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REVIEW ARTICLE

Pharmacological and Therapeutic Application of *Carissa carandas* L. Fruit on the Peril of Diseases

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Abstract

Carissa carandas L. (*Karonda*) fruits remain neglected in India, despite their effectiveness in achieving nutritional requirements. The majority of the underutilized fruits are widely accessible and native to the locality. The article intends to demonstrate the many positive health effects of *Karonda* fruits, which are composed of a number of anti-oxidant, bioactive and phytochemical components. Thus, the fruit has an abundance of nutrients and can help alleviate a variety of ailments. It is currently regarded as an essential source for multiple distinctive products for the production of several commercial products as well as medicines for different illnesses. The intention of this review paper is to analyse the pharmacologic and therapeutic findings that will assist in discovering the medicinal value of *Karonda* fruits while unlocking the way for more investigation into the detection of health effects in in vivo human studies.

Keywords: Disease, Health Effects, Human Study, *Karonda*, Nutrients

1. Introduction

Numerous plant species with nutritious and therapeutic qualities that nature has bestowed upon humanity are still underutilized today[1]. The majority of India's neglected fruit crops are utilized in healthcare[2]. Countless nutrient-dense wild edible plants, particularly those high in vitamins and minerals, enhance human and animal nutrition needs[3]. Nutrient-dense fruits are in high demand these days as a means of enhancing human metabolic and nutritional health. The *Carissa* species holds significant socio-economic value in India's tribal regions[4]. Fruits are a diverse range of plant foods that are an invaluable gift to humanity. Fruits add a range of flavours, aromas, colours, and textures to the diet. They are a high-moisture, typically acidic food that is quite simple to prepare. Thus, fruits are a crucial part of a diet[5]. The fruits of the valuable *Karonda* tree are known for their nutritional and therapeutic qualities. It has long been used as a component in nutritious diets and as therapy for a number of ailments. Despite its extensive past and medicinal benefits, *Karonda* fruit is still not domesticated through natural selection by humans[6]. *C. carandas*, commonly referred to as the "Christ thorn tree," is an indigenous shrub that is harshly evergreen, spiky, and extensively planted in India's mountainous regions. It is a genus of the *Apocynaceae* family[7] (Figure 1). Although it originated in India, it is now widely grown around the world, including in Nepal, Afghanistan, South Africa, Malaysia, Indonesia, Sri Lanka, and Australia, among other places[8]. There are about twenty-five species in the genus *Carissa*, five of these species *C.carandas, C.spinarum, C.congesta, C.edulis, and C.grandiflora* are native to India[3]. In addition, vernacular names for *C. carandas*, are Christ's thorn or Bengal currant in South India, *Karonda* in Devanagari, koromcha in Bengali, vakkay in Telugu, kilaakkaai in Tamil, karamardaka in Sanskrit, karjatenga in Asam, karamadan in Gujarati, karaunda in Hindi, karimkar in Kannada and

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Malayalam, karamanda in Marathi, garna in Punjabi and karaunda in Urdu[1,9]. Due to its many curative qualities, this plant is utilized by people in India and has gained popularity in a number of ancient medical systems, such as *Unani, Ayurveda*, and *homoeopathy*[6]. Despite the fruit's enormous nutritional advantages, the lack of awareness depicts it as underestimated and disregarded[10]. The therapeutic and pharmacological effects of *Karonda*, fruits on human health are discussed in tremendous detail in this review.

2. Methodology

An extensive search for the literature was conducted through databases such as Scopus and WoS, the free resource of PubMed, as well as Google Scholar, in order to thoroughly examine the published articles pertaining to biological and pharmacological activity. Research for insights on the therapeutic and pharmacological impacts of *Karonda* fruits on the health of individuals is presented in the current review paper.

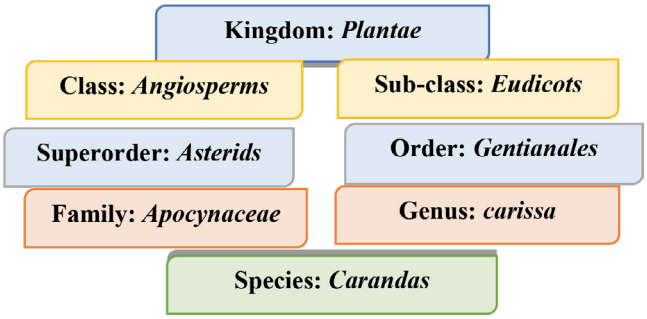


Figure 1. Taxonomical classification of *Karonda*[12].

3. *Karonda*: An Amazing Fruit for Superior Health

3.1 General Morphology of *Karonda* Fruits

The indigenous species of *Karonda* grows as a resilient, adaptable drought plant that can be cultivated in a variety of soil types and climates, including semi-arid and tropical regions. Throughout India, *Karonda* fruits act as an effective bio-fence and have been planted as hedge plants in fruit orchards, backyard gardens, and farmer's fields[11] (Figure 2).

The plants are perennially spreading shrubs that can reach a height of 1-2 meters as tiny trees. In June and July is when the planting must be done. From December to March, the plant begins to bloom, and from April to June, the fruit reaches maturity. Fruit maturity can be determined by analysing colour changes. Since not all of the fruits can develop at once, harvesting can be done three or four times[9]. When the fruits reach maturity, their green tint changes to white or reddish purple. When completely mature, these have round to rectangular shapes and a sweet, somewhat acidic juice. *C. carandas* contains an abundance of moisture, its shelf life is very short and fragile texture. Following that, the fruits are kept at room temperature for three to four days[13].

3.2 Therapeutic Effect of *C. carandas* L., Fruits

The *Karonda* fruit is renowned for its abundant vitamins and minerals while having a high level of flavonoids, tannins, anthocyanins, phenols, DPPH scavenging activity and other antioxidants[11]. *Karonda*



Figure 2. Morphology of *Karonda* fruits[14,15].

fruits were utilized to cure anthelmintic, antidiarrheal, and stomachic ailments. It is additionally reported to serve as an excellent appetizer. Traditional healthcare systems have utilized *Karonda* to treat a variety of illnesses, including ear aches, skin infections, fever, diarrhoea, constipation, stomach aches, and biliary dysfunction[1]. The fruits are abundant in iron, have antiscorbutic traits, may assist with treating anaemia, and have an appropriate amount of the antioxidant vitamin C. It is also used to treat neurological disorders, heart conditions, piles, and rheumatoid arthritis[16]. Historically, *Karonda* have been used to cure injuries, acidity, indigestion, and flatulence. The fruit of *C. carandas* is utilized for the treatment of many illnesses, such as leprosy, cough, colds, itchiness, fever, myopathic spasms, seizures, and malaria[17]. In the past, a variety of illnesses, including rheumatism, syphilis, oedema, rabies, stomach discomfort, hepatitis, heart conditions, headaches, syphilis, and asthma, have been treated through carissa species[18]. Unripe fruits have astringent, an appetizer, antipyretic, and anti-diabetic qualities in *Ayurvedic* medicine[19]. Fruits are also used to cure earaches and liver disorders[3]. In Azad Jammu and Kashmir, it is utilized as indigenous medicine for alleviating a variety of illnesses, including fever, colds, coughs, and jaundice[10]. The ancient Indian herbal healthcare system known as *Ayurveda* uses fruits that have been utilized for the management of different types of ailments, like biliousness, stomach aches, constipation, anemia, problems with the skin, anorexia, insanity, fresh and infected wounds, urinary abnormalities, and diabetic ulcers[7].

3.3 Nutritional Properties and Bioactive Compounds of Fresh and Dehydrated *Karonda* Fruits

The beneficial properties of *Karonda* fruits have been extensively utilized for millennia as a nutritional supplement and also in health care, are becoming more and more apparent to consumers[1]. The fruits of *Karonda* are plentiful in nutritional components that enhance flavour and increase food products shelf life. Research on the chemical constituents of dried and fresh *Karonda* fruit indicated that the dried fruit had a significantly more nutritional value apart from vitamin C than the fresh fruit[20]. For every 100 grams of fresh fruit, the fruits were found to provide 42 kcal of calories, 91% moisture, 1.1% protein, 2.9% carbs and fat, 200–500 mg of vitamin C, 2.1 mg of calcium, 28 mg of phosphorus, and 1619 IU of vitamin A[14,21].

3.3.1 Bioactive and Antioxidant Compounds

According to a study, *Karonda* contains 364 kcal of energy, 18.2% moisture, 9.6% fat, 160 mg calcium, 60mg phosphorus, 39mg iron, 62.93mg vitamin C, 19.32mg carbohydrate, and 15.64% crude protein per 100g of dried *Karonda*[14,22]. According to Laxmi *et al.*, 100g of dehydrated *Karonda* contains 0.394mg of total carotenoids[22], 260.74 GAE mg of total phenols, 525.83mg of total flavonoids, 36.39 TE mg of FRAP, and 350.80 TE mg of DPPH in terms of bioactive components and antioxidant activity[23].

3.3.2 Phytochemical Compounds

The following phytochemical compounds can be found in the fruits of *C. carandas*: Lupeol, carissol, rutin, epicatechin, epicatechin gallate, quercetin, kaempferol, piceatannol, resveratrol, syringic acid, vanillic acid, p-coumaric acid, caffeic acid, ellagic acid, chlorogenic acid, scopoletin and L-ascorbic acid, epimer of alpha-amyrin, linalool, beta-caryophyllene, carissone, carissate, carindone, urson, carinol, vitamin-C, lupeol and beta-sitosterol, isoamyl alcohol, isobutanol, and beta-caryophyllene[24-31].

3.4 Pharmacological Significance of *Karonda* Fruits on the Management of Diseases

Research demonstrates that the *C. carandas* embrace several kinds of pharmacological active components that are responsible for their different biological functions (Table 1, Figure 3).

4. Efficacy of Pre-treatment and Drying Techniques for *Karonda* Fruits

Many rural families can benefit from the use of these fruits as a source of income and nutritional supplements, as well as a resource of health. The most significant problem with *Karonda* fruit is its short storage life, which causes it to deteriorate within a few

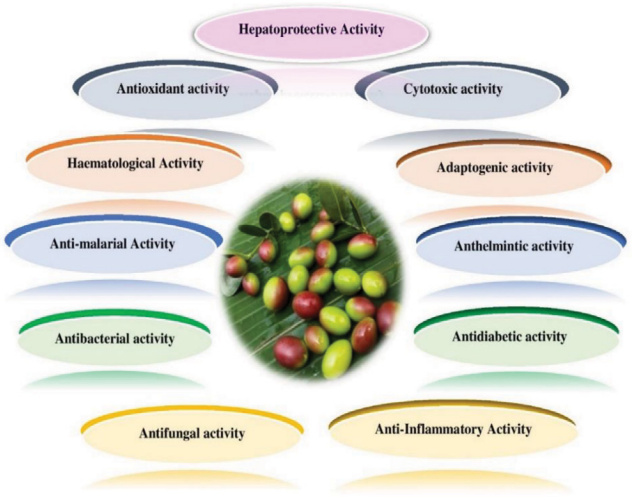


Figure 3. Pharmacological activity of *Karonda* fruits.

days of harvest[42]. Drying is regarded as one of the most effective and affordable ways to preserve fruit so that it is available throughout the entire year. By lowering the product's moisture content and microbiological growth, it extends its shelf life[43].

4.1 Pretreatment of *C. carandas* Fruits

One of the most effective and practical ways to extend the shelf life of fruits is osmotic dehydration. Because of its ability to retain taste, colour, flavour, and vitamins and minerals, this technique is favoured over others[44]. In a research investigation, the osmotically dehydration of *Karonda* was examined using a variety of osmotic solutions, such as sugar and jaggery, with varying concentrations (50, 60, and 70° Brix), and a 24-hour

Table 1. Pharmacological potential of *Karonda* fruits: Evidence from previous investigations

Pharmacological Significance of *C. carandas*	Aim and Methodology	Study Outcomes	References
Adaptogenic activity	After being separated from the fruits ethanolic extract, the lanostane triterpenoid was identified as Lanost-5-en-3βol-21-oic acid using spectroscopic techniques (UV, IR, H, C NMR, and MS) and its adaptogenic potential in experimental mice was examined.	According to the current study, experimental mice treated with the isolated chemical, identified as lanostane triterpenoid (Cc-01), revealed strong immunoprotective and adaptogenic properties.	Arif *et al.*,[32]
Anthelmintic activity	Analyze the *in vitro* anthelmintic efficiency of Indian Lumbricus terrestris by using *Karonda* fruit extracts of petroleum ether, chloroform. Timing the worms paralysis and death allowed researchers to assess the *in-vitro* anthelmintic potency of the different concentrations (50, 100, and 150 mg/ml) of the variable solvent extract.	Current research indicates that an anthelmintic effect of *C. carandas's* unripe fruit extract has been confirmed on Pheretimaposthuma.	Mishra *et al.*,[33]
Antidiabetic activity	In the current investigation, the hypoglycemic effects of hexane, chloroform, ethyl acetate, methanol, and aqueous extracts of *C. carandas* fruit was assessed in healthy Wistar rats. In order to monitor the blood glucose levels, 300 mg/kg body weight of AECC was administered to diabetic rats induced by streptozotocin.	After receiving ED50 of AECC for 28 days, diabetic rats showed significant improvements in their insulin levels ($p<0.05$), a reduction in Postprandial Glucose (PPG) of 33.65% ($p<0.01$), and it shows the positive significance ($p<0.01$) of an elevation in HbA1c of 45.79%.	Singh *et al.*,[34]
Anti-inflammatory activity	An earlier investigation explored at the anti-inflammatory properties of extraction of methanol from dried *Karonda* fruits given orally to the experimental rats with carrageenan-induced hind paw edema. The rats were given doses of dried fruit extract of 100, 200, and 400 mg/kg of total body mass.	Using the gas chromatography mass spectrometry technique to assess the phytochemical components of the extract, it was found that the dried fruits of *Karonda* contained 11 different compounds in the methanol extract. Hence, when compared with control, it demonstrates the positive significance ($P < 0.05$).	Anupama *et al.*,[35]

Cytotoxic activity	Finding cytotoxic substances in *C. carandas* extract is the intent of this investigation. The extract's and fractions cytotoxic potential were evaluated against eight cancer cell lines. Subsequent research resulted in the isolation of the new chemical Carissic Acid (CA), which comprehensive spectroscopic analyses affirmed.	Overall, the results indicated that carissic acid has a lethal effect on lung (A-549) cancer cell line by preventing cell proliferation and encouraging apoptosis.	Kour *et al.,*[36]
Antioxidant activity	The physicochemical and antioxidants abilities of certain of the *C. carandas* fruits have been assessed in this study. From the entire fruit pulp, hydrophilic and lipophilic extracts were taken and their antioxidant activity and TPC concentration were assessed.	By the ABTS and DPPH methods, the antioxidant activity of hydrophilic and lipophilic extracts of *Karonda* was considerably ($p<0.05$) higher. Furthermore, compared to the lipophilic extract, the hydrophilic extract had substantially ($p<0.05$) stronger antioxidant activity. The TPC and vitamin C concentration shown a very strong positive connection with antioxidant activity.	Prajapati *et al.,*[37]
Haematological activity	The study aims to determine how Feeding *Karonda* Whey Beverage (FKWB) affected the albino rats growth performance and haemoglobin markers. The control Group (G1) constituted the experimental group, and the treatment Groups (G2, G3, and G4) were fed a basal diet in addition to 10, 20, and 30% FKWB, respectively.	While RBC and WBC were similar across all groups, there was a significant improvement in haemoglobin levels ($P<0.05$) in the treatment groups. The HCT, MCV, MCH, and MCHC values were considerably ($P<0.05$) higher in the supplemented groups.	Sawant *et al.,*[38]
Antifungal and Antibacterial activity	By using disc diffusion method, both antifungal and antibacterial effects were evaluated in the extraction of methanolic and petroleum ether from unripe *Karonda* fruits with in vitro study.	In contrast, the isolates had modest antibacterial activity with ciprofloxacin and strong antifungal activity with fluconazole, a particular threshold.	Mishra *et al.,*[39]
Anti-malarial activity	The current study is to assess the antimalarial activity of *C. Carandas* fruits and their *in-vitro* antimalarial effects in opposition to the Plasmodium falciparum 3D7 strain.	When it came to antimalarial activity, the methanolic extract surpassed the aqueous extracts (IC50 ranged between 41.52 and >100 µg/mL) by demonstrating good results (IC50 ranged between 13.57 and 69.63 µg/mL).	Bapna *et al.,*[40]
Hepatoprotective activity	Using supporting data on *in vitro* and *in vivo* antiradical activity, the intent of the research is to evaluate the hepatoprotective effect of extracting *Karonda* fruits and administering them orally at doses of 200 and 400 mg/kg of body weight.	Fruit extract treatment would reduce the liver toxicity caused by CCl4; these effects can be attributed to the phytochemicals present, which include flavonoids, glucose, tannins, and phenolic components.	Singh *et al.,*[41]

dipping period. The osmo-dried *Karonda* made from T4 (70° Brix sugar syrup) was shown to be superior in terms of colour, texture, taste, and overall acceptability based on sensory evaluation. It also has an excellent shelf life and may be stored for over 90 days[45]. The study conducted by Suhasini *et al*., revealed that the osmotic dehydration of *Karonda* was achieved using a hot air oven and two different concentrations of NaCl (2% and 5%). Additionally, the dehydration time was varied, ranging from one to three hours. According to the findings, osmotic pre-treatment with 5% NaCl for three hours was deemed to be extremely effective and the maximum sensory score was obtained after 4 months of room temperature storage[46]. Although osmotic dehydration reduces the water activity of fruits and vegetables, it is widely used in the storage of

food commodities[47]. According to a study, there was a significant increase in weight loss, moisture loss, and solid growth gain slices of *Karonda* as the duration of osmosis and syrup concentration rose also osmo-dried *Karonda* made with 70° Brix sugar syrup has a good shelf life and may be stored for more than 90 days, according to the storability research[48,49]. A study revealed that, the best way to extend the shelf life of *Karonda* fruit is through thermal preservation, also known as blanching. This is the most widely used preservation method[50].

4.2 Primary Techniques for Drying *Karonda* Fruits

Mahajan *et al.,* state that research has shown that inexpensive drying techniques like the sun, hot air oven, and microwave influence the nutritional value of *Karonda* fruit. Mineral content and antioxidant activity were the dietary characteristics that were investigated. According to the findings, sun drying and low power microwaves are the optimal processing techniques for preserving the greatest number of nutritious components in *Karonda* powder. Additionally, when compared to oven-dried samples, both drying techniques demonstrated improved anthocyanin concentration and colour retention[42]. Another investigation examined the impact of three distinct processing techniques on the physical, nutritional, and phytochemical composition of the samples: Sun, freezing, and microwave drying. The results of this study obviously demonstrate that some processing techniques are beneficial for retaining more nutrients, and their primary goal is to educate consumers about the adverse effects of processing techniques[51]. Saxena *et al*., who have also tested these methods, report that cabinet drying improved ascorbic acid retention and reduced non-enzymatic browning[52].

5. Value Addition of *Karonda* Fruits

In spite of its excessive moisture concentration and delicate flesh, *Karonda* has an extremely short shelf life. The processing of fruit into value-added products has significant potential due to its strong nutritional and medicinal value. Although underutilized, *Karonda* fruits are processed to create a range of products with extra nutritional value, including jam[10], ready-to-serve beverages[53], pastry[54], vadiyam[55], salsa[56], alcoholic beverages[57], and *Karonda* squash[58] *etc.*

6. Conclusion

Plants are one of the most significant suppliers of medicinal components. The medicinal properties of plants have been known to improve people's health from ancient times to the present day by enhancing their capacity to cope with unpleasant and challenging scenarios. The fruits of the *C. carandas* have long been associated with a number of positive health effects that have been observed worldwide. As of right now, not enough information is available on *C. carandas* fruits in terms of the pharmacologic and therapeutic effects of *in vivo* human research. Therefore, to validate the potential responses of *Karonda* fruits that have been discovered in several animal investigations, more *in vivo* and clinical trials involving humans are required. Although *Karonda* contains a wide range of nutritional components, future research should concentrate on assessing its pharmacological and therapeutic effects in *in vivo* investigations with a sample of living individuals.

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