cm in length and exhibit a glossy, dark green upper surface with a lighter underside. The smooth surface and coriaceous texture reduce water loss, enabling the plant to thrive in dry climatic conditions. The prominent midrib and entire leaf margin further assist in morphological identification.

Flowers are small, white, and highly fragrant, arranged in terminal or axillary clusters. Each flower typically has five petals arranged in a star-like pattern. Flowering generally occurs during spring and early summer. The pleasant fragrance

attracts pollinators, aiding reproductive success. These floral characteristics are valuable macroscopic markers in pharmacognostic evaluation.

The fruits are small berries that undergo a color transition from green to pink, red, and finally dark purple or almost black upon ripening. They are rich in organic acids, vitamins, and phytochemicals. The fruit pulp is juicy and acidic to sweet in taste, while the seeds are small, flat, and brown. The distinct color change and berry morphology make fruit identification straightforward.

Overall, these macroscopic characteristics—including thorny shrub habit, opposite leathery leaves, fragrant white flowers, berry-type fruits, and milky latex—serve as essential parameters for crude drug authentication, adulteration detection, and botanical standardization.

2.2 Microscopic Characteristics

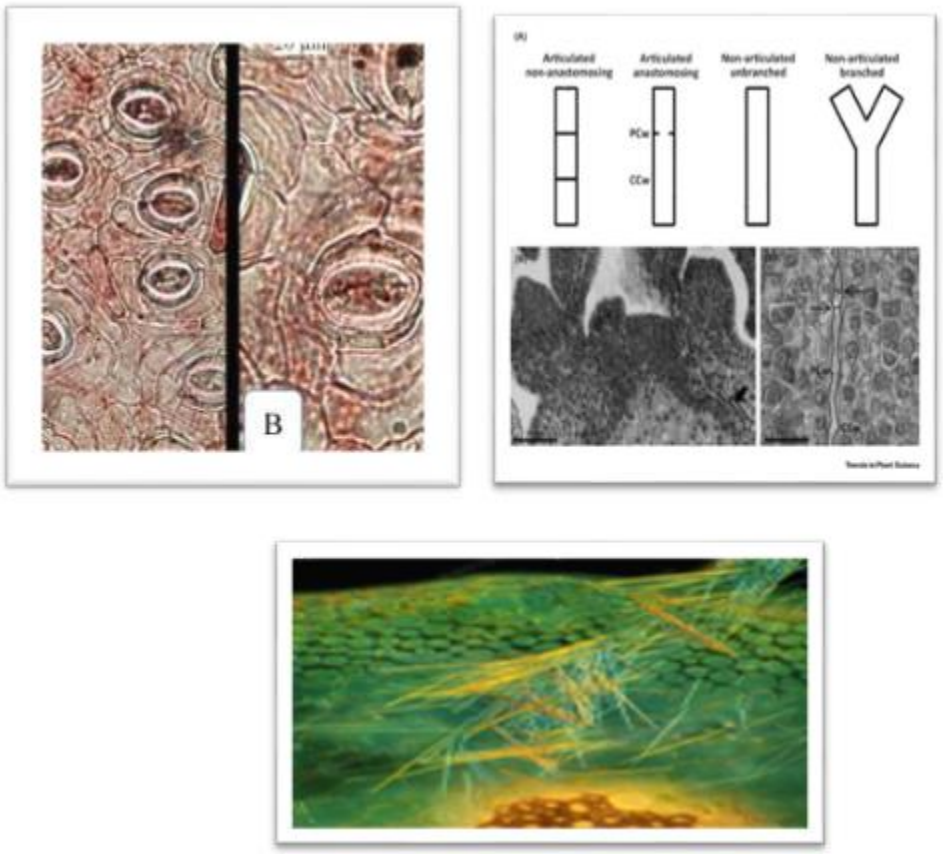

Figure 2: Microscopic examination of Carissa carandas

Microscopic examination of Carissa carandas provides detailed anatomical features crucial for pharmacognostic standardization and quality control. These characteristics help distinguish genuine plant material from substitutes or adulterants, especially in powdered or processed herbal drugs.

One of the most prominent microscopic features is the presence of laticifers, specialized latex-containing cells distributed throughout various plant tissues, including leaves, stems, and fruits. These laticifers produce the characteristic milky latex, which contains alkaloids, triterpenoids, and other secondary metabolites contributing to the plant's medicinal properties.

Calcium oxalate crystals are another significant diagnostic feature observed in the plant tissues. These crystals may occur in prismatic or rosette forms and are commonly present in parenchymatous cells. Their presence helps in microscopic authentication and is often used as a taxonomic marker in pharmacognostic studies.

Leaf microscopy reveals paracytic stomata, characterized by two subsidiary cells aligned parallel to the guard cells. This stomatal type is typical for many Apocynaceae members and aids in species identification. The epidermis is covered with a thick cuticle that minimizes transpiration and protects against environmental stress.

The transverse section of the leaf midrib shows well-developed vascular bundles composed of xylem and phloem tissues. These bundles are usually surrounded by supportive collenchymatous and parenchymatous tissues, providing structural strength. The mesophyll is differentiated into palisade and spongy parenchyma, facilitating photosynthesis and gaseous exchange.

Stem microscopy also shows cork cells, secondary phloem, xylem vessels, and medullary rays, along with latex canals. Such anatomical features contribute to the pharmacognostic identification of stem material used in herbal formulations.

These microscopic characteristics—including laticifers, calcium oxalate crystals, paracytic stomata, thick cuticle, and well-developed vascular bundles—are essential diagnostic markers. They are widely used in herbal drug standardization, ensuring authenticity, purity, and quality control of Carissa carandas raw materials.

3. Phytochemical Constituents of Carissa carandas

Carissa carandas (Karonda) is recognized as a rich source of diverse phytochemicals that contribute to its nutritional, medicinal, and therapeutic importance. Phytochemical investigations of different plant parts such as fruits, leaves, roots, and stems have revealed the presence of various secondary metabolites including flavonoids, phenolic compounds, terpenoids, alkaloids, glycosides, tannins, vitamins, and essential minerals. These compounds play a significant role in protecting the plant against environmental stress and also provide pharmacological benefits when used in traditional and modern medicine.

Among these constituents, flavonoids such as quercetin and kaempferol derivatives are considered major bioactive compounds. These molecules possess strong antioxidant properties by scavenging free radicals and reducing oxidative stress. Phenolic compounds and tannins further enhance antioxidant potential and contribute to antimicrobial and anti-inflammatory effects. The high vitamin C content in the fruits also strengthens antioxidant activity while supporting immune function and overall health.

Terpenoids and triterpenes identified in Carissa carandas are known for their anti-inflammatory, hepatoprotective, and cardioprotective activities. Alkaloids and glycosides present in the plant contribute to its pharmacological actions, including antimicrobial and potential anticancer effects. Additionally, minerals such as iron, calcium, and phosphorus increase the nutritional value of the fruits, making them beneficial in dietary supplementation.

The synergistic action of these phytochemicals is responsible for various biological activities such as antioxidant, antimicrobial, anti-inflammatory, cardioprotective, antidiabetic, and gastroprotective effects. Because of this broad phytochemical profile, Carissa carandas is widely studied for pharmaceutical, nutraceutical, and functional food applications.

Table 1: Major Phytochemical Constituents of **Carissa carandas**

Phytochemical Group	Examples Identified	Plant Part	Reported Biological Activities
Flavonoids	Quercetin, Kaempferol derivatives	Leaves, fruits	Antioxidant, anti-inflammatory, cardioprotective
Phenolic compounds & Tannins	Gallic acid, phenolic acids	Fruits, leaves	Antioxidant, antimicrobial, antiulcer
Terpenoids & Triterpenes	Lupeol, oleanolic acid	Roots, leaves	Anti-inflammatory, hepatoprotective
Alkaloids	Carissine (reported alkaloid)	Roots, stems	Antimicrobial, potential anticancer
Glycosides	Cardiac glycosides (reported)	Leaves, fruits	Cardioprotective activity
Vitamins	Vitamin C (ascorbic acid)	Fruits	Antioxidant, immune support
Minerals	Iron, calcium, phosphorus	Fruits	Nutritional supplementation

4. Pharmacological Activities of Carissa carandas

Carissa carandas (Karonda) is a medicinally important plant widely recognized for its diverse pharmacological activities. Various experimental and phytochemical studies have demonstrated that different parts of the plant, including fruits, leaves, roots, and stems, contain bioactive compounds responsible for multiple therapeutic effects. These activities support its traditional use in Ayurveda and folk medicine for treating several health disorders.

4.1 Antioxidant Activity

Extracts of Carissa carandas, particularly from fruits and leaves, exhibit strong antioxidant activity due to the presence of phenolic compounds, flavonoids, tannins, and vitamin C. These antioxidants help neutralize free radicals and reduce oxidative stress, which is implicated in aging, cancer, cardiovascular diseases, and diabetes. The antioxidant potential also contributes to improved immune function and protection against cellular damage.

4.2 Antidiabetic Activity

Several experimental studies have reported hypoglycemic effects of Carissa carandas extracts. These effects may result from enhanced insulin sensitivity, stimulation of insulin secretion, and inhibition of carbohydrate-digesting enzymes such as α-amylase and α-glucosidase. Such mechanisms help regulate blood glucose levels and suggest the plant's potential role in diabetes management and prevention of related complications.

4.3 Antimicrobial Activity

Leaf, fruit, and root extracts of Carissa carandas have demonstrated antibacterial and antifungal activities against a range of pathogenic microorganisms. The antimicrobial effects are attributed mainly to phenolics, flavonoids, and alkaloids, which disrupt microbial cell membranes and inhibit growth. These properties support the traditional use of Karonda in treating infections, wounds, skin disorders, and gastrointestinal problems.

4.4 Anti-inflammatory and Analgesic Activity

The presence of flavonoids, triterpenoids, and other phytoconstituents contributes to the anti-inflammatory and analgesic properties of Carissa carandas. These compounds inhibit inflammatory mediators and reduce pain responses. Consequently, the plant has been traditionally used in the treatment of fever, inflammation, arthritis, and pain-related conditions.

4.5 Anticancer Potential

Preliminary in vitro studies suggest that certain extracts of Carissa carandas possess cytotoxic and antiproliferative effects against selected cancer cell lines. These activities are largely attributed to antioxidant compounds that inhibit oxidative damage and regulate cellular signaling pathways involved in tumor growth. However, further clinical and mechanistic studies are required to confirm its anticancer efficacy.

4.6 Hepatoprotective and Cardioprotective Effects

Research indicates that Carissa carandas extracts may protect against liver damage by enhancing antioxidant defenses and reducing lipid peroxidation. Additionally, its cardioprotective effects are associated with lipid-lowering activity, improved antioxidant status, and regulation of cardiovascular risk factors. These findings suggest potential benefits in managing liver disorders and cardiovascular diseases.

5. Nutritional and Ethnomedicinal Importance

Carissa carandas (Karonda) is valued not only for its pharmacological properties but also for its significant nutritional and ethnomedicinal importance. The fruits are rich in essential nutrients such as vitamin C, iron, calcium, phosphorus, and various antioxidants, making them beneficial for maintaining overall health. The high vitamin C content helps boost immunity, prevents scurvy, and supports skin health, while iron contributes to hemoglobin formation and helps in the management of anemia. Additionally, the presence of dietary fiber and organic acids aids digestion and promotes gastrointestinal health.

In traditional medicine systems, particularly Ayurveda and folk practices, Karonda has been widely used for treating several ailments. The fruits are commonly consumed to alleviate anemia, digestive disorders, fatigue, and general weakness. Root and leaf extracts are traditionally used for managing fever, skin diseases, infections, and inflammatory conditions. The plant's antimicrobial and antioxidant properties further support its therapeutic applications. Overall, the nutritional richness and longstanding traditional use of Carissa carandas highlight its importance as both a functional food and a medicinal plant.

7. Conclusion

Carissa carandas (Karonda) is an important medicinal and nutritional plant recognized for its diverse therapeutic potential and rich phytochemical composition. The plant contains various bioactive constituents such as flavonoids, phenolic compounds, tannins, terpenoids, vitamins, and minerals, which contribute to its wide range of pharmacological activities. Scientific studies have demonstrated significant antioxidant, antimicrobial, antidiabetic, anti-inflammatory, hepatoprotective, and cardioprotective effects, supporting many of its traditional medicinal uses. Its fruits also serve as a valuable nutritional source, particularly rich in vitamin C, iron, and antioxidants, making them beneficial for improving immunity, managing anemia, and promoting overall health.

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