



CHAPTER- 2
REVIEW OF
LITERATURE

REVIEW OF LITERATURE

This chapter takes through review of available ancient literature pertaining to ayurveda, medicobotany and ethnobotany to understand use value on genus *Carissa* L. in general and species under study in particular. It also includes review of botanical, phytochemical and biological investigations. This review is essential to plan work and to follow certain methodologies during studies.

References have been availed from various books scientific journals and internet search including Pub-Med, Sci-Finder, Science direct, WEB of Science, SCOUNPS etc. Besides library of Agharkar Research Institute, libraries of Botanical Survey of India, Khadiwale Vaidyak Sansthan, Indian Drug Research Institute from Pune and National Botanical Research Institute, Central Institute Medicinal and Aromatic Plants and Central Drug Research Institute from Lucknow have been consulted for the same.

The review has been classified into Use Value literature, Botanical literature, and Phytochemical and Pharmacological literature as follows:

2.1 Use Value Literature:

All the species in genus *Carissa* are known worldwide for edible fruits (Singh, *et al.*, 1963; Watt, 1889; Anonymous, 1993). This use value is also reported in ethnobotany literature. Fruits of *Carissa carandas* L. have been reported as edible (Borthakur *et al.*, 1999; Hebbar *et al.*, 2003; Ram Murthy *et al.*, 2003; Bhatt *et al.*, 2004). Edible value of fruits of *Carissa congesta* Wight has been reported (Vartak, 1959, 1981; Singh and Arora, 1978; Shah, 1980; Shah *et al.*, 1981; Singh and Singh, 1981; Vartak, 1981; Diwakar and Ansari, 2003; Kumar, 2003; Mitaliya and Bhatt, 2003; Singh, 2003; Vyas, 2004). This edible value also has been reported for *Carissa opaca* Stapf ex Haines (Jain and De, 1966; Maheshwari and Singh, 1984; Ansari, 1998) and for *Carissa spinarum* L. (Singh and Arora, 1978; Abraham, 1981; Ramchandran and Nair 1981; Chettu, 1999; Dwivedi, 2003; Murthy *et al.*, 2003).

2.1.1 Review of traditional system of medicine:

Utility of fruits as medicine, particularly as cardio-tonic, has been reported in Indian system of medicine under the name '*Karmarda*' and a product '*Marmagutica*' has also been reported (Trivedi *et al.*, 1963; Deshpande *et al.*, 1989; Anonymous, 1999, 2005).

- 1 आम्नामातकलिकृचकरमर्दवृक्षाम्लाम्लवेतसकुवलबदरदाडिममातुलुङ्गोनीति
दशोमानि हृद्यानि भवन्ति -10, इति चतुष्कःकषायवर्गः ॥10॥ चरकसुत्रस्थान अध्यायः 4/10
- 2 करमर्दीत्रिकण्टकसैरीयकशतावरीगृधनरब्यइति कण्टकसैज्ञ : 73
रक्तपित्तहरौ ह्येतौ शौफत्रयविनाशनौ ॥
सर्वमेहहरौ चैव शुक्रदोषविषनाशनौ ॥ 74 ॥; शुश्रुतसुत्रस्थान अध्यायः 38/78
मधुरो वर्ग :
- 3 दाडिमामलकमातुलुङ्गोमातककपित्थकरमर्दबदरकोलप्राचीनामलकतिन्तिडीककोशाम्रकभब्यपरा
वतवेत्रफललकुचाम्लवेतसदन्तशठदधितञ्कसुराशुत्कसोवीरकतुषोदकधान्याम्लप्रभृतीनि
शुश्रुतसुत्रस्थान अध्यायः 42/11
- 4 करमर्दकमाविघ्नं सुषेणं पाणिमर्दकम् ।
कराम्लं करमर्दं च कृष्णपाकफलं मतम् ॥” (ध.नि.)
- 5 अम्लं तृष्णापहं रुच्यं पित्तकृत्करमर्दकम् ।
पक्वं तु मधुरं शीतं रक्तपित्तहरं मतम् ॥”(ध.नि.)
- 6 करमर्दः सुषेणः स्यात्कृष्णपाकफलस्तथा ।
तस्माल्लघुफला या तु सा ज्ञेया करमर्दिका ॥ (भा.प्र. 77)
- 7 करमर्दद्वयं त्वाममम्लं गुरु तृषाहरम् ।
उष्णं रुचिकरं प्रोक्तं रक्तपित्तकफप्रदम् ॥
तत्पक्वं मधुरं रुच्यं लघु पित्तसमीराजित् । (भा.प्र. 78.79)
- 8 करमर्दः सुषेणश्च कराम्लः करमर्दकः ।
आविघ्नः पाणिमर्दश्च कृष्णपाकफलो मुनिः ॥ (रा.नि.)
- 9 करमर्दं सतिक्ताम्लो बालो दीपनदाहकः ।
पक्वस्त्रिदोषशमनो रुचिघ्नो विषनाशनः ॥ (रा.नि.)
- 10 कृष्णपाकफला प्रोक्ता सुषेणा करमर्दिका ।
वनेक्षुद्रा क्षीरफेना साम्लपुष्पा च तत्फलम् ॥
पाणिमर्दकमाविग्नं कराम्लं स्थलमर्कटम् । (कै.नि.)
- 11 करमर्दं गुरुणाम्लं रुच्यं पित्तकफासकृत् ।
तूड्वातजित् सरं पक्वं लघु स्वादु कफासजित् ।
शुष्कं पक्ववदप्यामं पक्वमप्यार्दमामवत । (कै.नि.)
- 12 करमर्दफलं चार्दमम्लं पित्तकफप्रदम् ।
भेदनं चोष्णवीर्यं च वातप्रशमनं गुरु ॥
पक्वशुष्केल्पित्ते च तन्मूलं कृमिनुत्सरम् । (सो.नि.)
- 13 करमर्दफलं चामं तिक्तं चाग्निप्रदीपकम् ।

गुरुपित्तकरं ग्राहि चाम्ळमुष्णं रुचिप्रदम् ।
 रक्तपित्तं कफं चैव वधयेत्तृड्विनाशकम् ॥
 तत्पक्वं मबुरं रुच्यं लघु शीतत्रूच पित्तहम् ।
 रक्तपित्तं त्रिदोषत्रूच विषं वातत्रूच नाशयेत् ॥
 तच्छुष्कं पक्वसदशं गुणाज्ञेय विचक्षणैः
 अत्यम्लस्य गुणाश्चैव ज्ञेया आमकराम्लवत् ॥ (नि.र.)

According to Charakasamhita (Ray and Gupta, 1965), the first written treatise of Ayurveda, Karmarda (*Carissa L.*) is amongst the ten fruit drugs 'Phaladivarga' which are cordials (Su 4/10). Charakasamhita (Su 27/ 161) also states that as the drug is sour, it causes internal haemorrhage. In Sushrut (Su 38/78, Su 42/11) it is mentioned as one of the ingredient in '*Kantak panchamula*' the roots are '*Raktapitta hara*', '*Shoth nashak*', '*Sarvamedhara*' and '*Shukra shodak*'. In Astangahrydaya, it has been reported amongst '*Amlagana*' (Su 10/26-26). The unripe fruits of *Carissa amla*, *ruchya*, *trishnahara*, *deepani*, *graahi*, has been reported to aggravate *kapha*, *pitta* and *rakta* while ripe fruits are reported to be easily digestible, mitigates *pitta* and *vata* in Bhavaprakash of Bhavamisra 1550 AD (Chunekar and Pandey, 1982), Dhanwantariya nighantu (Kamat and Mahajan, 1972), Kaiyadev nighantu 1450 AD (Sharma and Sharma, 1979), Raj nighantu 1500 AD (Tripathi, 1982), Nighantu ratnakar. Insecticidal property of root has been mentioned in Shodhal nighantu (1978).

विदारिजीवन्तिवरी समुस्तावासहिकूवाकूरुविकिलडुःगुम् ।
 नेल्लिककनन्तारिगुलूचिदूर्वा प्रत्येकमूलकुडवांशभागान् ॥
 यष्टी चन्दनचुं नल्लरक्तचन्दमेन्व ।
 अरच्चुचाणमेल् मूनुंचेव्वेर नालिकोल्लुग ॥
 सहरत्रवेधिकन्नारं कन्मदं पालुनिर्वाशि ।
 गरुडप्पच्चयुं कूट् टिपलार्धड लितंचुने ॥
 ओक्के कूटिटयरप्पानाप् कषायंवक्कमौषधम् ।
 तलनीलि कोलुप्पा च पोन्नाडाणि च मूर्ववेर ।
 नाल्पामराणां मुकुलं तोट्टाम्बालत्रजेरिञ्जिलुम् ।
 इरुबेलि सरामच्चं पलमीरण्डुकोल्लुग ॥

द्वादशप्रस्थ वेल्लत्तिल कषायं वच्चरक्षुक ।
नाल्पामरत्वक् पाच्चोद्विआरपुल्लानिपेडु तोल् ।
करिंकारयुडे तोलुं निशात्वक पूर्ववत् पचेत् ।
कल्लूस्वजियदिन्केरु पलमेदुल कूट्टक ॥
षोडशप्रस्थवेल्लत्तिल कषायं वच्चरक्षुग ॥
मून्नामत्तेयरप्पिन्नु मुद्गमांषड लेलवुम् ॥
कूट्टिपचिच्चुकूट्टेणं सर्वमर्म विकारजि । (Sahasrayoga Gutikaprakarana, 53)

Formulation of Marmagutika in which Karmada has been included is used for vital organs and *aghata* (Anonymous, 1989).

2.1.2 Medicobotany review:

According to Indian Materia Medica (Nadkarni, 1976) these properties have been assigned to *Carissa carandas* L. Fruits of *Carissa carandas* L. are described as rucha, trishnahara, deepani, graahi, raktapittahara, twagdosshara, stomachic, antiscorbutic, and refrigerant, digestive. Fruits are reported to treat the cardiac diseases, haemorrhage and diseases of nervous system. Unripe fruits are sour, tasty, astringent and antiscorbutic, always thirst causes biliousness, kapha and blood impurities where as ripe fruits have cooling and digestive properties and used as appetizer and as cardio tonic (Desai, 1927; Kirtikar and Basu, 1935; Trivedi *et al.*, 1663; Sawant, 1974; Nadkarni, 1976; Anonymous (Satyavati *et al.*,) 1976; Deshpande *et al.*, 1989; Singh *et al.*, 2000; Sharma *et al.*, 2001). Unripe fruits are sour, astringent, bitter, thermogenic, constipating, anaphrodisiac, appetizer and antipyretic, and are useful in vitiated conditions of pitta and kapha, hyperdipsia, diarrhea, anorexia, and intermittent fevers. The ripe fruits are sweet, cooling, appetizer and antiscorbutic, and are useful in anorexia; vitiated conditions of pitta and vata, burning sensation, skin diseases, scabies and pruritus, roots have purgative properties (Anonymous, 1993).

Similar use value of *Carissa carandas* L. has also been recorded in ethnobotany (Naim *et al.*, 1988; Hasnain and Ali, 1990; Vaghasiya and Chanda, 2007). Otherwise use value of *Carissa carandas* L. fruits is also recorded in ethnobotany viz. ripe fruits are used to treat mouth ulcer, sore throat and skin disorders (Burkill, 1935); to cure cough (Verma and Chauhan, 2006); scurvy (Dwivedi, 1999); skin diseases and burning sensation (Vanila

et al., 2008); Diarrhea, dysentery, venereal diseases, gonorrhoea and syphilis (Ashton *et al.*, 1997); sour unripe fruits are reputed for their aphrodisiac, appetizer, antipyretic and astringent properties and are used in the treatment of diarrhea and intermittent fever (Jayaweera, 1981); fruits are used to treat the cardiac diseases, haemorrhage and diseases of nervous system (Hebbar *et al.*, 2003), leaves refrigerant in fever (Nadkarni, 1976); Roots are anthelmintic, bitter, stomachic and are used in Konkan, pounded with horse urine, lime juice and camphor as a remedy for itch (Kirtikar and Basu, 1935).

According to (Morton and Miami, 1987) *Carissa congesta* Wight fruits have similar properties as described for *Carissa carandas* L. i.e. unripe fruits are used medicinally as an astringent while ripe fruits are taken as antiscorbutic and remedy for itches. Ripe fruits are digestive and alterative (Anonymous, 1986; Husain *et al.*, 1992). Juice in large dose acts as ecobolic, astringent and used to remove freckles and other blemishes from the skin, anthelmintic (Anonymous, 1986; Husain *et al.*, 1992). Fruits of *Carissa spinarum* L. are used in the treatment of scurvy (Dwivedi, 2003).

Medicinal use of other parts of Karmarda (*Carissa* L.) is rarely found in ancient literature. Recent literature on medicinal plants brings on record use value of bark and fruit as medicine (Anonymous 1999, 2005). Root bark is used for skin rash, scabies & snake bite. Root is used for fever, kapha, vatta, wormifuge, diarrhea, and urinal and in the treatment of wound in animals; leaves are used in cough & fever (Trivedi *et al.*, 1663; Deshpande *et al.*, 1989; Anonymous, 1999, 2005). Paste of roots of *Carissa carandas* L. is used as a remedy for itch (Dymock *et al.*, 1891); roots are anthelminitic, stomachic and antiscorbutic, and are useful in stomach disorders, intestinal worms, scabies and pruritus (Anonymous, 1993). Decoction of leaves is given in remittent fever (Nadkarni, 1976); decoction of leaves is used for the febrile complaints (Dymock *et al.*, 1891).

Roots of *Carissa spinarum* L. pounded and mixed with country liquor made from *Madhuca longifolia* flowers are applied on sore for removing the worm, Body pains, cuts, injuries. Paste with cold water is administered orally in fever (Kirtikar and Basu, 1935). Roots of *Carissa opaca* Stapf ex Haines are purgative, also used in worm infested sores of animals; juice of roots in wounds of cattle (Anonymous, 1976)

2.1.3 Ethnobotanical review:

Lots of references have been found in ethnobotany literature. Species specific use value has been compiled as follows:

2.1.3.1 *Carissa carandas* L.

Decoction of roots is used in cough (Verma and Chauhan, 2006); stomachic and anthelminthic (Burkill, 1935; Balasingh *et al.*, 2000; Ranjan, 2003; Vaghasiya and Chanda, 2007; Vanila *et al.*, 2008); Roots ground in lemon juice are used for curing asthma (Rajakumar and Shivanna, 2009). Roots crushed into fine powder and mixed with coconut oil is used in snake bite, fever (Sawant, 1974); root bark moistened with water and scraped with stone and the paste is applied externally to the area of a diabetic ulcer to cure for preventing diabetic gangrene (Bennet, 1978). Juice of leaves with honey is given in whooping cough (Verma and Chauhan, 2006); Decoction of leaves given in remittent fever (Balasingh *et al.*, 2000).

2.1.3.2 *Carissa congesta* Wight

Pulp of macerated roots applied on the wound to hasten healing (Mokat and Deokule, 2004), paste of roots in lime juice is used in skin diseases (Kothari and Rao, 1999); roots in combination with other roots are used in rheumatism (Parveen *et al.*, 2007); paste of the pounded roots serves as a fly repellent (Morton and Miami, 1987).

Leaves ground with rhizome of *Curcuma longa* in to a paste and applied on wounds & sores (Bhandary and Chandrashekar, 2003); used in asthma (Kothari and Rao, 1999); decoction of leaves is valued in cases of intermittent fever, diarrhea, oral inflammation and earache (Morton and Miami, 1987).

2.1.3.3 *Carissa opaca* Stapf ex Haines

Root- purgative, in worm infested sores of animals, root juice in wounds of cattle, used as contraceptive (Singh and Zaheer, 1998; Srivastava *et al.*, 2003); roots are used to cure fever, it is good in eye disorders, fruit mixed with roots of *Mimosa pudica* is taken as aphrodisiac (Acharya and Rai, 2011); root paste along with the root paste of *Bombax cieba* and rhizome paste of *Acoras calamus* is applied on the chest and back for the treatment of Pneumonia (Singh and Prakash, 1994); decoction of the root bark is given in the treatment of fever (Singh and Maheshwari, 1983, 1985; Maheshwari, 1986; Singh and Kumar, 1999); controlling fertility (Maiti and Manna, 2000); antirheumatic (Husain *et al.*, 1992).

Decoction of leaves mixed with curd or milk is given to cure dysentery and cough (Maheshwari and Singh, 1987); fruits and leaves are cardiac stimulants, leaf decoction is used for asthma (Saghir *et al.*, 2001); leaf and root are used in fever (Kala, 2007).

2.1.3.4 *Carissa spinarum* L.

Root powder is highly poisonous and is given as laxative, paste is applied to treat wounds (Raveendra and Martin, 2006); paste of roots with water taken orally to cure evil eye or smoke produced by sprinkling powder of roots on the burning charcoal is inhaled in the disease of evil eye (Teklehaymanot and Giday, 2007); Root paste is used in body pains, cuts, injuries; paste with cold water given orally in fever (Pal and Srivastava, 1976); in treatment of rheumatism (Bhatnagar and Raina, 1970; Nayak and Choudhary, 2003); roots pounded and mixed with country liquor made from *Madhuca longifolia* flowers and applied on sore as medicine for removing the worm (Pal, 1980); used as laxative, on malignant ulcers as an antibiotic (Uniyal and Chauhan, 1973); used in eye diseases and for scabies treatment (Kapur, 1993); roots are used against the bleeding after delivery (Giday *et al.*, 2007); root powder is taken with water as a purgative (Singh *et al.*, 2002).

Leaf juice and stem decoction is given to control intermittent fever. Stem bark with the other plant is grounded together and given orally in ephemeral fevers & anthrax in cattle (Reddy *et al.*, 1997).

This review reveals that fruits, roots and leaves of four species viz. *Carissa carandas* L., *Carissa congesta* Wight, *Carissa opaca* Stapf ex Haines and *Carissa spinarum* L. are used as medicine. These ethno-medico-botany claims however, needs validations.

2.2 Botanical literature:

2.2.1 Taxonomy:

Carissa L. is a genus of more than sixty species distributed mostly in warm parts of Africa, Australia and Asia. Hooker (1882) described five species of *Carissa* L. from the Indian subcontinent with special note that the species in the area are very difficult to define and may probably be reduced to one or two variable types. Cooke (1957) described four species from Bombay Presidency indicating *Carissa carandas* L. as the most common species distributed throughout the region whereas *Carissa inermis* Vahl, *Carissa spinarum* L. and *Carissa suavissima* Bedd. ex Hook. are found only in southern regions. In addition, a mention has been made about *Carissa arduina* Lamk., as exotic species grown in gardens. Talbot (1911) also recorded occurrence of four species from Bombay Presidency with remarks that all the four species are closely allied, only apparently differing in habit,

vestature of leaves and size of flowers and fruits. Talbot considers *Carissa suavissima* as just a variant of *Carissa inermis*, and differs with latter in glabrous cymes and climbing habit. Diversity within and between the species of Indian *Carissa* L. has been described by Haine (1929) where five distinct species were classified and described diversity within species at varietal level. Santapau (1967) described *Carissa congesta* Wight. and *Carissa congesta* Wight var *albida* Santapau from Khandala region with comments on confusion of the species identity in Indian floras particularly with reference to *Carissa congesta* Wight and *Carissa carandas* L. describing the differences, claiming occurrence of only *Carissa congesta* Wight widely and wildly in India. Also record had been made about intra-specific variability on the basis of fruiting characters, one from smaller fruits in which the sweetness improves when it is over-ripe while the other from with larger with fruits, deteriorates fast at the stage of over-ripening and develops a taste similar to fermenting sugar. Fruit based diversity within and between the species has also been reported by Ghate *et al.*, (1999). Prasanna in Flora of Maharashtra State by Singh *et al.*, (2001): Dicotyledones records occurrence of three species from Maharashtra state viz. *Carissa congesta* Wight, with two varieties *Carissa congesta* Wight var. *congesta* and *Carissa congesta* Wight var. *albida* Santapau, *Carissa inermis* and *Carissa opaca* Stapf ex Haines. Almeida in Flora of Maharashtra (2001) enumerated five species and one variety of *Carissa* of which *Carissa bispinosa* (*Carissa arduina* of Cooke) is cultivated and other three *Carissa congesta* Wight *Carissa carandas* L., *Carissa inermis* and *Carissa villosa* growing wild. *Carissa villosa* is accepted name for *Carissa spinarum* L. by Almeida.

In the international list of valid names www.tropicos.org *Carissa spinarum* L. is the only valid name for *Carissa carandas* var. *congesta*; *Carissa carandas* var. *paucinervia*; *Carissa congesta* Wight; *Carissa paucinervia*; *Carissa suavissima*; *Carissa villosa* Karthikeyan *et al.*, (2009) on the other hand claims occurrence of total 10 species viz. *Carissa carandas* L., *Carissa congesta* Wight var. *congesta* var. *albida*, *Carissa gangetica* Stapf and Gamble, *Carissa grandiflora* A. DC., *Carissa hirsuta* Roth, *Carissa inermis* Vahl var. *inermis* var. *dalzellii* Haines, *Carissa opaca* stapf ex Haines, *Carissa paucinervia* A. DC., *Carissa salicina* Lam., *Carissa spinarum* L. var *spinarum*. var. *microphylla* Gamble, var. *scandens* Haines in India. **This reference has been used in present work to describe validity of species.**

All the above mentioned literature indicates diversity and ambiguity in species delimitation.

2.2.2 Pharmacognosy:

Literature review on pharmacopeial standards reveals that *Carissa carandas* L. has been studied for microscopic and the diagnostic characters of the powder of root bark (Chauhan and Pillai, 2005); macroscopic, microscopic character and preliminary phytochemical have been studied for stem bark (<http://ayurvedaconsultants.com>; Anonymous, 1999, 2001); macroscopic and microscopic characterization of fruit (Anonymous, 2005); limit tests -foreign matter 2%, total ash 12%, acid insoluble ash 3%, alcohol soluble extractive 4%, water soluble extractive 8% (<http://ayurvedaconsultants.com>). Histological study of roots of *Carissa carandas* L. and *Carissa spinarum* L. has been carried out (Singh *et al.*, 1963). Microscopic characters of root of *Carissa spinarum* L., ash values, fluorescence characters of the powdered roots have also been determined (Bhatnagar and Raina, 1970). Structural stomatal studies have been done for *Carissa carandas* L. (Patel, 2005); epidermal and venation studies of *Carissa carandas* L. have been reported by Kapoor *et al.*, (1969); bark elements of *Carissa carandas* L. have been studied using pharmacognostic tools (Datta *et al.*, 1981); preliminary phytochemical contents of *Carissa carandas* L. have been studied by (Rajshekharan *et al.*, 2000). From these studies it is suspected that there have been ambiguities in species identity. These studies are inadequate for complete pharmacopeial standards of medicinally important species of *Carissa* L.

2.3 Phytochemical studies:

Since fruits of almost all species in the genus *Carissa* L. are commonly valued as edible, different species have been evaluated for proximate contents, vitamins and minerals such as *Carissa congesta* Wight (Morton and Miami, 1987); *Carissa carandas* L. (Gopalan *et al.*, 1971; Anonymous, 1992); *Carissa spinarum* L. (Parmar and Kaushal, 1982).

Fruits, roots and leaves of different species have also been studied for other chemical contents.

2.3.1 Fruits:

The fruits of *Carissa carandas* L. are reported to contain a triterpene alcohol-carissol (Naim *et al.*, 1985); fruits contain glucose, galactose, serine, glutamine, alanine, valine, phenylalanine and glycine (Naim *et al.*, 1986); salicylic acid (Sawant, 1974); A C₃₁ terpenoid-carindone isolated from the plant (Singh and Rastogi, 1972); Fruits contain a

number of alkaloids (Hasnain and Ali, 1990); chemical classes represented in the fruit flavor are alcohols comprising the largest class of volatiles (29.8%), while the composition of the other classes of compounds are as follows- terpenoids 24.0%, esters 23.1%, fatty acids 11.9%, carbonyls 2.2%, furanoids 1.7% and others 4.2%. major constituents are isoamyl alcohol (6.65 ppm), isobutanol (6.06 ppm) and [β]-caryophyllene (5.94 ppm) (Pino *et al.*, 2004); seed oil contains fatty acids (Shrivastava and Bokadia, 1979); the seed oil is found to contain palmitic (66.42%), stearic (9.36%), arachidic (21.19%), oleic (2.038%) and linoleic (0.99%) acids (Shrivastava, 1979); The major compound in the extract is identified as Apigenin 6-C-rhamnosil-7-O-rhamnoside. After four hours hydrolysis treatment, Apigenin 6-C-rhamnoside and rhamnose are identified. The minor components found in the extracts are Pelargonidin 3-O-glycoside, Chrysoeriol 7-O-glycoside and Quercetin 3-O-methy-7-O-glycoside (Shaïda *et al.*,2008). Tannin content in *Carissa spinarum* L. fruit 7-8% (Rao and Kumar, 2001)

2.3.2 Roots:

In *Carissa congesta* Wight – glycoside of β -sitosterol, carissone and bitter oil have been isolated (Joshi and Boyce, 1957); roots contain carissone, D-glycoside of β -sitosterol, glycosides of odoroside H, carindone, a terpenoid, lupeol, ursolic acid and its methyl ester, carinol, phenolic (Morton and Miami, 1987). In *Carissa carandas* L. Alkaloids, flavonoids, saponins and large amounts of cardiac glycosides, triterpenoids, phenolic compounds and tannins are present (Hegde *et al.*, 2009); extract of roots of *Carissa carandas* L. shows positive results for steroids, flavonoids, tannins, alkaloids, glycosides, terpenoids, carbohydrates, saponins, gums and mucilage (Bhaskar and Balakrishnan, 2009); β -sitosterol glycoside, sesquiterpene-carissone and bitter oil, odoroside H, digitoxigenin, 14, 15- anhydrodigitoxigenin, glucose and D-digitalose (Rastogi *et al.*, 1966,1967); four new crystalline substances are isolated from the roots of which one substance is cardioactive as confirmed by pharmaceutical tests (Vohra and De, 1963); roots and fruits contain carindone, carinol, odoroside, digitoxidenin, carissol, tartaric acid, citric, malic, laonic acid, glycine, alanine, phenyl alanine, carine, glucose, galactose, palmitic, stearic, oleic, linoleic acid, triterpene, ursolic acid, myrcene, limonene (<http://ayurvedaconsultants.com>); A series of substituted hydrazones, carbohydrazones, thiocarbohydrazones, carbazate derived from carissone, α -cyperone, 4,5-dihydrocarissamine, and 4 H, 5-cyanocarissone have been synthesized (Bhaduri *et al.*, 1968); carissone has been isolated by (Naim *et al.*, 1988); the D-glycoside of β -sitosterol, glycoside of odoroside H, carindone, a terpenoid, lupeol, ursolic acid and carinol, a

phenolic lignin from bark and two new compounds, the sesquiterpene glycoside carandoside and (6*S*, 7*R*, 8*R*)-7a-[β -glucopyranosyl]oxy] lyoniresinol were isolated from the stem together with three known lignanas (Wangteeraprasert and Likhitwitayawuid, 2009). Five cardiac glycosides have been isolated from root of *Carissa spinarum* L.. These were identified as odoroside H, evomonoside and odoroside G. The remaining two substances are identified as rhamnoside and rhamno-glucoside respectively, whose genins have not been characterized (Rastogi *et al.*, 1969); caffeic acid has been isolated from roots of *Carissa spinarum* L. (Raina *et al.*, 1971); a new germacrane derivative, carenone is isolated from the stems together with a new ester, 3'-(4''-methoxyphenyl)-3'-oxopropionyl hexadecanoate (Rao *et al.*, 2005). Roots of *Carissa opaca* Stapf ex Haines contain caffeic acid, cardiac glycosides, steroids and triterpenes (Singh and Zaheer, 1998).

2.3.3 Leaves:

Carissa carandas L. leaves contain alkaloids, tannins, steroids and saponins (Vaghasiya and Chanda, 2007, Hasnain and Ali, 1990); four pentacyclic triterpenoids are isolated from fresh leaves including one new constituent carissin and two hitherto unreported compounds; a new triterpenoid has been elucidated as 3- β -hydroxy-27-E-feruloyloxyurs-12-en-28-oic acid (Siddiqui *et al.*, 2003); leaves and stem bark contain β -sitosterol and lupeol (Anonymous, 1999); leaves in addition, contain ursolic acid and methyl ursolate (Pakrashi *et al.*, 1968). In *Carissa spinarum* L. 9-15% tannin content has been reported in leaves (Rao and Kumar, 2001).

2.4 Biological investigations

2.4.1 *Carissa congesta* Wight:

An aqueous extract of *C. congesta* Wight leaf shows the activity against *Proteus mirabilis*, ethanolic extract showed the activity against *A. fecalis*, *B. cereus*, *B. subtilis*, *K. pneumoniae*, *P. mirabilis*, *P. aeruginosa*, *S. subfava*. Yeast- *C. tropicalis* (Jigna *et al.*, 2005). Roots contain salicylic acid and cardiac glycosides causing a slight decrease in blood pressure (Morton and Miami, 1987).

2.4.2 *Carissa carandas* L.:

Leaf and stem extracts of *Carissa carandas* L. show the antimicrobial activity more in methanol extract than the acetone extracts. Methanol extracts show activity against *S. aureus*, *B. cereus*, *B. subtilis*, *K. pneumoniae*, *P. mirabilis*, *C. tropicalis* and *C. luteolus*.

While the acetone extract shows the activity against *B. cereus*, *C. albicans* and *C. luteolus* (Vaghasiya and Chanda, 2007); the cream containing 3% and 10% extract of *Carissa carandas* L. leaves showed 74% and 100% wound healing property and antimicrobial activity (Nair *et al.*, 2008); carindone is a new C₃₁ type terpenoid isolated from *Carissa carandas* L. and *Carissa lanceolata* has a significant antimicrobial activity (Lindsay *et al.*, 2000); petroleum ether extracts of stem and leaves show the moderate juvenile activity (JH Score- 1.9-2.9) (Neraliya and Srivastava, 1997); ethanol extract produced a 60% negative inotropic effect, a 20% negative chronotropic effect and a 40% reduction in coronary outflow (Sajid *et al.*, 1996). Fruits have IC₅₀ value of 62.97 ug/ml as antioxidant but little potential use in hyperuricemia due to poor xanthine oxidase inhibition (Ahmad *et al.*, 2006); (Shaida *et al.*, 2008) reported the lowest optical density value is indicated by the chloroform extract of the unripe fruits, followed by the 80% methanolic extract of the stem and the half ripe fruits juice; flavonoid compounds from the half ripe fruits juice are isolated and characterized as the extract performed the best activity. The chloroform extract of the unripe fruits is also cytotoxic on NCI with slightly higher EC₅₀ value than the *n*-hexane extract (Shaida *et al.*, 2008); Chloroform and methanolic extracts of the unripe fruits show very strong antioxidants activities as compared to BHT (a commercial antioxidant). The mixture of compounds in the extracts exhibited better antioxidant activity than the isolated fractions; the synergistic effects of the constituents in the chloroform extract of the unripe fruits perform the best antioxidant property (Shaida *et al.*, 2008); The alcoholic fraction of the roots causes a significant fall of blood pressure in cats both in depth as well as in duration (Chatterjee and Roy, 1965); the alcoholic extracts of roots, stems and leaves of *Carissa carandas* L. and *Carissa spinarum* L. shows positive inotropic activity on hypodynamic guinea pig heart and isolates papillary muscle preparation of cat. The ECG changes produced in cats are typical of a cardenolide. An aqueous extract of the root demonstrated anthelmintic, spasmolytic, cardiogenic and hypertensive action in a preliminary pharmacological screening (Zaki *et al.*, 1983); aqueous extract of the roots shows antipyretic activity (Rajasekaran *et al.*, 1999); ethanol and aqueous extracts from roots of *Carissa carandas* L. pose significant analgesic, anti-inflammatory and antipyretic activities in rodent models (Bhaskar and Balakrishnan, 2009); the alcoholic extract of roots produce vomiting, rhinorrhoea, diarrhea, tachypnea, exhaustion and finally death in conscious cats. In anaesthetized cats it produces a biphasic hypotensive effect. The initial evanescent effect is abolished by atropine where as the second prolonged hypotensive effect was reduced by mepyramine maleate. The histamine releasing effect is observed by

estimating plasma histamine in cats, histamine content in rat hind-limb perfusate as well as in the lung tissue (Joglekar and Gaitonde, 1970); carissone-3-(0-carboxyphenyl) hydrazone, 3,3'-bis-(carissyl) thio-carbohydrazone and carissone-3-N¹- homopiperidyl hydrazone exhibited antizygot, antimycobacterial and atropine-like spasmolytic activity respectively (Bhaduri *et al.*, 1968); oral pre-treatment with ethanolic extract of the roots shows significant hepatoprotective activity against CCl₄ and paracetamol induced hepatotoxicity by decreasing the activities of serum marker enzymes, bilirubin and lipid peroxidation, and significant increase in the levels of uric acid, glutathione, superoxide dismutase, catalase and protein in a dose dependent manner, which is confirmed by the decrease in the total weight of the liver and histopathological examination. Data also shows that ERCC possesses strong antioxidant activity, which may probably lead to the promising hepatoprotective activities of roots extract (Hegde and Joshi, 2009). *Carissa carandas* L. extracts show strong levels of inhibitory activity towards lipid oxidation. The ethanolic extract of roots of *Carissa carandas* L. may produce its anticonvulsant effects via non-specific mechanisms since it reduces the duration of seizures produced by maximal electroshock as well as delays the latency of seizures produced by pentylenetetrazole and picrotoxin (Hegde *et al.*, 2009); the chloroform extract of *Carissa carandas* L. leaves exhibit cytotoxicity on human ovarian carcinoma cell line (Caov-3) with EC₅₀ value of 7.702 ug/ml, while the *n*-hexane extract of the unripe fruits is cytotoxic towards the lung cancer cell line (NCI) with EC₅₀ value of 2.942 ug/ml when assayed using methylene blue assay (MBA).

2.4.3 *Carissa opaca* Stapf ex Haines:

CNS depressant activity in mice: The alcoholic extract of the aerial parts is found to have CNS depressant activity in mice (Bhakuni *et al.*, 1971).

2.4.4 *Carissa spinarum* L.:

Chloroform extract of whole plant shows strong antioxidant (DPPH) activity (Rao *et al.*, 2005); the cardiostimulant activity of *Carissa spinarum* L. was found to be 4-6 times greater than that of *Carissa carandas* L. (Vohra and De, 1963).