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Full Research Article

Karonda (*Carissa* spp.): An Underutilized Minor Fruit Crop with Therapeutic and Medicinal Use

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Abstract

Karonda (*Carissa* spp.), a minor fruit crop is a source of ayurvedic and *unani* medicine and widely used in India as a medicinal plants by tribals. Different parts of this plant contain various chemical constitutents *i.e.* carissol, carissic acid, ascorbic acid, lupeol, β-sitosterol, glucose, galactose, serine, glutamine, alinine, valine, phenylalanine and glycine etc. This plant is commonly utilized for remedy of several diseases like biliousness, anemia and also used as aphrodisiac for women, antiparasitic, antifungal, antimicrobial, topical wound treatment (juice) and skin remedy. This paper reviews the literature supporting evidence for the medicinal and therapeutic uses of fruit, leaves, root and shoot of karonda along with its ethno-botanical relevance.

1. Introduction

Karonda (*Carissa* spp.) is a large dichotomously branched evergreen shrub with short stem and strong thorns in pairs belonging to the family Apocyanaceae (Wiart, 2006). In traditional system of medicine the plant is used as an anti-helminthic, astringent, appetizer and antipyretic, in stomach disorders, rheumatism, disease of the brain, in biliousness and biliary disfunction. Earlier studies have shown that the extract of the plant posseses cardiotonic, antipyretic and antiviral activity. Various cardiac glycosides, triterpenoidal constituents like carissone, carissin and β-sitosterol were reported from different parts of the plant. Different parts of this plant are used by tribals of the Indian subcontinent as effective remedies against several diseases and ailments.

2. Origin and Distribution

Karonda plant grows well under tropical and sub tropical climatic condition (Karale, 2002). The plant is commonly found in India, Srilanka, Java, Malayasia, Myanmar, Pakistan, Australia and South Africa. The berry-like fruits are believed to originate near the Himalayas, though some botanists place the fruit's origin to Java. Its natural range extends from Nepal to Afghanistan and encompasses several parts of India throughout that stretch. The fruit grows well throughout several regions in India including the Siwalik Hills, Bihar, West Bengal, the Western Ghats, Karnataka and the Nilgiri hills. Most karonda shrubs are ornamental, though the tribal areas of Madhya Pradesh, Chhattisgarh, Rajasthan, Gujarat and Jharkhand are known to grow the fruit on a limited scale. In Varanasi district of Uttar Pradesh and South 24-Parganas district of West Bengal, it is grown on a commercial scale. A few of the important cultivated species of karonda are *Carissa carandas* L., *Carissa grandiflora* DC, *Carissa bispinosa* Desf., *Carissa spindrum* DC, *Carissa ovata*, *Carissa edulis* Vahl., *Carissa inermis* Vahl. Syn. *Carissa macrophylla*, *Carissa paucinervia* D.C., *Carissa spinarum* L. Syn. *Carissa diffusa* (Pareek and Sharma, 1993; Singh and Arora, 1978). Natal plum, an African species (*Carissa grandiflora*), bearing large and dark red fruits are also grown in India.

3. Karonda plant

It is an evergreen spiny shrub or a small tree, which may attain a maximum height of about 3-6 meters. It is very popular as a protective hedge plant. It is a very hardy, drought-tolerant plant that thrives well in a wide range of soils including saline and sodic soils throughout tropics and subtropics. However it cannot thrive well in heavy rainfall and water logged condition

(Chadha, 2001). The stem is rich in white latex and the branches contain sharp spines. The leaves are oblong and conical, 4-6 inch long and 2-3 inch wide, green on the top and brown below. The bark is smooth gray. The bark is thick, soft and of red color from inside. Flowers are white or yellowish in colour and are found in groups. The Flowers are small, measuring 3-5 cm in diameter. The fruit is a berry, which is formed in clusters of 3-10 fruits. The fruit is globose to broad ovoid in shape and contains many seeds. Young fruits are pinkish white and become red to dark purple when ripe. Ripe fruit color varies from white, green and pinkish red depending on the genotype. Flowering starts in the month of January-February and fruits mature in May-June. Fruits are generally harvested at immature stage for vegetable purpose, fully ripen fruits are consumed fresh or processed.

4. Propagation

Karonda is commonly propagated by seeds and vegetative methods like stem cuttings, inarching and air layering. The fresh seeds are sown in nursery in the month of August or September. One year seedlings are transplanted. Karonda can be propagated by hard wood cuttings successfully. Though cuttings are difficult to root type, they may also be planted inside polyhouses which gives higher rooting because of high humidity under such structure. Soft wood grafting is also successful in karonda and is very useful technique for in situ propagation in arid regions. Air layering is quite successful in karonda and it is done in the beginning of monsoon. Rooted layers are obtained after 3-4 months of layering. Propagation of karonda has also been tried by inarching and found to be successful. However, compared to other methods, inarching is not very popular.

5. Fruit

Karonda fruit is a rich source of iron and contains a fair amount of vitamin C and therefore very useful for curing of anaemia and has antiscorbutic properties. Ethnomedically, fruits are used as astringent, antisorbutic and as a remedy for biliousness. In its raw state, the fruit is sour and acidic with little sweetness. In its ripest phase it becomes a bit sweeter, but only a few varieties become sweet enough to be edible in its raw state. Mature fruit contains high amounts of pectin and therefore besides being used for making pickles and chutney, it can be exploited for making jelly. Raw fruit can be used for making chatney (Kumar et al., 2007).

6. Leaf

Karonda leaves are palatable and contain a fair amount of nutrient which is browsed by sheep, goats and camels in arid and semi arid areas. If fruits fall on ground, enrich soil by adding organic carbon and other mineral nutrients. It reduces evaporation from soil underneath due to dense foliage. Leaves are used for feeding silk worm. Leaf decoction is used against intermittent fever, diarrheoea, oral inflammation and ear ache (Kumar et al., 2007). The leaves contain quercetin, kaempferol, leucoanthocyanins and vanillic and syringic acids (Pullaiah, 2006).

7. Root

Roots are heavily branched which improves binding capacity of soil. During rainy season, it minimizes run off and soil loss on sloppy land. Roots serve as stomachic, vermifuge, and as remedy for itches and insect repellant. Roots contain salicylic acid and cardiac glycosides causing a slight decrease in blood pressure. Reports reveals carissone, the D-glycoside of B-sitosterol; glucosides of oderside H; presence of carindone; lupeol; ursolic acid and its methyle ester; also carinol, a phenolic lignan in roots of karonda plants (Kumar et al., 2007).

8. Nutritional Value of Karonda

According to Morton (1987), Karonda (*Carissa carandas* L.) fruits contain 83.17-83.24 g of moisture, 0.39-0.66 g protein, 2.57-4.63 g fat, 0.51-0.94 g carbohydrates, 0.62-1.81 g fiber and 9-11 mg ascorbic acid per 100 gram of fresh fruit. Another study on the food value of karonda fruit published by the National Bureau of Plant Genetic Resources (Malik et al., 2010) provides the following nutritional information per 100 g of edible fruit: 42.5 kcal energy, 0.39-1.1 g Protein (negligible), 2.5-4.63 g Fat, 0.51-2.9 g Carbohydrate, 0.62-1.81 g Fiber, 21 mg Calcium, 28 mg Phosphorous, 1619 IU Vitamin A and 9-11 mg Ascorbic Acid.

The proximate composition and food value of fresh ripe and dry karonda fruits as reported by Anonymous, 1950 and 1979 respectively are mentioned below.

Composition of fresh fruit (Anonymous, 1950)		Composition of dry fruit (Anonymous, 1979)	
Constituents	*Values 100 g^{-1} edible portion*	*Constituents*	*Values 100 g^{-1} edible portion*
Moisture	91.0	Moisture	18.2
Protein	1.1	Protein	2.3
Carbohydrate	2.9	Fat	9.6
Fat	2.9	Mineral matter	2.8
Fiber	1.5	Carbohydrates	67.1
Calorific values (per 100g)	42.0	Calorific values (per 100g)	364.0
Minerals	*mg 100 g^{-1}*	Calcium	0.16
Calcium	21.0	*Minerals*	*mg 100 g^{-1}*
Phosphorus	38.0	Phosphorus	0.06
Iron	39.1	Iron	39.1

9. Phytochemical constituents

The roots of *C. congesta* have volatile principles including 2-acetyl phenol, lignan, carinol from root of *C. congesta* sesqui terpenes, namely carissone and carindone. The leaves were reported to have triterpenoid constitutes well as tannins, and a new isomer of urosolic acid namely carissic acid was also found. Fruits of this plant were reported to contain a mixture of volatile constituents including 2-phenly ethanol, linalool, ß-caryophylline, isoamyl alcohol, benzyl acetate and a novel triterpenic alcohol, carissol. Enzymatic mild hydrolysis of polar glycoside from the plant yielded oderoside H, digitoxigenin and the sugars D-glucose and D-digitalose. Moreover, *C. congesta* contains crude protein 13%, polyphenols 7.8%, fixed oil 5.3% hydrocarbons 58% and free acid 31.4%. Higher gross hest values of this species indicate that it can be used as fuel source. Essential oil from *C.congesta* was found to contain coumarin (Pino et al., 2004; Pal et al., 1975; Singh and Rastogi, 1972 and Reisch et al., 1990). It has been reported that fresh leaves of C.congesta contain four pentacyclic triterpenoids including one new constituent carissin and two hitherto unreported compounds (Joshi and Boyce, 1957; Siddiqui et al., 2003; Naim et al.,1988 ; Chandra, 1972 and Maheshwari et al., 2012)

Table 1: Different phytochemical constituents of Karonda plant and their probable therapeutic and medicinal role(s)

Sl. No.	Different phytochemical constituents of Karonda	Probable therapeutic and medicinal role(s)	References
Root			
1.	Salicylic acid	Anti-inflammatory compound and is known for its ability to ease aches and pains and reduce fevers	Kumar et al., 2007
2.	Carissone	Antibacterial compound	Lindsay et al., 2000
3.	Glucosides of oderside H	Anti-oxidant	Perry,1980 Wangteeraprasert and Likhitwitayawuid, 2009
4.	Carindone	Antibacterial activity	Lindsay et al., 2000
5.	Lupeol	Anti-inflammatory and Anti-cancer dietary Triterpene	Saleem, 2009
6.	Ursolic acid and its methyle ester	Anti-obesitic activity, Anti-cancer activity Cardioprotective compound	Liobikas et al., 2011; Shishodia et al., 2003 and Pathak et al., 2007
7.	Carinol (a phenolic lignan)	Antioxidant, Antibacterial compound	Hettiarachchi et al.,2011
Wood and Bark			
1.	Carissone	Antibacterial activity	Mohr et al., 1954;
2.	Carindone	Antibacterial activity	Lindsay et al., 2000
3.	Dehydrocarissone	Antibacterial activity	
Leaf			
1	Carissin	Anti-cancer and useful for treating Herpes simplex virus	Anonymous, 2013c
2.	3-hydroxy-27-p-E-coumaroyloxyurs-12-en-28-oic acid	Anticancer activity	Lee et al., 2000
3.	Oleanolic acid	Anti-inflammatory And Anti-hyperlipidemic , Hepatoprotective	Liu, 1995
4.	Ursolic acid	Anti-obesitic activity, Anti-cancer activity Cardioprotective	Liobikas et al., 2011; Shishodia et al., 2003 and Pathak et al., 2007
Fruit			
1.	2-phenly ethanol	Antimicrobial effect	Anonymous, 2013a
2.	Linalool	Antimicrobial effect	Park et al., 2012
3.	ß-caryophylline	Anti-inflammatory effect	Gertsch et al., 2008
4.	Benzyl acetate	Anti-Infective agents, Local Anti-Inflammatory agents,	Anonymous, 2013b
5.	Carissol	Anti-viral activity	Festus et al., 2009
6.	β-D-glucosides	Anti-microbial activity	Pullaiah, 2006
7.	Coumarin	Anti-HIV, Anti-tumor, Anti-hypertension, Anti-arrhythmia, Anti-inflammatory, Antiseptic and analgesic	Pino et al., 2004; Pal et al., 1975; Singh and Rastogi,1972 and Reisch et al., 1990, Liu, 2011
8.	Carissin	Anti-cancer and useful for treating Herpes simplex virus	Anonymous, 2013c

10. Ethno-medicinal use

Karonda has a lengthy history in Indian folk medicine. The roots of *Carissa carandas* have been used to treat inflammation and pain and to reduce the fever by the folklore people of south India. It is traditionally used as stomachic, antidiarrheal and anthelmintic; stem is used to strengthen tendons; fruits are used in skin infections and leaves are remedy for fevers, ear ache and syphilitic pain (Khare, 2007; Kirtikar and Basu, 1999; Nadkarani, 1976 and Anonymous, 1995). In traditional medicine the fruit is used to improve female libido. The fruits have anti-microbial and antifungal properties and theirs juice used to clean old wounds which have become infected. The juice can be applied to the skin to relieve any skin problems. Traditionally karonda has been used to treat anorexia and insanity. Tribes in the Western Ghats use the fruit as a blood sugar stabilizer and as a guard against liver damage. Traditional healers of Chhattisgarh use different parts of this plant for treatment of different types of cancer. A Karonda decoction prepared by mixing its roots, flowers, spines, leaves and fruits in equal proportion and crushed to make an aqueous paste, is applied at very initial stages of cancer. This paste is boiled in water and when half quantity of water remains, the boiling is stopped and lukewarm decoction is used to wash the cancerous wounds. The healers claim that this decoction is having immense potential to heal the wound and make it infection free. In many ways, it acts in more promising ways than Neem (*Azadirachta indica*) plant parts. Many healers boil the aqueous paste in Sarson (Mustard seed) oil and when all watery contents evaporate, the boiling is stopped and special oil is used for wound dressing. The vapours from a hot aqueous root bark infusion are inhaled as a treatment for chest congestion. Root extract is also useful against skin allergy.

11. Therapeutic use

Different plant parts of *Carissa* spp. have been utilized for remedy of several diseases like biliousness, anemia. These are also used as aphrodisiac for women, antiparasitic, antifungal, anti-microbial, topical wound treatment (juice) and skin remedy. Chloroform and Menthanol extracts of root showed antibacterial activity (Omer et al., 1998). Alcoholic extractof root material decrease the blood pressure (Chatterjee and Roy, 1965) and aqueous extract of the root is reported to have various pharmacological activities like histamine releasing (Joglekar and Gaitonde, 1970), anthelmintic, sapsmolytic and cardiotonic (Zaki et al., 1983). Fruits have also been studied for its analgesic, anti-inflammatory (Sharma et al., 2007) and lipase (Mala and Dahot, 1995) activity. The karonda fruit is an astringent, antiscorbutic and as a remedy for biliousness and useful for cure of anaemia. The root extracts of *Carissa carandas* are known to have anti-inflammatory and antipyretic properties (Bhaskar and Balakrishnan, 2009a). The root bark has been found to have potent anthelmintic properties comparable to the drug, albendazole (John et al., 2007) and hemaprotective properties with efficacy, equivalent to the liver drug, silymarin (Bhaskar and Balakrishnan, 2009b and Hegde and Joshi, 2009). Chloroform extracts of *Carissa carandas* leaves also exhibited cytotoxicity on human ovarian carcinoma cells and n-hexane extracts of the unripe fruits is cytotoxic towards the lung cancer cell line (Sulaiman et al., 2008).The root extracts of this plant are known to have anticonvulsant activity in experimental mice (Hegde et al., 2009).

12. Other uses

Immature fruits are used as vegetable while mature fruits are eaten raw. The berry sized fruits are used as a condiment or additive to Indian pickles and spices. Fruits are also processed as jam, jelly and marmalade for domestic use as well as commercial preparations for export purpose (Malik et al., 2010). The fruit is very sour at maturity but it is sweet and sour when ripe. It is eaten fresh or stewed with salt or sugar. It contains pectin and is a useful ingredient in food processing. In Rajasthan karonda fruits are commonly cooked with green chillies to make a tasty dish taken with chapattis. Karonda bushes are suitable for hedging in the home gardens and are sometimes grown as an ornamental plant due to its beautiful cherry-like fruits. The roots of the plant are heavily branched, making it valuable for stabilizing eroding slopes (Morton, 1987). The roots extracts are also used as insect repellent (Malik et al., 2010).

13. Conclusion

Though karonda is a minor fruit its therapeutic and medicinal utility is immense. More research on this aspect can only help in unraveling these potentials of this neglected fruit plant which is otherwise grown as ornamental hedges in India. The pharmacologically active ingredients of this plant should be identified, isolated and tested for their efficacy against different pathogens. This fruit should be incorporated in to the daily diet of people to avail the goodness of this fruit.

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