

Carissa carandas Linn. (Karonda): An exotic minor plant fruit with immense value in nutraceutical and pharmaceutical industries

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ABSTRACT :

Carissa carandas Linn. (Karonda) a native plant of Indo-Malaysia is best known for its fruits, which contain about 75 percent juicy edible pulp. The acidic pulp is a common ingredient in culinary preparations such as condiments, curries, beverages, jams in countries where the plant grows naturally. The fruit is pickled in salt solution which is rich of minerals, acids, phenolic compounds, terpenoids, flavonoids, vitamins, peptides and sugars. Ripe fruit is full of acids and micro and macro nutrients which combine well with sugars, and used to prepare a variety of jam. It is now considered as a valuable source of several unique products for the medicines against various diseases and also for the development of some industrial products. The present review includes comprehensive information on the chemical constituents, traditional uses, pharmacological actions and nutraceutical values of raw material and processed products. Karonda is relatively a new item yet to explore the full potential and a fruit that needs promotion and publicity in the international markets.

Key words: *Carissa carandas*, processed product, nutraceutical potential, phytochemistry, pharmacological activities.

INTRODUCTION:

Carissa carandas Linn. (F. Apocynaceae) is an important, exotic, minor fruit commonly known as Karonda 'Christ's thorn' which grows wild in bushes. In India it is cultivated in a limited way in the tropical and subtropical Mediterranean region⁽¹⁾. It is widely used medicinal plant by tribals throughout India and popular in various indigenous system of medicine like Unani, Ayurveda and Homoeopathy. Traditionally the plant has been used in the treatment of scabies, intestinal worms, diarrhoea, intermittent fever and reputed for its aphrodisiac, antipyretic, appetizer, antiscorbutic, anthelmintic, and astringent properties^(2, 3). The karonda is inhabitant and widespread throughout much of Burma, India and Malacca and dry areas of Ceylon; is rather generally cultivated in these areas as a dodge and for its fruit and the fruit is marketed in urban area. There are about 30 species in genus the *Carissa* being native of tropics and subtropics of Asia, Africa and Australia; four species in China⁽⁴⁾. It is a perennial plant and very easily maintained a hardy shrub, usually growing up to 12ft (4-5 m) high. The plant produces abundant whitish pink berry-size fruits in the monsoon tropical climate. The fruit is simple, succulent, fleshy, globular, 14-18 mm diameter. The epicarpis thin, whitish pink and of maroon colour when ripe. Mesocarp is acidic soft moist but not juicy. After drying

the fruit is shrunk and changed to dark brown colour⁽⁵⁾. The fruit exudes much gummy latex when being cooked but the rich-red juice becomes apparent and is used in cold beverages⁽⁶⁾. The sweeter types may be eaten raw but the more acid ones are best stewed with plenty of sugar. The alcoholic extract of the roots of *C. carandas* had been reported to possess cardiotoxic activity and antihypertensive activity⁽⁷⁾. The ripe fruit is cooling and acidic; used to treat sore throat, mouth ulcer and skin disorders⁽⁸⁾. The fruits possess significant amount of jelly grade pectin therefore a large number of factories have been built for making commercial jelly/jam and a product name 'Nakal cherry' which closely resembles the canned cherry fruits⁽⁹⁾. Equal quantity of fresh leaves, fruits and roots bark is grounded and taken once a day with water for eight days for the permanent cure of piles. The plant is used as component in a number of ayurvedic formulations, which includes: Hridya Hahakashaya, Marma Gutika, Kalkantaka Rasa, Kshudrakarvanda Yoga and Marichadi Vati^(10, 11). Ethanolic extract of the plant root has been reported for histamine releasing activity used to assess the intensity of snake poisoning^(12, 13). The chemical investigations on *C. carandas* had led to the isolation of several substances including β -sitosterol, lupeol, mixture of cardenolides, carissone and a new sub-

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stance, carindone⁽¹⁴⁾. *C. carandas* fruits have been used as a dietary supplement or medicinal food for centuries and are of increasing importance to consumers^(15, 16). A natural 'food colourant cum nutraceuticals supplement' was prepared from the ripe karonda fruits. The formulation had been named as 'Lalima'. 1 ml of this pigment suspension formulation is sufficient to give lovely red colour to one serving of any colourless beverage (100 ml) such as lemonade. One serve of such supplemented beverage may in addition contain 469.2 µg anthocyanin, 12.7 mg flavonoids, 14.1 mg phenol, with total antioxidant activities to be 390 µM Trolox Equivalent⁽¹⁷⁾. At present, many commercial fruit products are available in the market hence the present review will possibly act as bridge between nutraceutical food and industrial pharmaceutical potentials of *C. carandas*.

Traditional uses

The plant is commonly used as a condiment or additive to Indian, spices and cold beverages. The sweeter types may be eaten raw but the more acid ones are best stewed with plenty of sugar. Unripe fruit is good appetizer; astringent, antiscorbutic, cooling, acidic, stomachic, anthelmintic and leaf decoctions are given in the commitment of remittent fever⁽¹⁸⁾. Leaf extract is externally applied for curing leprosy. Two drops of plant oil is given with half cup of honey for controlling worms of minors⁽¹⁹⁾. Traditional healers of Chhattisgarh use the different plant parts to cover the cancerous wounds and to kill the maggots⁽²⁰⁾. Karonda is mainly used for making pickle, jelly, jam, squash, syrup and chutney at industrial scale. The ripe fruit emits gummy latex when it is cooked, but yields a rich red juice which becomes clear when it is cooled, so this is used as a refreshing cooling drink in summer. It is also sometimes substituted for apples to make an apple tart, with cloves and sugar to flavor the fruit. In many part of India fruits are commonly caring with green chilies to make a tasty dish taken with chapattis^(21, 22). In Konkan, India, root is pulverized with horse urine, lime-juice and camphor as a remedy for the itch⁽²³⁾.

Phytochemical constituents

The methanolic extracts of the fruit showed the presence of reducing sugar, flavonoids, protein, cardiolides, terpenoids, steroids, phenolic compounds, saponins and acids⁽⁵⁾. The chemical investigations of *C. carandas* had led to the isolation of several substances including β-sitosterol, lupeol, glucosides of odoroside-H, ursolic acid and a new cardioactive substance⁽²⁴⁾. The leaves were reported to have triterpenoid constituents as well as tannins, and carissic acid. Fruits contain a mixture of volatile principles like 2-phenyl ethanol, linalool, isoamyl alcohol, β-caryophyllene, benzyl acetate, carissol and lanost-5-en-3β-ol-21-oic acid^(25, 26). It also contains a mixture of sesquiterpenes, namely carissone and carindone as a novel type of C₃₁ triterpenoid⁽²⁷⁾, a new lignancarinol and carinol dimethyl ether diacetate⁽²⁸⁾ (**Fig. 1A-G**). Various fatty acids such as 66.42% palmitic acid, 9.36% stearic acid, 2.04% oleic acid and 0.99% linoleic acids were found in the seed. Reducing sugar glucose, galactose as well as amino acids serine, glutamine, alanine, valine, phenylalanine has been

reported in the fruit⁽²⁹⁾.

Pharmacological activities

C. carandas is known to possess extensive range of phytochemicals in its fruits that impart enormous medicinal value to the plant. These active constituents offer medicinal value to the plant. Pharmacological importance of the plant fruits has been evaluated by several researchers through *in vitro* and *in vivo* advances. These activities of *C. carandas* have been reported from the crude extract and their different fractions and isolates from fruit, leave and root.

Anti-inflammatory and anti-pyretic activity:

Methanolic extract of *C. carandas* leaves reduced the edema induced by histamine, carrageenan and dextran in rat hind paw at the dose of 200 mg/kg b.w. It exhibited maximum inhibition of inflammation, i.e., 72.10 %, 71.80 and % 71.90 % at the end of 3 hrs with histamine, carrageenan and dextran induced rat paw edema respectively. The methanolic extract of *C. carandas* leaves at the dose of 100 and 200 mg/kg p.o., showed significant reduction in yeast induced increased temperature in a dose depended approach and the effect also extended up to 4 hrs after the drug administration^(30, 31).

Anti-oxidant activity:

C. carandas is found to be a very potent antioxidant. The results suggest that *C. carandas* fruit extract was the most potent antioxidant as it exhibited exceptional reducing power, scavenging activity against Nitric oxide, DPPH and peroxide radicals. Good correlation was observed with radical scavenging activity of extracts, flavonoids and total phenolic content. All the antioxidant activities were compared with standard antioxidant such as ascorbic acid. Methanol extract exhibited the highest free radical scavenging activity at tested concentrations. High scavenging activity was observed with aqueous extract while petroleum ether and chloroform extract showed poor antioxidant activity⁽³²⁾. Total total flavonoid and phenolics were determined using aluminium chloride and Folin-Ciocalteu colorimetric method respectively⁽⁵⁾.

Anticancer activity:

The extracts of *C. carandas* fruits in chloroform, n-hexane and methanol were screened for their anti-cancer activity on the lung cancer cells and human ovarian carcinoma cells. All extracts showed excellent anti-cancer activity⁽³³⁾. Further, anti-cancer and antioxidant potentials of the extracts were analyzed by unusual antioxidant enzymes such as catalase, dismutase, superoxide, glutathione-s-transferase and glutathione on MCF-7 cancer lines. This study exhibited significant antioxidant activity, and fortification of cell death in MCF-7 cell line pretreated with *C. carandas* extracts. The researchers suggested the potential anti-cancer value of this medicinal plant fruit for future development of therapeutic drugs⁽³⁴⁾. Furthermore, *in-vitro* anti-cancer studies showed that aqueous ethanolic fruit extract (AEE) induces cytotoxicity at 800 µg/mL on HeLa cancer cells maintained in Dulbecco's Modified Eagle's Medium (DMEM). The study concluded that, regular daily intake of fruits in diet suggested with reduced risks of infectious diseases and cancer⁽³⁵⁾.

Anti-diabetic activity:

Anti-diabetic activity of aqueous extract of *C. carandas*

leaves are evaluated on alloxan induced and normoglycemic Wister rats, and it was found that the doses of 500 and 1000 mg/kg of the drug significantly ($P < 0.05$) reduced the blood glucose level of alloxan induced diabetic rats at 4, 8 and 24 hrs. Both doses of plant extract had significant ($P < 0.05$) hypoglycemic as well as anti-hyperglycemic property. Further, methanolic extract and its fraction of fruits were evaluated for anti-diabetic activity in alloxan induced diabetic rats. It is reported that the methanol extract and its ethyl acetate soluble fraction have significantly lowered the increased blood glucose levels at dose level of 400 mg/kg p.o. after 24 hrs, as compared to diabetic control. The researchers accomplished that the anti-diabetic potential of ethyl acetate portion over methanol extract is due to its partial purification achieved by fractionation which resulted increase the polymerization, and separation of secondary metabolites flavonoids and phenolic compounds^(36, 37).

Hepatoprotective activity:

Ethanol extract of roots of *C. carandas* (100, 200 and 400 mg/kg, p.o.) showed significant hepatoprotective activity against paracetamol induced and carbon tetrachloride hepatotoxicity by declining the activities of serum marker lipid peroxidation and bilirubin and significantly amplifying the levels of glutathione, uric acid, super oxide dis-

mutase and protein⁽³⁸⁾.

Cardiovascular activity:

The ethanolic extract of roots of *C. carandas* exhibited cardiotoxic activity and lowered the blood pressure. The cardiac activity of plant has been recognized to the presence of water soluble glucosides known as odoroside. The dose 45 mg/kg, i.p. caused significant (50.75%) decrease in arterial blood pressure ($P < 0.001$) and the frequency of heart rate was also reduced significantly. It was also found that the ethanol extract of plant possess potent hypotensive effect in normal rats⁽³⁹⁾.

Anti-malarial activity:

Methanolic and aqueous extracts of leaf, stem bark and fruit of the plant *C. carandas*, tested against *Plasmodium falciparum* 3D7 strain. Both aqueous and methanolic extract exhibited promising anti-malarial activity (IC_{50} ranged between 41.52 and 100 $\mu\text{g/mL}$) and (IC_{50} ranged between 13.57 and 69.63 $\mu\text{g/mL}$). The cytotoxicity of host cell was also analyzed on Madin-Darby canine kidney cell line by means of the MTT test that exposed no cytotoxicity in maximum dose tested⁽⁴⁰⁾.

Anthelmintic activity:

The different concentrations (50, 100, and 150 mg/ml) of fruits extract *C. carandas* in solvent petroleum ether (60-

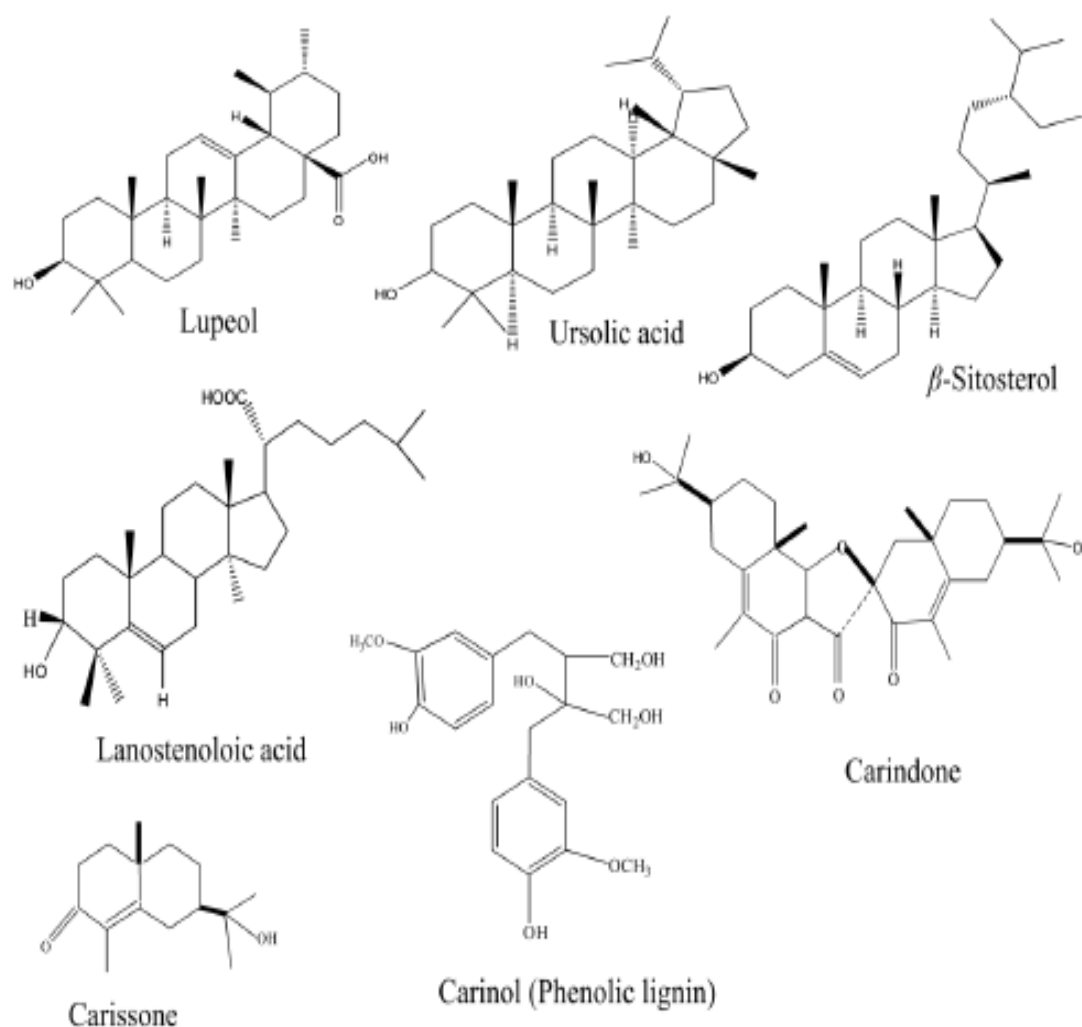


Fig. 1: Phytochemical constituents of *C. carandas*



Fig. 2; (A), *C. carandas* twig with leaves and fruits; (B & C) *C. carandas* homemade fruit pickles (D) *C. carandas* pieces of fruit in the jam (E) *C. carandas* smooth fruit jam, (F & G) *C. carandas* fruit murabba canned in sugar; (H & I) *C. carandas* marketed product of fruit (murabba).

80), ethanol and chloroform were evaluated *in vitro* anthelmintic potency on *Pheretimap osthuma* by determination of time of paralysis and time of death of the worm. The Piperazine citrate (15 mg/ml) was used as standard drug. It was concluded that the fruits extract of *C. carandas* causes earthworm paralysis and also its death after some time⁽⁴¹⁾.

Antiviral activity:

The ethanolic fruits extract of *C. carandas* possess effective antiviral activity against polio virus at 6 µg/ml HIV-1, Sindbis virus at 3 µg/ml and herpes simplex virus at 12 µg/ml⁽⁴²⁾.

Antimicrobial activity:

The ethanolic extract of fruit has powerful antibacterial action against different test bacteria like *B. subtilis*, *S. aureus*, *E. coli*, *S. faecalis*, *S. typhimurium* and *P. aeruginosa*. Moreover ethanolic extract has also showed extensive anticandidal action⁽⁴³⁾.

Adaptogenic activity:

The ethanolic fruit extract and lanostane triterpenoid isolated from the *C. Carandas* ethanolic extract were screened for adaptogenic activity using swimming endurance, anoxia stress tolerance and cyclophosphamide induced immunosuppression model. The levels of RBC, Hb, WBC, organ weight and body weight suppressed by cyclophosphamide

were estimated. It was observed that extract and lanostane triterpenoid significantly increased the swimming endurance, anoxia stress tolerance and normalized the RBC, Hb, WBC, changed organ and body weight ($P < 0.05$ and $P < 0.01$) suppressed by cyclophosphamide demonstrate that extract and isolated compound showed significant adaptogenic activity⁽²⁶⁾.

Processed product of *Carissa carandas*

Carissa carandas fruit is full of calcium, iron, vitamin C, vitamin A, and other nutrients used as food and treatment of many ailments like anorexia, diarrhea, anemia, blood sugar stabilization etc. (Fig. 2A). It freezes well and can also be kept in the fridge for long time or pickled in brine or canned with sugar.

Homemade fruit recipes

In north India fruits are made into condiment, pickles, syrups and jams. The tastes of fruit are extremely sour and make delicious by pickled with hot green chilies and garlic clove, both ingredients are packed with health benefits and increase the taste of the pickle. Karonda pickle is easy to prepare and ready to eat, this pickle can be made fresh or can be stored for at least four months (Fig. 2B -C).

It was found that chemical composition of the fresh and dried Karonda fruit showed that dried products contained

substantially higher nutrient content than fresh one with the exception of vitamin C which was almost half of that present in fresh one. The plant fruit is rich in nutrients, vitamins and minerals such as protein, carbohydrate, calcium, iron, carotene, vitamin B1, B2, C etc. (Table 1).

Table. Food and nutritional value of *Carissa carandas* fruit⁶

Components	values
Total acids	9 to 11 mg per 100 g.
Total Protein	0.39-0.66 g %
Total crude fat	2.57-4.63 g %
Fibers	0.62-1.81 g %
Carbohydrate	0.51-0.94 g %
Sugar	7.35-11.58 g %;
Iron	150 mg %
Calcium	115 mg %
Phosphorus	66 mg %
Energy (kcal/g)	338-342/lb calories (745-753/kg)
Ash	0.66-0.78 g %
Moisture	83.17-83.24 g %

Different colored fruits of karonda from purple to deep red are available in India which is used to make jam from them. Fresh and undamaged karonda fruits are washed properly and cut them in halves. Take out the seeds and place the fruit in heavy bottom pan containing water. Heat and boil the fruit in water. The moment fruit becomes tender, add sugar if you want the pieces of fruit in the jam and continue stirring. For the preparation of smooth jams the tender fruit can be passed through a sieve so a smooth pulp is obtained and then add sugar. Once cool, pack it in a glass bottle (Fig. 2 D-I).

The ripe fruits of karonda are boiled with baking soda and salt. For every cup of juicy pulp half tea spoon of baking soda is added and boiled in one liter of water at 100 °C. The mixture is then boiled down one half of the original quantity, removing the rising scum in the process and juice is again strained. For every cup a quarter cup of sugar is added. The mixture is again boiled for 40 minutes. The cool syrup is poured in to sterilized bottle and sealed⁽⁴⁴⁾.

Ayurvedic formulations

The plant is used as ingredient in a number of ayurvedic formulations and preparations. Marmagutika used in the treatment of vital organs, like diseases related to heart, brain, urinary system. Hridayamahakashaya is employed in the treatment of heart disease. Kalkantaka rasa, 'juice' or 'essence' used for mental disease. Marichadvati used in the treatment of diseases of respiratory conditions and black pepper is the first ingredient of this medicine⁽⁴⁵⁾.

DISCUSSION

The underutilized, edible raw fruits of *Carissa carandas* from the north eastern region of India were investigated for their nutraceutical and therapeutic potential. A thorough nutritional characterization of this fruit demonstrated it as a source of energy, natural antioxidants, phenolic compounds and minerals. It is a major source of ascorbic acid, iron, calcium, phosphorus and other nutrients. It has

diverse pharmacological activities like anti-inflammatory, anti-pyretic, anti-oxidant, anticancer, anti-ulcer, anti-diabetic, hepatoprotective, cardiovascular, antimalarial, anthelmintic, antiviral, antimicrobial and adaptogenic activity. The plant *Carissa carandas* easy to cultivate, free of serious pest and disease and its can be utilized as food or parts of food may provide medical health benefits including the prevention and or treatment of diseases. The bioactive ingredients of the plant fruits protect or promote health whether delivered from raw fruits, or processed foods, dietary supplements, extracts, beverages or other products. Phytoconstituents of the fruit i.e. organic acid, minerals, flavonoids, steroids, terpenoids and vitamins can act against allergies, tumors, ulcers, platelet aggregation and hypertension. Over the centuries, this plant has served as a major source of medicines for treating dysentery, anemia, diarrhoea, and prevention of diseases of mankind. There is an information gap on utilization, development and diversification required for commercial exploitation in Asian and African countries.

CONCLUSION

Karonda is relatively a new item yet to explore the full potential and a fruit that needs promotion and publicity in the international markets. It has been identified as a new addition to the available tropical fruit range with multiple uses. The demand for this fruit is limited mainly due to lack of awareness on food value of the fruit, its uses and non availability of organized supply. Therefore it is necessary to established large scale cultivation units where sizable quantities are made available for market promotion. Market promotion should focus mainly to create awareness on quality attributes nutritional value health value multiple uses etc. to introduce a product in the local and overseas markets. The plant fruits have played a prominent role in the diet and medicine of human beings, particularly in the tribal and rural areas of the country, for thousands of years. Educated/uneducated and unemployed youth of this region should engage themselves fully in the preparation of quality food and other related products from karonda fruits as a source of income.

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