

Carissa carrandas L. and *C. spinarum* L. – Ignored Nutraceutical Fruits

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| Received: 09.05.2024 | Accepted: 13.06.2024 | Published: 04.07.2024

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Abstract

Review Article

Carissas (*C. carandas* and *C. spinarum*) are natives of India. Duo is evergreen, hard, diffuse and spiny shrub that being highly drought-resistant grows well in semiarid and arid areas, may serve as a wind break and protective hedge. The plants offer multifarious uses in landslide protection and as a live fence, food (direct and processed, beverages, wine, salad, vegetable, jam), fodder, timber, fuel, wood, a green source of dye and diesel, and of sacred value and sorcery. Unripe fruits are used in pickling while ripe ones are edible. People in various states of India, Bangladesh, Myanmar and Pakistan, Kenya, Ethiopia, Senegal and West and South African countries eat raw fruit. Fruit also serves as a spice and a condiment. Known as Karonda (in vernacular language) duo has been used as a folk, veterinary and traditional medicine in the Ayurvedic, Unani, Homeopathic and Chinese and Thai systems. Additionally, duo serves as nutraceutical being rich in iron and vitamins. *C. carandas* finds place in historical accounts, Ayurvedic and culinary treatises as well in literature and folklore. The multifarious uses of *C. spinarum* in traditional medicine has earned it epithet as 'magic tree' in East Africa. The present paper reviews the history, distribution, folklore, uses as food, forage, feed, folk medicine, and the pharmaceutical, therapeutic, cultural, ecological and nutritional value of Karandas.

Keywords: *Carissa carranda*, *Carissa spinarum*, Habit, Distribution, Names, Origin, History, Uses, Food, Nutrition, Spice, Fuel, Browse, Timber, Tannin, Food colourant, Biodiesel, Great Indian Hedge, Folk Medicine, Veterinary, Ayurvedic, Chemical Constituents, Pharmacological activities, Fly repellent, Folklore, Sacred Uses, Names after *Carissa*.

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INTRODUCTION

Linnaeus raised Genus *Carissa* in 1767. It belongs to family Apocynaceae. Of the 119 species described, only eight are accepted as valid taxa. *Carissa carandas* L. (CC) and *C. spinarum* L. (CS) native to India are known respectively as *Karonda* and *Karondi Jungli* (wild *Karonda*) in some Indian languages.

Plant Habitat and Habit

Duo of CC and CS serves as an ideal windbreak and is a very popular as a live protective hedge plant. CC is a hardy, drought tolerant plant that thrives well in arid and semi-arid regions and in a wide range of soils. It is an evergreen, rank-growing, straggly, woody, shrub climbing, diffuse and spiny shrub that attains a height of 3 to 6 meter. Stem is rich in white latex. The branches are numerous and spreading, forming dense masses and set with sharp thorns [1]. Flowers are white, cymes; fruit 1.2-2.5 cm, globose to obovoid in shape and about 1.2-2.5 cm long, 4 seeded, dark purplish when ripe. The

young fruits are grape green, white and pink at maturity and black on ripening.

Carissa spinarum is an erect thorny shrub, with forked branches, 2-3 meters in height; wood very hard; bark, light brown to green, can be stripped off longitudinally by hand, exposing the white to light-green wood underneath; thorns, 3.2 cm long, brown to greenish at the base and deep brown towards the tip. This highly drought-resistant plant commonly grows in the forests and wastelands up to elevations of 1,500 meters, bear small edible fruits. Leaves exude white latex, when plucked from the stem. Fruit, an ovoid berry, 9 mm in length, 6 mm in diameter, 642 mg in weight, 586 microliters in volume; fruit color, hyacinth blue 40; pulp, scarlet 19/2; juice, shrimp red 616/3. Seeds are lanceolate, 5 to 6 mm long, 4 mm in diameter, black, each 28 mg in weight, 42 microliters in volume [2]. It is grown as ornamental shrub in most areas in Sudan and as a live hedge in Ethiopia.

Distribution

CC is distributed in Nepal, Afghanistan, Bangladesh, India, Sri Lanka, Java, Malaysia, Myanmar, Pakistan, Australia, and South Africa. In India it is found in the Himalayas at elevations of 300-1800m., in the Siwalik Hills and the Western Ghats. It is grown in the states of Maharashtra, Bihar, West Bengal, Chhattisgarh, Orissa, Gujarat, Haryana, Madhya Pradesh, Rajasthan, and in the Western Ghats.

CS is distributed in Australia, Kenya, Uganda, Ethiopia, Namibia, Northern Nigeria, Mali, Guinea, Ghana, Togo, Madagascar, Senegal, Somalia, Yemen, Thailand, India, China, and on Islands of Indian Ocean [3, 4].

Names

Names of *C. carrandas* L. (= *C. congesta* L.) {CC} and *C. spinarum* L. (CS) prevail in number of languages of Asian, African, European and Australian continent. CC has 48 names in Kannada, Tamil (36), Telugu (37) and Sanskrit (32) language followed by 15 each in Hindi and Marathi (Table 1). Tribes in 11 African countries know names for CS in their own language. As many as 35 tribes of Kenya, 16 in Tanzania, 8 in Ethiopia and 5 in Uganda identify CS with specific names in local dialects. Sharma (2000,5) mentions names in Sanskrit in his book '*Namarupajnanam*' (Characterization of Medicinal Plants) CC as a densely thorny plant (*karamarda*, *avigna*, *susena*) which bears sizable fruit resembling those of parkata (*sthu-laparkata*) and turning black on ripening (*krsnpakaphala*).

It is interesting that Bhava Prakash of Bhava Misra as early as 1555 CE mentions two types, as *Karamarda* (CC) and *Karamardika* (CS) and differentiated the two on basis of fruit size. The latter having smaller fruit size [6], is the hardiest species known to thrive in poor and rocky soil. Although people in early history could differentiate the two species, but there have been many mis- determinations at specific level in genus *Carissa*. The taxa *C. macrophylla* Wall., ex G. Don., *Carissa macrophylla* Wall., *Carissa ovata* R.Br., *Carissa opaca* Stapf ex Haines; *Carissa paucinervia* A.DC., *Carissa diffusa* Roxb., *Carissa inermis* Vahl, and *Carissa edulis* (Forssk.) Vahl. are synonymous to *Carissa spinarum* (for detailed synonymy see [7, 8] while taxa *Carissa carrandas* (L.) Burm. f., *Carissa salicina* Lam., *Echitessp inosus* Burm. f., *Jasminonerium carandas* (L.) Kuntze, *Jasminonerium salicinum* (L.) Kuntze, are synonymous and taxa *Arduunia carrandas* (L.) Baill., and *Arduunia carrandas* (L.) K. Schum., have been treated as basionym of *C. carrandas* L.

Origin

Botanists differ on place of origin of CC. Some consider origin in India, while others believe it to be native of Java. Orwa *et al*. [9] opined it as native of India, Myanmar and Sri Lanka. Kew Botanical Gardens holds

CC and CS as natives to India (Index Kewensis, 1985-1990). Morton [10] considered Malacca also as one of its native places. In India, CC grows wild in Bihar, West Bengal and South India, is common in deciduous forest and exhibits variability in fruit and plant type in Chhota Nagpur Plateau region [11,12]. While CS grows wild in most parts of India, especially in the dry foothills of the Punjab, the sub-Himalayan tract up to 4,000 feet in the trans-Indus territory and also on the coast of the southern Andaman.

Archaeological excavations at Sanghol (Harapan/ Baran period, 2000-1400 BC) in Ludhiana, Punjab reveal lemon seeds (*Citrus limon*) and CC fruits as remains. This provides the first archaeological record in the context of the Indian subcontinent and information on their cultivation [13]. Wild occurrence in many parts of India, historical accounts and archaeological and philological evidence in shape of prevalence of names in many languages as well in multitude of names in number of Indian languages (Table 1) corroborate the Indian origin of the duo.

CC is exotic to Cambodia, Malaysia, the Philippines, Puerto Rico, Thailand, Trinidad and Tobago, the United States of America and Vietnam. It was introduced into Java long ago as a hedge and has run wild around Djakarta. The karanda first fruited in the Philippines in 1915 and P.J. Wester described it in 1918 as "one of the best small fruits introduced into the Philippines within recent years." The United States Department of Agriculture received seeds from the Middle Egypt Botanic Garden in 1912; from P.J. Wester in the Philippines in 1918 and in 1925. The shrub has been cultivated in a limited way in Florida and California and in some experimental gardens in Trinidad and Puerto Rico [10].

History

The earliest reference on CC seems to be that in Charak Samhita (700BC). It finds place in ancient Sanskrit treatises as Kautiliya's Arthashastra (321-296 AD) [14], Upavana Vinod (1300 AD) of King Someshvara [15] and Bhava Prakash of 1555 AD (6). It was one of the common fruits used during Buddha and Jain periods [16]. References on *Karmarda* as fruit also occur in Jataka and in *Indica* of Greek writer McCrindle (who accompanied Alexander, in his ventures in India). Pauma Cariu III, Karpura manjari and Sukraniti written in 750- 1200 AD mention about *Karamarda*'s common use [16]. Kautiliya described *Caranda* / *Karmarda* in section the Superintendent of stores house and included in acidic fruits recommended to be stored in Kings' Fort [14]. The earliest Awadi poet Mulla Dauda (14th Century AD) refers to CC in his epic poem "Chandayan" [17]. It also finds reference in the great epic poem of Padmavat by Malik Mohamad Jaisi [18]. Babar-Nama, Memoirs of Babbar (1525 AD) lists it in the Fruits of Hindostan [19]. Sursagar of Surdas (1525 AD) mentions the use of *Caranda* and *Suran* (*Amorphophallus*

campanulatus Blume) in ailment of Lord Krishna [20]. Abdul Rahim Khankhana known as Rahim (1556-1626 AD), one of the nine gems of Akbar's court, refers to it in a *doha* (small couplet) to convey human ego [21]. The *Ni'matnāma*, or Book of Delights of Sultan Ghiyath Shahi of Mandu, Malwa (AD 1469 to 1500) records its use as spice, vegetable and constituent of a pain killing and sex composition [22]. In the epic poem of Shivraj Bhushan (1613-1715), poet Bhushan refers to Karonda as being grown in Raigarh port of Maharaja Shivaji Marhatta [23].

Uses

Duo offers multifarious uses as fence, landslide protection, food (direct and processed, beverages, spice, salad, vegetable, jam, jelly) fodder of some birds, in folk and veterinary medicine, in religion and sorcery and as timber, fuel, wood for furniture, and as a green source of dye and bio-diesel. It has been used as a traditional medicinal plant over years in the Ayurvedic (in Indian and Sri Lanka), Unani, Homoeopathic and Thai and Chinese systems of medicine. CS is used for treatment of both human and veterinary diseases in North Ethiopia and Gujarat, India [24].

As Food

The berries of sweet karonda are relished for their good taste and characteristic flavour. Ripened berries of CS form part of normal diet of tribes like Borena, Kara, and Kwego of Ethiopia; Maasai, Sonjo, Gogo, Kurya and Barbaigs of Tanzania; Samburu and Maasai of Kenya and Zulu of Africa, [25, 26]. In Asia, Periyars in Western Ghats, tribes in Tamil Nadu, Maharashtra, Karnataka and Bangladesh eat CC fruits and prepare pickle [27-29]. Ripened CS berries having a sweet flavour form a popular food for the indigenous peoples, particularly in central Australia [30]. Sun-dried berries are famous as a snack or as an additional ingredient in granola bars and cereals [31].

Carissa fruits are used for making jams, marmalades, squash, juice (sharbot), sauces, syrups, jellies, candy, *muraba* (fruits preserved in sugar), pickles, chutney (sweet thick sauce), yogurt ice cream, soup, pies, curries, tarts, puddings and bread [7, 32-34]. Slightly under ripe fruits make an excellent acid jelly for serving with fish and meats. Seasoning the skinned and deseeded fruits with sugar and cloves, make it into a popular substitute for apple tarts. Green, sour fruits are made into pickles in India. CS plums can be relished as fruit salads, topping for cakes, puddings and ice cream.

Karonda jam prepared (in proportion of 1.0 kg Karonda pulp + 1150 g sugar) may be stored for at least three months without undergoing any deterioration [35]. The karonda pectin showed higher sensory value compared to babugosha (endogenous pectin) and commercial pectin. It gave high quality jams, which compared favorably with that of commercial pectin [36].

British residents in India favoured CC as being reminiscent of goose berries of their native place [37]. Now-a-days, fruits are used for making commercial jelly 'Nakal cherry' which closely resembles the canned cherry fruits [38]. Maasai of Narok Dist. Kenya, make chewing gum from CS for children [39,40].

As Vegetable

In Rajasthan and Bihar and Odisha fruits of Duo are commonly cooked as vegetable with green chillies to make a tasty dish taken with chapattis [41].

Beverages

The fruit is a rich source of iron and vitamins and can be potentially made into/ converting/making juice, squash, and fermented beverages [1]. Ripe fruit emits gummy latex on cooking, yields a rich red juice which clears on cooling and is used as a refreshing cooling drink in hot weather. In Uganda, juice is made from CS(=CE) fruit or is fermented to make alcoholic beverage [42]. CC fruit juice blends well with pineapple juice [43].

Ripe fruits give a natural 'food colorant cum nutraceuticals supplement' named 'Lalima'. It's one ml is sufficient to give lovely red color to one serving of any colorless beverage (100 ml) such as lemonade. One serving of such supplemented beverage contains 469.2 µg anthocyanin, 12.7 mg flavonoids, and 14.1 mg phenol, with total antioxidant activities to be 390 µM Trolox Equivalent (10) [44, 45].

In Africa, the fruit pulp is also used in the production of red wine which is good in terms of overall sensory acceptability. It possesses fair amount of essential nutrients and significant antioxidant activity and contains about 15 % alcohol [46, 47].

Nutritional value

The available nutraceutical contents of ripe CC fruits include carbohydrate, protein, crude fiber and ascorbic acid. These constituents offer high nutraceutical properties and therapeutic value, making fruits to be useful as dietary supplement.

CC fruits offer good nutrition value, 100 g of fresh fruit is a source of 42(364) kcal energy, 1.1 g protein (2.3), 2.9 g (96) fat, 2.9 g (67.1) carbohydrate, 21 mg/100 (160) calcium, 28(60) mg phosphorous, [39] mg iron; 1619 IU vitamin A and 250-500 (1) mg ascorbic acid [10, 48]. The figures in parentheses represent values for dry fruit. While, same quantity of CS fruits may provide: proteins 2.07g, 1.30g fat, 18.66 g carbohydrates, 29 mg calcium, 32.1 mg phosphorus, 3.45g iron, 0.44 mg total QE flavonoids and 53.1 mg TAE total phenolics [49]. CC fruits are also rich in minerals such as iron, calcium, magnesium, phosphorus, and sugars and lipids [50]. The presence of vitamin C and anthocyanin afford and enhance the antioxidant properties of karonda fruits [51-53] and make CC all the more important. Fructose

level of CC fruits (61.06%) reduces the chances of sugar in human body [55]. On basis of high nutraceutical value and therapeutic by virtue of their antioxidant activity use of CC fruit is recommended as a dietary supplement [53].

Nutritive values of CS fruits (3.6%, P) compare well with mango; banana (1.09%P), guava (2.5% P), papaya and sapota, in terms of protein and carbohydrate content and same as exotic fruit like paw-paws [7, 33, 54]. Anywar [42] recommended consumption of CS fruits to alleviate vitamin A deficiency in malnutrition ridden Uganda.

In Culinary as a Spice

CC fruit is a good appetizer, and the fruit is pickled before it gets ripened. It is also used as condiment and spice in many of Indian dishes. The earliest Sufi Poet, Mulla Dauda, who wrote in Awadi language refers to it in “Chandayan” (1379 AD) on its use in preparation of Beswar meat “*Kumkum meli kiye biswaru, daryo karvanchh ambli charu*”. Even today, in Awadi Cuisine, in unavailability of mango, CC is used as a spice for preparations. A karonda-meat biryani from Hyderabad is a well-known dish.

The *Ni'matnāma*, or Book of Delights of Sultan refers to a recipe for “Corinda (*karūnda*) and well fried *māst* (sour coagulated milk, thick and creamy yogurt). It gives recipe for pickle as “take figs (*pīpal*), wild figs (*gūlar*), *phīphar*(gardenia), *jāman* fruit, sour corinda, *āmla* seeds, bananas, green chickpeas, roasted chickpeas and small cucumbers. Put in sourness (*tarshī*), sharpness (*tīz*) and salt and make the pickle”. This treatise on Cookery also refers to a recipe having CC as one of the constituents for improvement in semen sperms [22].

Other Uses

CS plants frequently appear forming fences in many parts of Ethiopia. The species is deliberately grown as live fence for protecting fields of growing crops and to get benefit of fruits from third year [56-58]. Bushes of duo are suitable for hedging in the home gardens, and are sometimes grown as an ornamental plant due to its conspicuous starry bloom and beautiful cherry-like fruits. Being a plant hardy plant, drought-tolerant in nature that can be grown in a wide range of soils.

The Great Indian Hedge

British constructed an immense impenetrable hedge in India in 1869 using the tough thorny Karaunda as one of the plants. This 4000 kilometres long Customs hedge stretched all the way from Indus to Mahanandi (Himalayas to Orissa) to prevent the smuggling of salt to avoid taxes which were important source of the East India Company. It was once described in The Guardian as “one of the most grotesque and least well-known achievement of British in India.” [37,59]. The hedge is one of the monumental undertakings that has been largely ignored in the history.

Miscellaneous Uses

The Bhil tribe in Rajasthan sells karonda leaves for use as rolling tobacco paper to beedi manufacturers [44]. Caronda is used to purify Munga and silver in use ayurvedic medicines [60]. Leaves of CS and root paste are used as a mosquito and insect repellent [61, 62]. The milky latex exudation of unripe berries is useful in the preparation of chewing gum and rubber [40].

Fuel

A higher gross heat value of this species indicates its higher potential to be used as good fuel source. In Kenya CS is considered as an excellent source of firewood [63].

Browse, Forage and Fodder

In Australia, fruits are a popular food for the Australian bustard, emu and many other birds. CC leaves provide forage for butterflies, Australian crow and moth and the tussar silkworm [64]. In central Australia plant is sometimes seen as a useful browse plant for stock [30]. In Ethiopia and Embu County, Kenya goats browse CS bushes (called *Mukawa*) vigorously [65]. CS provides bee forage in Tanzania [66] and also serves a food plant for the larvae of several species of Lepidoptera, including *Digama marmorea*, *Nephele subvaria*, *Coenotes eremop* [30].

Timber

The white or yellow wood is hard, smooth and useful for fashioning spoons, combs, household utensils, ladles and other useful household articles [67].

Tannin or dyestuff and food colourant

The fruits have astringent properties and are employed as agents in tanning and dyeing. CC dyed silk imparts a range of brown colour with acceptable range of fastness properties [68]. CC leaves are fairly rich in tannins (9-15 %) and constitute a promising tanning material, particularly in combination with other tanning stuffs, such as the twigs and bark of *Embllica officinalis* Gaertn [69]. Fruit of CC is a potential source of anthocyanin and used as a natural colouring agent for products that require mild processing treatment and low temperature storage [70]. The ripe fruits are very rich in anthocyanins, pelargonidin-3-o-glucoside Cyanidin-3-o-rhamnoside(a) and cyanidin-3-o-glucoside(b) responsible for the color.

The natural bio-pigments, such as anthocyanins from fruit and food products are an excellent alternative to synthetic colors [71]. Bio-pigments are non-toxic, from renewable resources, biodegradable, without disposal problem and their production may help in providing sustainable livelihoods for the agriculturists and make textile industries more competitive by eliminating the huge expenses of chemical imports. Sarkar [72] pointed out that higher anthocyanin content (12-19%) of berries make it a suitable source of natural

colourant for nutraceutical utilisation, earlier mentioned in the subtitle Beverages.

Source for Bio-diesel: CC and *Jatropha gossypifolia* yield 1.7% hydrocarbon and 5.8% oil and can be grown as potential alternative crops for renewable energy in areas of underutilized lands, stimulating industrial and economic growth [73].

As Ornament and Ornamental plant

In Tanzania and Sudan, CS is grown as an ornamental [66]. The white flowers are strung into garlands and put on their coiffures by women in Western coastal region of India [74].

As Medicine

Duo has been used as a medicinal plant in the Ayurvedic (India and Sri Lanka), Unani, and Homoeopathic system of medicine. In Ayurveda it has been used for thousands of years. In Folk medicine, whole CC and CS plants and parts have been used in the treatment of various ailments.

Folk Medicine

Various tribes in different states of India and in African countries use fruits, leaves, roots, stem and flower as folk medicine (Table 2). Multiple medical uses of CS have earned for it the epithet 'Magic Herb' [8]. Tribes in Africa, use CS as diuretic and to cure several diseases such as: headache, chest complaints, rheumatism, gonorrhoea, syphilis, rabies, herpes, malaria, sickle-cell anemia, hernia, oedema (edema/dropsy/anasarca), toothache, cough, ulcer, worm infestation.

The fruits, seeds, leaves, bark and roots of duo have been used as ethnomedicine. CC as a whole plant is effective in the treatment of liver diseases, convulsions [75, 76], asthma, tuberculosis, scabies, and wound healing [77-79]. While plant parts are useful in the treatment of diarrhoea, stomachic, anorexia, intermittent fever, mouth ulcer, sore throat, syphilitic pain, burning sensation, scabies, and epilepsy. CS as a whole plant is used in India, Ethiopia and other African countries for the treatment of venereal, respiratory, and gastrointestinal infections, gonorrhoea, stomach-ache, chickenpox, wound healing, rabies, and also as an antidote to snake bites [62,80]. It is also useful for treating microbial infections such as herpes, gonorrhoea, syphilis, rabies, typhoid fever, jaundice, and polio, and as an antivenom for snake bites.

CS gained a lot of prominence in East Africa; in 2011 thousands of people in and outside Eastern and Central Africa flocked to the remote Samunge village in Tanzania with their sickly, loved ones for treatment by the catholic priest against many diseases including infertility, hypertension, diabetes, asthma, cancer and acquired immunodeficiency syndrome (AIDS) through elimination of the causative agent, the Human Immunodeficiency Virus (HIV) [81].

In India, people of Karnataka use the CC fruits as an astringent, antiscorbutic and a remedy for biliousness [82]. While, Santals and folks in Rajasthan use fruits in dropsy/anasarca/edema/odema [83] and to check madness, rheumatism, hemiplegia, epilepsy, convulsions, post-natal complaints, collapse, sores, bites of rabid jackal or dog [84]. Fruits are also useful to treat liver dysfunction, to break fever, to counteract the blood putrefaction. Karonda juice, chutney (sweet pickle or sauce) and Muraba (sweet preserved fruits) keep heart disease away. Chutney destroys gum ailments. Ripe fruits alleviate *pit vikara* (vitiated) and *aruchi* (tastelessness) [83]. Borana tribe in Ethiopia use CS fruits as appetizer [85,86].

Sudanese use CS stem as antidote for snake bites [87]. Lodhas prescribe CS root powder about 300 grams (more than that is fatal) as laxative [88]. The roots are useful in stomach disorder, intestinal worms, scabies, diabetic, ulcer and pruritus [90].

CS ranked first and is the most popular medicinal plant to cure gonorrhoea [65]. It is an important traditional medicinal with antidiarrheal, anthelmintic properties and used to treat skin infections, remittent fevers, earache, soreness, syphilitic pain of the mouth, stomachic and blood pressure. Powder of the whole plant is taken orally to treat diabetes [89].

Folk medicine in Veterinary

In India, CC was used in ancient times for checking rabies in animals [133]. The paste of aerial parts is given orally for Rinder pest in cattle [134]. Root juice is used to treat diarrhoea and dysentery [135]. CS has been used to treat ulcers, muscle cramps, stop bleeding after delivery and to treat worm infestations in wounded animals. Lodhas give fried CS fruit powder to cattle in fever [88]. Plant is widely used in maggot infested wounds [136, 137, 140]. People in Jashpur district use CS roots to kill the worms. In Jhansi, India people use root paste with coconut oil on maggot wound [136] while in West Africa whole plant is used to kill maggots. Tribes here use whole plant in eye disorder, horn injury and maggot infection in animals [137].

Pastoralists in Karamoja, Uganda use CS as a medicine for anaplasmosis, a tickborne disease afflicting ruminant, caused by the bacterium *Anaplasma phagocytophilum* [77,138]. Pounded *Nicotiana tabacum* leaf and CS root mixed with water is orally given to calf for treatment of internal parasites [65]. Ameru tribe of Buriri district, Meru County, Kenya uses CS to cure infertility of sheep, goat (*Kuthata*), poor milk let down (*Kuitha iria*), mastitis (*Kuimba riere*) and miscarriage (*Guta Njau*) of cattle [139]. In Ethiopia roots are traditionally used for their purgative properties as well as to treat worm infested wounds in animals [140]. In Mensera, Abbottabad and Haripur, tribes in Pakistan use ground fresh leaves and seeds mixed in water and orally administer for 2–3 days for throat infection in animals

and sprinkle dried ground root powder on infected sores and wound healing [141].

Ayurveda

Ayurvedic practitioners use duo in a number of diseases and affections. All parts as roots, leaves, stem and fruits unripe and ripe of CC and CS are used. Depending upon ayurvedic characteristics the effect of parts differs in use as medicine. CC alleviates *vata* and *pitta* disorders. Being stomachic, antidiarrheal, anthelmintic, cardiotoxic properties and cooling agent it is an ingredient in a number of ayurvedic formulations and preparations including *Marma gutika* (used in disease related to brain, heart, urinary system), *Hridya mahakashaya* (for heart disease), *Kalkantaka rasa* (for mental disease), *Kshudrakarvanda yoga*, and *Marichadi vati* (in respiratory diseases) and *panchmulak* [142,143].

Ripened and unripe fruits of CC and CS differ in ayurvedic properties. Unripe fruits are appetizers and cause burning sensation, whereas the ripened ones pacify the three *doshas* and combat tastelessness and poisoning [144].

Charak (700BCE) described internal use of CC is beneficial in hemoptysis, oedema, urethral discharge and seminal disorders [145]. Bhava Prakasa mentioned that the duo promotes taste, controls thirst, hemorrhage and enhances Kapha dosa [6]. Ripe fruits are sweet, tasty, light in action and alleviate *Pitta* and *Vata* [6, 146], help to mitigate tastelessness (*aruchi*), indigestion (*agnimanya*). It is laxative (*sara*), purgative (*bhedna*), emetic (*vamaka*), diuretic (*mootrajanana*), combats poison (*vishghana*). It checks disease of tooth (*prashitada*), *vata* (*vatavikara*), liver (*yakrit vikara*), boils (*visphota*), and poisoning (*vishvikara*) [144]. Unripe fruit is astringent and the ripe fruit is cooling, acid and useful in bilious complaints. Fruit possesses antiscorbutic properties and fruit as well as seed latex are used for treating rheumatoid arthritis, anorexia, indigestion, colic, hepatomegaly, splenomegaly, piles, cardiac diseases, oedema, amenorrhoea, fever and nervine disorder [152,153].

Root being pungent (*katu*) and bitter (*tikta*) in taste is emetic (*vamak*) and diuretic (*mutral*) [146]. CC root ground in lime juice and camphor is given for cure of watery boils in children. Bhav Prakash mentions its use to confirm the snake bite. Ground root in cool water, given to a snake bitten person does not cause vomiting [6, 146]. CC roots are useful in stomach disorder, intestinal worms, scabies, diabetic, ulcer and pruritus [90] while root paste is used for diabetic ulcer. Stem is used to strengthen tendons, fruits are used in skin infections and as stomachic, antidiarrheal and anthelmintic [126,149].

Ayurvedic practitioners use CC plant parts for treatment of malaria, dysentery, diabetes in Bangladesh [29] and for dropsy/ anasarca, madness, rheumatism,

hemiplegia, epilepsy, convulsions, postnatal complaints, sores and bite of rabid jackal or dog in India [148]. The leaf decoction is valued in cases of intermittent fever, diarrhoea, oral inflammation, earache and syphilitic pain [146, 147,149-152].

Like CC, CS has also been used in the Ayurveda particularly, against liver, epileptic, microbial and viral diseases disease, and is cytotoxic, therefore, has emerged as a good source of the traditional medicines for the treatment of inflammation, arthritis, microbial infection, epilepsy, viral infection, and cancer disease. It is also used to treat infertility and sexual problems such as asthenia and premature ejaculation in males and for checking libido in women [69].

Chinese Medicine

In Chinese system of medicine, roots are used for treatment of rheumatoid arthritis and hepatitis [154].

Ayurvedic determinants for Prediction of antimicrobial/insecticidal herb

A plant product, to be effective as an insecticide, must possess some specific Ayurvedic properties. It has been known that the plants with pungent (*katu*), bitter (*teekta*), astringent (*kasaya*) taste; *katu* in *vipaka* (transformed taste), *ushna* (hot) in *veerya*; penetrating (*teeksna*) quality; hot (*ushna*) potency are antagonistic to the *kapha dosha* and possess insecticidal and anti-worm properties [155]. Later, Ahuja [156] identified additional requisite for a pesticide such as possession of *sara rooksha* (dryness) and *snigdha* (soothing) *guna*. Root of CC is pungent (*katu*) and *tikta* (bitter) taste, *guru* (heavy) in *guna* (quality) while stem is *amla* (acidic) in *rasa*, *katu* in *vipaka*, *usna* in *virya*, *guru* and *sara* (mobile) in *guna* and *kaph*, *vaat hara* as well as *pittakara* in Karma [142]. Stem and root of CC possesses all the requisite qualities of an herbal antimicrobial identified earlier [155-157]. Anti-worm and antimicrobial properties of CC as per prediction on the basis of Ayurvedic characteristics are corroborated by pharmacological testing by various researchers [165,205,206; Table-3]. Similar prediction for *Vitex nigrundi* stand corroborated by pharmacological testing [157].

Chemical Constituents

The major bioactive constituents imparting medicinal value to a plant are alkaloids, flavonoids, saponins and glycosides, triterpenoids, phenolic compounds and tannins.

CC possesses a wide spectrum of phytochemical constituents that vary in each part and result in various biological activities. Tannin, steroidal glycosides, phenolic compounds, and tri-terpenoidal constituents are abundant in the leaves [158,159]. Fruits contain several volatile compounds, as well as carissone and carindone [160], while the seeds possess fatty acids

such as linoleic acid, oleic acid, palmitic acid and stearic acid [161,162].

The therapeutically active phytoconstituents of fruits include carrisin, carindone, carinol [163], carisol, epimer of α -amyrin, linalool, β -caryophyllene, carissone, carissic acid, carindone, ursolic acid, carinol, ascorbic acid, lupeol and β -sitosterol [164-166]. The volatile flavour constituents of the CC fruit include isoamyl alcohol, isobutanol, and β -caryophyllene being the major constituent. Fruit pigments include pelargonidin-3-o-glucoside, cyanidin-3-o-rhamnoside and cyaniding-3-o-glucoside. Fresh fruits contain a terpinic alcohol carisol, which is an epimer of α -amyrin. In addition, the fruits contain glucose and galactose as well as the amino acids serine, glutamine, alanine, valine, and phenylalanine [167].

Root contains phytochemicals as alkaloids, flavonoids, saponins and large amounts of cardiac glycosides, triterpenoids. The volatile principles include 2-acetyl phenol, lignan, carinol, sesquiterpenes (carissone, carindone), lupeol, β -sitosterol, 16 β -hydroxybetulinic acid, α -amyrin and β -sitosterol glycoside, and des-Nmethylnoracronycine, an acridone alkaloid [75, 168, 169,170].

Stem contains chemicals as sesquiterpene glucoside [171]. Leaves possess triterpenoid constituents as well as tannins, and an isomer of ursolic acid namely carissic acid triterpene carandinol, betulinic acid, β -sitosterol-3-O- β -d-glucopyranoside, oleanolic acid, ursolic acid, and 4-hydroxybenzoic acid [77,159, 172].

Pharmacological activities

CC and CC possess number of pharmacological activities (Table 3). Some activities are inherent to the duo while others are properties are species specific.

Activities possessed by CC and CS

Antimicrobial, ant-plasmodial, antiviral, anticonvulsant, antioxidant, anticancer, anthelmintic, hepatoprotective, antidiabetic, diuretic,

Activities specific to CC

Hypotensive, histamine releasing, constipation and diarrhoea, anti-inflammatory, antipyretic, analgesic, anti-candida, erythropoietic, antiaging.

Activities specific to CS

Antarthritic, wound healing,

Scientific validation of ethnomedical and Ayurvedic uses

Use of herbs as ethnomedicines and Ayurvedic remedies has been mind boggling for the common people in general and medical professional in particular. Botanists and pharma scientists have been trying to authenticate/ validate such uses since long. Scientists in various countries have been trying to understand the

basis of ethnomedical practices adopted and used by forefathers.

Folk medicines owe their use to the ayurvedic practices/uses or vice versa. Some of the ayurvedic practices based on activities attributed to CC and CS have been proved and authenticated by pharmacological tests. These include: anticonvulsant, antimalarial and ant plasmodial, anti-helminthic and purgative. In addition, use of duo as diuretic, antimalarial, hepatoprotective and chronic joint pain healer, anti-herpes, hypotensive, laxative, and wound healing both in folk and Ayurveda, and ethnomedical use as anti-herpes, hypotensive, laxative and wound healing activity have also been pharmacologically tested and proved to be correct (Table 4).

Aqueous leaf extract shows significant analgesic and anti-pyretic activities supporting the traditional use of the plant in the treatment of pain and fever [1351, 173]. Alcoholic root extract decreases the blood pressure while aqueous extract shows histamine releasing, anthelmintic, spasmolytic and cardiotoxic activity. Fruits show analgesic, anti-inflammatory and lipase activity [150]. CC leaf ethyl acetate leaf extract is natural antiaging antioxidant and skin whitening due to presence of ursolic acid [174].

Fly repellent: Pounded root paste can serve as an insect repellent [41].

Anti-aging /Use in cosmetics and cosmeceuticals

Ethyl acetate extract of CC leaves having Ursolic acid as a key component, cytotoxic to cancer cells is beneficial to human skin and has been proposed for use in cosmetics and cosmeceuticals as an anti-aging agent due to its superior anti-wrinkle, anti-inflammation, and whitening properties. Moreover, antioxidant, anti-inflammation, and anti-tyrosinase activities of CC are known to be very beneficial for skin care [174].

Sensitivity to Pollutants

CC shows higher sensitivity to toxic pollutants of cement dust than *Azadirachta indica* (L.) A. Juss. and *Delonix regia* [175]. Traces of toxic metals such as chromium and copper are common in some varieties of Portland cement and are harmful to human beings and other living systems [176].

Poisoning caused by Carissa parts

CC plant extract caused vomiting, rhinorrhea, diarrhea, tachypnea, exhaustion and death in conscious cats which has been attributed to the presence of glucoside in CC root [177]. Inadvertent contamination of CC roots with other root material is known to cause poisoning [178]. The milky sap of CS plant and its unripe fruit is poisonous; hence the Australian website warns about poisonous nature [30].

As a possible Pest

In central Australia CC is sometimes seen as a useful browse plant for stock (30) but it is capable of reducing pasture production when infestations occur over a large area, even then the plant is not a declared pest under Queensland legislation. It is drought-tolerant, and not grazed as readily as pasture species, giving it an advantage in dry times or in over-grazed situations. In many places it helps to reduce soil erosion, and it offers good habitats for birds and small wild animals.

Sacred Value

The flowers are used in Puja (worship) and are offered to the God [179]. Tribals in Satpra and Purna of Dangs district Gujarat use *C congesta* flowers in a religious ceremony [180].

Religious Belief

According to Hindus, a person who avoids all types of oils -scents, does not cut nails, and avoids eating brinjal, kohida (sweet pumpkin), carrot, masar (lentil), chho and Karonda during the four rainy months, enjoys happiness of heaven [181]. Upvana Vinoda considers the planting of Karamarda in the east of home as auspicious [182].

Magico- religious belief

Lodhas put 2-3 pieces of roots in a room for keeping away snakes. It is reported that snakes avoid this plant [88]. Mundas also believe that root infusion drives away the snake from holes. Possibly smell of the root is repellent to snakes [149, 183]. In Bengal gardener use sesamum oil dipped of thorn of *Carissa* to rupture the matured small pox pustules [184].

In Kenya, Pokot tribe believes that the CS trees with quite sour fruits are because of a spitting of snake on the fruits and pregnant women are not allowed to collect these fruits because of belief that it could break their hands [4]. Nandis of Kenya fix a *legetetuet* (CE=CS) tree stick in the roof of huts as a charm against snakes [185]. In Ethiopia root of *Croton macrostachyus* and CS are chopped and fumigated for treatment of evil eye whereas in Sudan CS stem is used for expelling evil spirit [87].

Names after Carranda

Some clans and villages owe their name to the duo of Karondha and Karaundi. Maira, a Bhil clan of Rajasthan owes its name to *Carissa congesta* [186]. They neither cut their totemic plant nor burn wood. Karondha is name of a place in Bundelkhand and Gumla of Jharkhand and a clan of Dube of Sawalaxhi Brahmins [187]. A village in District Lucknow, Uttar Pradesh is named as Ber Karonda because of abundance of the bushes of Karonda in the area. *Villages named as Karaundi are located in Devaria, Varanasi; Amethi, Sulatanpur; Rohtas District of Bihar and Kraundi Kalan in Banda, Kanpur; Radauli Tehsil, Faizabad District and*

Chitrakoot Districts of UP and in Dhimarkheda tehsil of Katni district in Madhya Pradesh.

Folklore and Art

CC has influenced /fascinated the artist's mind and heart of Damodar Lal Gurjar, born in Rajasthan that he portrayed it in tempera forming subject of the cover page of Bulletin of the Hunt Institute for Botanical Documentation, Carnegie Mellon University, Pittsburgh, Pennsylvania13 (1) Spring 2001[188].

Karondha in Proverbs, and Folk songs

Caranda finds mention in proverbs, sayings and folk songs of Bundeli, Hindi and Rajasthani languages. It attracted attention of great poets as Surdas and Saint Carandas. It finds reference in the epic poem of Padmavat of Malik Mohammad Jaisi [18]. The poet referred to various fruits describing the beauty of Garden. National poet, Mathailisharan Gupt [189] mentions on Karaundi in his epic poem Saket (page 227) as "*Ufful phul karauni kunj rah rah karti sabko pulak purn mahmahkar*. Karonda has also appeared in The Maan Carit written by Amrit Rai, a contemporary of Keshav Das [1545]. He describes the types of gardens and grooves on the outskirts of City of Amber:

*Ambo amba amara anvili nimbi nimbu narange,
Sundara sadaphala sada supari sebasat patu lu
sagi*

*Jamun jambhira anjira jarada juradalu ghane
Kathala karaunda naliya badhi veli vana
vadhahala vane*

Dense orchards of myrobalan, mangoes, pomegranates, tamarind, neem, lemons and oranges Delectable citrus fruits, excellent betel nuts, appeasing plums flourished Jaman. Limes, figs, copious orange, apricots, jackfruits, corinda, coconuts, large bells and barhal trees [190].

Proverbs and Couplets

Karonda also finds place in proverbs and Dohavalli. Bhartendu Harish Chander, the Father of Hindi Prose in an act refers to the following proverb: *Parchal goh, Karonda khae*.

In Prediction of Produce

In an agricultural proverb, Karonda predicts the production of sorghum crop.

*Akkā kodom neem ban, ammā mauren dhān, ray
karaundā junri upajai amit parmān*-The year in which aak (*Calotropis*) flowers richly, *kodon* yields are rich, likewise, when neem (*Melia* flowers) much cotton, mango flowers much that year rice and the year in which ray Karonda fruits well that year sorghum production is good [191].

Proverb on human nature

Rahim uses small sized Karonda fruit in one of Doha to express human nature as:

*Bare badai najai, laghu Rahim Itrai
Rai karonda hot hai, kathar hot na rai*

“Rahim says that Great, bold, thoughtful/serious and judicious persons do not shed/lose their calm and seriousness; while low people are often obsessed/ intoxicated /mad in arrogance/vanity. Carranda in its early development equals size of a mustard seed (*Sinapsis racemosa*), but jack fruit is never as small as a grain of rai (*Sinapsis racemosa*)” [23].

Folksongs

Karondha makes its appearance felt in number of Bundeli and Rajasthani folksongs [192-197]. Most of these folk songs connect Karonda as a food item while one of Bundeli folksong refers to planting of Karonda while other refers to coloring of turban and *chunari* (scarf):

In Bundeli folk song *rai-karonda* appears as:

हमाई माई की चूनरी औ पिता की पाग रंगों / बुन्देली
नरी औ पिता की पाग रंगों
काना करौदा ऊपजे औ काना पसरी है बेल औ
करौदा हम भले।
अजुद्धा करौदा ऊपजे सो मिथिला पसरी है बेल।
करौदा...कौने बरन बाकी बौड़िया कौने बरन फुल
होय। करौदा...
हरदी बरन बाकी बौड़िया सो कुसुंभ बरन फुल होय।
करौदा...एक फूल धर तोड़ियो सो नौ गडुआ रंग होय।
करौदा...
रंगियो सजन बरु की चूनरी और पचरंग सजनजू की
पाग।काना जो सूखे चूनरी काना जो पचरंग पाग।
करौदा...
खुटिलन सूखे चूनरी सो छत्तन पचरंग पाग।

Color my scarf and color my fathers' turban-
where is karonda born and where vine is born; Karonda
is born in Ayodhya, in Mithila spreads the vine

*Piri samhari karondha laga aai, hil mil le ri---
ujjhai kai do do kan uljhai re
Kaun karondha hiyro piyro karaundha lal
konna re
Ye pilo karondha hiyro piyro pailo re karondha
lal pelo re [192].
Kadam karondha kusmit ber makoh, nirhat hi
tilake suman,
man andandit hoy.
Swachh sarkadi sasata ki kari bakhan,
sainan main samjhat marm jo haa rasik sujan
(196).
हरे आमरे सेब गाजरें विविध मुरब्बा स्वार, टेली मिर्च
करौदा नीबू परसत आम अचार । तिसाला घट धरना
॥ अब बैठो [197].
Kahun ketaki kadli karonda kund aru karbir
hain. Kahun dakh dadhim sev tut aru jambhir
hain.
Kithun kadamb kadamb kahun hitaltaal tamaal
hain.Piyush te meethe fale kitun rasaal rasaal
hain.*

Describing the garden of Raigarh fort, the poet says that the plants of *ketaki* (screw pine, *Pandanus odoratissimus*), banana, karonda, kund (Jasmine), *kaner* (*Nerium oleander*) grapes, pomegranate, apple, *shatut* (mulberry), *nimbu* (*Citrus jambhiri*), hitaal, taar (*Semecarpus australiensis*), juicy fruits and *rasaal* (mango), are growing at someplace here and there, and mango fruits sweeter than *amrit* (nectar, Sanskrit word for immortality, meaning nectar) are in fruit, and a cluster of white kadam tree (bull flower-tree, *Neolamarckia cadamba*) is also [198].

DISCUSSION

Duo is distributed in continents of Asia, Africa and Australia. Majority of scientists, agree on India as place of origin of the duo. Historical references, philological (multiple names in Indian languages) and archeological evidences and its occurrence of duo in the folksongs, proverbs corroborate its Indian origin, whereas occurrence of distinct name of CS in many tribal languages suggests Africa as another place of origin. Duo is well recognised for its role as food, medicine, live fence and wind break Multiple medical uses of CS have earned for it the epithet ‘magic herb’ in East Africa. The Indian origin of duo is corroborated on basis of its wild occurrence in many parts of India, historical accounts and archaeological and philological evidence in shape of multitude of names in number of Indian languages [Table 1.].

In addition, nutritive value as food duo is used as pickles and spice. Ripe fruit in many countries is taken raw and dried fruit as a snack. The nutritive value of duo compares with that of many of traditional fruits. It contains an appreciable amount of iron. The nutritional value (protein and carbohydrate) of Karonda and some wild fruits equals or sometimes is better than the common fruits like mango. *Carissa* has potential to be a popular fruit like many other tropical fruits [33, 54, 98]. Thus, nutrition available in CC makes it a good candidate to be part of the regular diet of the local population in Bangladesh [29] and as a source of functional food material [149].CS like CC contains significant level of micronutrient and minerals of nutraceutical importance [54]. Consumption of CS fruits has been recommended to alleviate vitamin A deficiency in malnutrition ridden Uganda [42].

Fruit can also be used in preparation of beverages as well as quality wine. Its wine seems to be highly promising choice for the development of non-grape fruit wine [199] and would also help to preserve and make available the fruit nutraceuticals, aroma and taste throughout the year. Moreover, use of CS fruits during glut season would help in reduction of post-harvest losses, substantially boost the consumption and utilization of fruit and generate revenue among rural households (46). Karonda wine being good in terms of overall acceptability holds a strong potential to be used as a commercial value-added product. Wine offers a

better option to access these berries with all its nutraceuticals, aroma and taste in view of lack of awareness among people that limits its accessibility and use [199].

CC can serve as an alternative source of oil, hydrocarbon a herbal dye for fabric and also as a bio-colorant for beverages. and antiaging medicine. CC and *Jatropha gossypifolia* yield 1.7% hydrocarbon and 5.8% oil and can be grown as potential alternative crops for renewable energy(bio-diesel) in areas of underutilized lands, stimulating industrial and economic growth [73].

In traditional healing system CC and CS has been used for respiratory disorders, chest pain, pneumonia, cough, and liver disorders, skin problems as ulcer, itches, and for heart problems in India and African countries. Pharmacological trials have scientifically validated folkloric use of duo as wound healing, antiulcer, antipyretic, hepatoprotective, diuretic, antiviral, anti-plasmodial, anti –constipation, laxative, analgesic (Table 4a).

It would therefore be important to pharmacologically determine their activities for future drug discovery and development. It would be very necessary for the pharmacology community to explore and investigate more of its species in order to determine their chemical constituents and report their potential.

The high antioxidant content and DNA damage inhibiting potential of CC could be used to develop antioxidant compounds for therapeutic applications [48].
Kaunda

Bioactive constituents of leaf, unripe and ripe fruit show antioxidant potential [209], aqueous leaf extracts contain antioxidant enzymes (such as catalase, superoxide dismutase and glutathione-s-transferase [210] suggesting its potential for future development of therapeutic drugs against breast cancer. The anti-nociceptive activity of leaves is comparable to the standard pain-killing drug; aspirin. Isolation of anti-nociceptive components may lead to the discovery of novel and more efficacious painkilling drugs. Standard pain-killing drugs like aspirin and paracetamol suffer from the problem of inducing gastric ulceration or hepatotoxicity from overdose or prolonged use. As such, newer and more efficacious painkillers can prove to be highly beneficial to human beings [211].

Fruits can be a good source of natural antioxidants for both pharmaceutical and dietary requirements and appears to be useful in relieving oxidative stress. Antioxidant, anti-inflammation, and anti-tyrosinase activities of fruit proves it to be very beneficial for skin care and show promise to be used in development of antiaging medicine. Ethyl acetate extract of CC leaves possess high ursolic acid responsible for cytotoxicity effect on human skin cells is proposed for

use in cosmetics and cosmeceuticals due to its superior anti-wrinkle, anti-inflammation, and whitening properties.

The young generation is unaware of medicinal uses minor fruits as *Carissa* for both animals and humans and depend heavily on antibiotics which have played havoc with the immune system. There is an urgent need to educate young generation on the awareness on importance of these small wild fruits regarding identification, use and conservation of the plant. Pharmaceutical companies can play an important and leading role in the conservation looking at their medicinal importance [200]. *Carissa* and such useful small fruits should be introduced to young persons through courses in the school text books at various levels as the lessons learnt from the traditional wisdom of the older generations combined with the modern scientific approach can provide the key to many of the unresolved issues of present-day medicine and open new vistas for the biotechnology industry [201].

Table 1. Names of *Carissa carandas* and *C. spinarum* in Various languages

Carissa carandas

English: Bengal-currants, carandas-plum, karanda, Christ's thorn, craneberry, goose berry, black cherry.

Assamese: Karja tenga. **Bangla:**Karamada, Karamach, Koromcha; **Bihar:****Kanoud,** **Karamij;**

Gujarat:Karamada, karamadan; **Haryana:**teent; karaunda; **Hindi:**garinga, gotho, kantakregi, karaunda,

karaunta,karijige, karonda, karondi, karonti, karrona, karumcha, karunda, korada, timukha, timukhia;

Jharkhand:Kanwad; **Kannad:** dodda kalaa, dodda kavali, doddakavale, doddakavali, garacha, garaja,

garchinakai, garji, harikalavi, heggarichige, heggaricige, heggarjige, hirikalavi, hirikavali, kalaagida, kalavige,

kalivi, kalla, kali hannu, kamarika, kamrdeputi,karjige,karayige, karanda, karande, karande pli, karavadi, karekai, karekayi, kareki, karevati, kari,

karice, kariche, karichi, karichina kaayi, karichinakayi, karicinakayi, karimkar, karinda, karndepuli, kauligida,

kavale, kavali, kavali gida, kawliballi, korinda, malekalaavu; **Marathi:**boranda, boronda, haradundi,

karamanda, karanda, karandi, karaunda, karavanad, karavanda, karavandi, karvadi, karwand-karanja, kali maina.**Malayam:** Modakam, Kilakkai, Pedavallikalavu,

karakka, karimkar, karanta, karekai, keelay, kilai, , klavu, kulay, pedavalli, perumklavu, Karutta cheri, kara kandaki; **Orissa:**Dudkoli, Ankhukoli Koraput:Karanda

koli; **Punjabi:** karaunda, garna. **Sanskrit:** avighna, avighnah, avinga, bahudala, bolekarambuka, dimdima,

dridhakantaka, guchhi, jalipushpa, kanachuka, kantaki, karamarda, karamardaka, karamla, karamlaka, karinkara,

krishna-pakphula, krishnaphala, krisnapakphala, kshiraphala, kshiri, ksiraphala, pakakrishna, pakaphala,

panimarda, phalakrishna, supushpa, stulparkata, susena, vanalaya, vanekshudra, vasha. **Sindhi(Pak):** Kakronda;

Tamil: aintarikam, aintarikamaram, alarukam, alarukamaram, cenkala, cirapalam, cirukala, kala,

kalaaha, kalaka, kalakka, kalakkay, kalakke, kalar, kalarva, karavintai, kila, kilakkai, kilakki, kilamaram, kilatti, kilay, kirusnapakapalam, kirusnapalai, kiruttinapakapalam, periyakala, perukala, perumkla, perungala, perungila-maram, perungkala, perunikila, perunkala, perunkala ver, perunkila, yokatumacceti, yokatumam; **Telugu**: kalay, kali, kali-kai, kalikai, kaliva, kalive, kalivi, kalli, kallia, kalumi, kaluva, karavande, kavila, oka, okalive, pedda kalive, peddakalavi, peddakalive, peddakalivi, peddavaaka kaaya, peddavaka, peddavakakaya, vaaka chettu, vaaklive, vaka, vakalive, vakalivi, vakalvi, vakudu, waaka, waka, wakay, wyaka, yaakudu, vakkaya, wakkayalu; **Urdu**: Karamarda

Bangladesh: Koromcha; **Transcribed Chinese**: cu huang guo; **Indonesia**: Bua Renda Kerendang, Bua Samarinda; **Java**: Karandan, natal plum, bengal currant, karandang (Java); **Timor**: senggaritan;

Malaysia: kerenda, kerandang, berenda; **Myanmar**: Khan; **Nepal**: Karona, Karonda; **Phillipines**: kerenda, kerandang, berenda, caramba, caranda, caraunda, perunkila; **Thailand**: **Bangkok**: naam phrom/ naam daeng S. Peninsula: manao ho; **Chiang Mai**: naam khee haet ; **Vietnam**: cây sirô; **German** : Karandang, karanda Wacsbaum ; **Portuguese**: carandeira;

Spanish: caranda;
Carissa spinarum

Common Name: Amantungula plum, Jangli karonda; **English**: Climbing num-num, simple-spine carissa, simple-spined num-num;

Bangla: Bainchi karancha; **Gujarati**: Timbarra; **Haryana**: gan; **HP**: karondhu, garna, kharnu; **Jharkhand**: Gara, Gadasur, Khunti, Karonda, Karanda,

Konad; Irula : Kalakkodi, **Kashmir**: Garaunda; **Marathi**: karavada, karanda, karwant; **Orissa**: Khira koli, Khiri koli Sanakerenda, Anka, Kol; Koraput: Khirkolia; **Punjabi**: Gan, Garan; **Tamil**: kalakkay, kalachedi Chiru, kila; **Telugu**: vaka, kalivi, kalli, lalimivaka, kalivi, kalli, kalimi, kalimi kaya ; **Lodha**: karowan, **Oroans**: gadasur, Khunti, **Santals**: karonda, konad; **Munda**: Gadasu, **Pusto**: Garanda, granda; **Myanmar**: Khanazat, Natal plum, thau-khan-pin;

Ethiopia: **Borana**: dhagama, **Amharic**: Agam; **Orom**: Hagamsa, Agamsa; **Afar**: Titita; **Oroma**: Agmasa; **Meskan Dist.**: Agame; **Konso**: Agamta; **Tigrina**: Agam ; **Tanzania**: **Chagga**: Manka, **Fipa**: Msuuku; **Haya**: Moyonzaki; **Iraq**: Quach, Titiyo; **Kerewe**: Mkangaonza, mkangayonza; **Kuria**: Munyore, rinyore; **Nguu**: Mkumbaku; **Nyamwezi (Nyam)**: Mfumbeli; **Pare**: Mchofwe ; **Mgiito**: Mkabaku; **Rangi**: mkabaku **Sambaa**: Mfumba, Mkumbaku; **Zara**: mukambaku; **Maasai**: Engamryaki, Olmuriaki; **Sonjo**: Engamryaga;

Kenya: **Ameru**: Mukawa, nkawa(F); **Boni**: Mulumul~ ; **Borana**: dagams; **Bukusu**: burwa(F), kumurwa(F); **Chonyi**: mtandambo; **Digo**: mtandambo; **Duruma**: Mulowe; **Embu**: Mukawa , Nkawa (fruit); **Giryama**: mtandambo; **Gabra**: Gagamsa; **Kambe**: mtandambo; **Lakotetwo/Lökötetwö**; **Kamba**: mukawa, mutote; Kikawa, Mukawa (Machakos, Makueni), Mutote (Kitui), Ngaawa (fruit), Ndote (fruit), Nzunu (fruit, Kitui), Matote (fruit); **Kikuyu**: mukawa, ngawa (fruits); **Kipsigis**: legetetyet, Legetiet; **Kisii**: omonyangateti; **Kuria**: munyoke; **Luhya**: kumurwa; Shikata; Luhya (Buk~u): Kumurwa (plant), Burwa (fruit), Sirwa; **Luhya** (Tachoni)

Table 2: Ethno-medical Uses of Carissa carandas and C. spinarum

Use as/in	CC	CS	Tribe/country/ District	Reference
Anti-malarial		RD	Kikuyu tribe, Nandi Dist. Kenya	Njoroge & Bussmann, 2006;91 Pascaline <i>et al.</i> , 2010 92
		RD	Borana, Ethiopia	Tura, 2013 85
		R	East Africa	Kokwaro, 1993 93
		R Boiled	Borana, Ethiopia	Tura, 2013 85
			Bangladesh	Ramatullah <i>et al.</i> , 2009 29
		L	Mozambique	Kokwaro, 1993 93
		F and Leaves	Ethiopia	Meragiaw and Asfaw, 2014 94
STD, Amoeba, Gono		R decoction	Suba, Kenya	Nagata <i>et al.</i> .2011,95, Geissler <i>et al.</i> , 2002;96 Mandau <i>et al.</i> , 1999, 4
Viral Measles@			Sabots	Okello <i>et al.</i> , 2010 97
Polio			Samburu	Bussmann, 2006 98
Rabid, Jackal, dog	CC		Santals, Bangladesh	Jain & Tarafdar, 1986; 84 Ramatullah <i>et al.</i> , 2009; 29
			CS	Al-Youssef and Hassan, 2010 99
For strength		Root boiled *	Suiei Dorso	Ichiwaka, 1987 100
Joint pains		Root* boiled	Suiei Dorso	Ichiwaka, 1987 100
Strength, General fitness		Root**; Roots	Borana, Pokot	Tura, 2013 85
Muscle, Joint Pain		Roots	Maasai	Bussmann <i>et al.</i> , 2006 101
Joint affections		Stem	Sudan	Safi, 2006 87
Diarrhoea#	RE		Zimbabwe	Gerhardt & Nemarudwe, 2016 102

		Bark	Samburu, Kenya	Omwenga <i>et al.</i> 2009 103
		RD	Nandi dist, Kenya	Pascaline <i>et al.</i> 2010 92
	FL		Ayurveda	Khare,2007; 104 Vaidyaratnam, 1994 105
laxative		RP powder	Lodhas	Pal and Das, 1998 88
Cough		CS		Al-Youssef and Hassan, 2010 99
Cough			Rajasthan	Achalji Maharaj 83
Cough		RE	Zimbabwe	Gelfaut <i>et al.</i> 1985 103
Cough		RD	Nandi	Pascaline <i>et al.</i> 2010 92
Chest Pain		RE	Zimbabwe	Gelfaut <i>et al.</i> 1985 106
Chest Pain		RD	Nandi	Pascaline <i>et al.</i> 2010 92
Chest Pain		RD	Borana	Tura,2013 85
Chest Complains		CS		Al-Youssef and Hassan, 2010 99
Pneumonia		CS		Al-Youssef and Hassan, 2010 99
		RE	Zimbawe	Gelfaut <i>et al.</i> 1985 106
		RD	Nandi	Pascaline <i>et al.</i> 2010 92
		RE	Zimbabwe	Mabogo,1990 107
		RE boiled	Samburu, Kenya	Bussmann,2006 98
		Root	Zimbabwe	Mayori, 2013 108
		LR RB	S Africa, Uganda, Kenya	Tabuti <i>et al.</i> 2010 U, 109, Green <i>et al.</i> 2010SA 110; Mariita, <i>et al.</i> ,2010 K 111
Headache#		RD	Borana, Ethiopia	Tura.2013 85
Headache		Stem	Sudan	Mohammad <i>et al.</i> 2006, 127;Safi, 2006 87
Headache		F	Borana	
		CS	Egypt	Al-Youssef and Hassan, 2010 99
		Bark	Pokot	
		Leaves	Ethiopia	Amenu, 2007 65
		CS ls+2	Ethiopia	Amenu, 2007 65
Urinary tract			Sabaots, kenya	Okello <i>et al.</i> 2010 97
Urination burning	R		Maharashtra	Kadam <i>et al.</i> 2013 112
Snake bite	R		Maharashtra	Kadam <i>et al.</i> 2013 112
Snake bite		S	Sudan	Safi, 2006 87
Fever@#	LD			Kirtikar 150
Fever	CC		Bangladesh	Ramatullah <i>et al.</i> 2009 29
Remittent Fever#	LD			Khare,2007 104
Fever		SD	Santals	Pal and Das, 1998 88
Typhoid & Fever		RP	Santals	Tarafdar,1986 113
Typhoid		RD	Nandi Dist, Kenya	Pascaline <i>et al.</i> 2011 92
Antipyretic	SLF		Pak	Ahmed <i>et al.</i> 2009 114
Fever			TN	Bhaskar &Balakrishnan,2009 153
Fever			Borana	Tura,2013 85
Fever		Stem		Safi, 2006 87
Fever	R		Jharkhand	Singh,2008 116
Fever		FR	MP	Samar <i>et al.</i> 2015 118
Remittent fever		SD		Pal and Das, 1998 88
Rheumatic fever	RP		Lodhas	Pal and Das, 1998 88
Rheumatism	CC		Santals	Pal and Das,1998 88
Rheumatic pain		Root paste		Pal and Das ,1998 88
Rheumatism, itch, sore, wound	R, Seed		Uttar Pradesh,	Singh and Dubey, 2012 117
Rheumatism		CS		Al-Youssef and Hassan, 2010 99
Rheumatic pain		FR	MP Guna	Samar <i>et al.</i> 118
Rheumatism			Mundas	Rose and Prasad, 2013 119
Edema/dropsy	CC	FE	Santals	Paul and Das, 1998 88
	CC		Jodhpur, Ajmer	Achalji Maharaj, 83 Jain <i>et al.</i> 2009 120
Edema		CS		Al-Youssef and Hassan, 2010 99
Epilepsy	R	RD	Nandi, Dist, Sabaots of Kenya	Pascaline <i>et al.</i> , 2010; 92 Okello <i>et al.</i> 2010 97
Epilepsy	RD		Santals	Jain & Tarafdar, 1970 84
	RD		West Ghat, Santals, Bangladesh	Jain and Tarafdar, 1970; 84 Hegde <i>et al.</i> 2009; BSI 76 Rahmatullah <i>et al.</i> 2009, 29
Aphrodisiac	F+		Bangladesh	Rahmatullah <i>et al.</i> 2009 29

Nerve Disorders	CC		Bangladesh	Ramatullah <i>et al.</i> , 2009 29
psychiatric disorders		Stem	Sudan	Safi, 2006 87
Insanity	CC		Bangladesh	Ramatullah <i>et al.</i> 2009 29
Toothache	CC		Bangladesh	Ramatullah <i>et al.</i> 2009 29
		CS		Al-Youssef and Hassan, 2010; 99
		CS leaf +5	Ethiopia	Amenu, 2007 65
Stomach-ache#		CS	Borana	Tigist <i>et al.</i> , 2006 121
	CC		Buldahna Dist Maharashtra	Theng and Gaikwad, 2022 122
	R		NK	Raja Sahib and Issacs 2004 83
		Ls+Honey	Ethiopia	Amenu, 2007 65
		RS	Ethiopia	
Lower abdominal pain in pregnant mothers		RD	Borana	Tura, 2013 85
Relieves pain after child birth	RD			Sonawane <i>et al.</i> , 2012 123
inter protection for lips	Latex			Sonawane <i>et al.</i> , 2012 123
Laxative#		Root powder	Lodhas	Pal and Das, 1998. 88
Antiscabies			Santals	Pal and Das, 1998/ 88
Astringent	F		NK	Raja Sahib and Isaq, 2004 83
Liver Dysfunction#@	F		NK	Raja Sahib and Isaq, 2004 83
Liver diseases	F		Karnataka	Bint e-Sadek <i>et al.</i> 2013, 124 Hegde and Joshi , 2009 75
Blood Petrification			NK, Bangladesh	Ramatullah <i>et al.</i> 2009 29
Ulcers		RD	Nandi Dist, Kenya	Pascaline <i>et al.</i> 2010 92
Body pain, cuts, injury, sores, anti-inflammatory		Root	Khammam, Telengana	Ravi <i>et al.</i> , 125
Pain	CC		Bangladesh	Ramatullah <i>et al.</i> 2009 29
Heartburns		RD	Nandi dsit, Kenya	Pascaline <i>et al.</i> 2010 92
Diuretic#@				
Anti cancer@		RD	Nandi	Pascaline <i>et al.</i> 2010 92
Breast Cancer		RD	Borana	Tura, 2013 85
Appetizer#		F	Borana	Tura, 2013 85
Appetite Stimulant	L		Bangladesh	Ramatullah <i>et al.</i> 2009 29
Hepatoprotective Antigliycemic@			West Ghat	Itankar <i>et al.</i> 126
Diabetics	#PP		Lodhas	Pal and Das, 1998 88
Antihelmintic#		F	Sudan	Memood <i>et al.</i> 1996 127
		CS		Al-Youssef and Hassan, 2010 99
		RD	Borana	Tura, 2013 85
	R		NK	Raja Saheb & Isaq, 2004 82
	RD	R	Jharkhand	Singh, 2008 116
Venereal Disease			Nandi district Kenya	Pascaline <i>et al.</i> , 2010 92
Gonorrhea		CS	Nyiru, Nandi distict Kenya, Borana Ethiopia	Amenu, 2013; 65 Pascaline <i>et al.</i> 2010; 92 Al-Youssef and Hassan, 2010; 99 Tura 2013 85
			Samburu, Kenya	Bussmann, 2006 98
Symphilis		CS	Nebi district, Uganda	Anywar <i>et al.</i> 2014 42
Hernia		CS		Al-Youssef and Hassan, 2010 99
Burns, Bruises, Boils, blisters	CC		Kani tribe, South India	Ayyanar and Ignacimuthu, 2009 128
Wound healing#@		Root		Sanwal and Chaudhary 2011; 129 Singh and Dubey, 2012 117
Septic wounds		RP	Lodhas	Pal and Das, 1998 88
Itch			Kani, Bangladesh, UP	Singh and Dubey, 2012 117
Itch		Seed oils	Asurs of Bihar	Gupta, 1991 130
Itch		Pounded @	Kokan	
Sunstroke,		S	Sudan	Safi, 2006 87
Fungal nfections@		S	Sudan	Safi, 2006 87
Water Purification		Stem	Sudan	Safi, 2006 87
Fumigation ingredient		Stem	Sudan	Safi, 2006 87

Antiscorbutic	F		Anantpur District, AP, NK	Basavaraju <i>et al.</i> 2009; 131 Raja Saheb & Isaq, 2004 82
Hemiplegia	CC		Santals	Jain and Tarafdar, 1970 84
Post natal complaints	CC		Santals	Jain and Tarafdar, 1970 84
Evil eye		Leaf fumes	Ethiopia	Amenu, 2007 65
blood glucose Regulation anthelmintic, antiscorbutic, astringent, stomachic and toothache.		Leaves root	Saudi Arab	Kaunda and Zhang, 2017 132

*Boiled with goat bone ** root boiled with soup D= decoction E= extract F= fruit L =leaf PL= plant PP = plant powder R= Root, S= stem; # Used in Ayurveda @ validated in pre-clinical tests

Table 3: Comparative pharmacological activities of *Carissa carrandas* and *Carissa spinarum*

	Part	Extract	<i>Carissa carrandas</i>	<i>Carissa spinarum</i>
Antimicrobial Antiinflammatory			Anupama and Madhumita 78	
Anticonvulsant*	WP EE	RE EE	Hegde <i>et al.</i> 2009a, b 75, 76	Hegde <i>et al.</i> 2011, 219,
	Root		Hegde <i>et al.</i> 2009a 76	
Anticonvulsant	Root	RB		Ya'u <i>et al.</i> 2008 220
Antiarthritic	Root	EE		Hegde <i>et al.</i> 2011 221
Anti bacterial	WPEE		Devmurari <i>et al.</i> 2009 164	
Hepatoprotective	Root	RE	Chatterjee & Roy,1965,202	Hegde and Joshi, 2010 222
Hepatoprotective	Leaf	ME		Khan <i>et al.</i> 2011 223
Antioxidant	Fruit	FM	Sarma <i>et al.</i> 2015 53	
Antioxidant	Stem Leaves	Ccl e	Chatterjee & Roy,1965, 202	Rao <i>et al.</i> 2004 224
	Root	extra		Hegde and Joshi, 2010 222
	Stem RB	AQE		Khan <i>et al.</i> 2010 225
Antihelmintic	Root	Crude e		Harwansh <i>et al</i> 2010 226
Wound healing	Root	RM		Sanwal and Chaudhary, 2011 129
Antimicrobial	Root	RAQ		Sanwal and Chaudhary, 2011 129
Antimicrobial	Leaf, fruit,	LF;EE		Ibrahim <i>et al.</i> 2005,227; Sarla <i>et al.</i> , 2012 228
Antiviral Herpes virus	Root	RA		Tolo <i>et al.</i> 2006 232
Antiviral		SRBA		Tolo <i>et al.</i> 2007 233
Antiviral		RBDEE M		Tolo <i>et al.</i> 2010 234
Antiviral (Sindbis, SINV; Polio; Herpes Simplex Virus SIV)		EE	Taylor, 1996 135	
Anti-plasmodial	RB	RBM		Kebenei <i>et al.</i> 2011 235; Koch <i>et al.</i> 2005;236 Kirira <i>et al.</i> , 2006;237
Erythropoietic	RB	E		Koffuor <i>et al.</i> 2012 238
Anti -cancer	Seed	S		Sehar <i>et al.</i> 2011 229
	Fruit	EE	Jain <i>et al.</i> 2015 203	
Anticancer, antioxidative		FEE	Jain <i>et al.</i> 2015 203	
Antipyretic, analgesic, anti- inflammatory	REX L	EA M Aqe	Bhaskar and Balakrishnan, 2009 152 Haiti <i>et al.</i> , 23 204	
Analgesic anti inflammatory	Fruit		Sharma <i>et al.</i> 2007 165	
Diuretic	Root	RB M		Nendi <i>et al.</i> , 2004 230
Antidiabetic	Leaf E		Gaurav <i>et al.</i> 2010(hypo and 205 antihyperglycemic	El-Fiky <i>et al.</i> , 1996 231
Cytotoxicity	EE WP		Chatterjee & Roy,1965, 202 Joglekar & Gaitonde, 1970, 178	

Antibacterial			Devmurari <i>et al.</i> 2009 164	
Antibacterial	LME	M	Singh and Sangwan, 2009 206	Zia <i>et al.</i> 2011 239
Gram+ and Gram-	SLR	CE	Fartyal and Kumar, 2014 207	
Antifungal	EE WP		Siddiqui <i>et al.</i> 2011 208	
Anticandida	WP		Devmurari <i>et al.</i> 2009 164	
Anti DNA damage, antinfla, antioxidant			Sidique <i>et al.</i> 2003 159	
Anticancer	LRURF		Sulaiman <i>et al.</i> 2008 209	
Anticancer, antioxidant	LAQ		Dua and Srivastava, 2013 210	
Analgesic			Ibrahim <i>et al.</i> 2007 3	
Hypotensive	RAI		Chaterjee <i>et al.</i> , 1965 202	
Hypotensive	LEE		Shamim and Ahmed, 2012 211	
Antihyperglycemic	L	M	Rahman <i>et al.</i> 2011. 212	
Antihyperlepidemic	Leaf	EE	Sumbul and Ahmed, 2012 213	
Analgesic antiinf	F		Sharma <i>et al.</i> 2007 165	
Lipase	F		Mala and Dahot, 1992 244	
Anthelmintic	RB	RBM	John <i>et al.</i> 2007 217	
central depressant activity, Diuretic	L	M	Saha <i>et al.</i> 2010 218	
hepatoprotective and antioxidant	Root	extract	Chatterjee & Roy,1965, 202Hedge joshi 2009 bhaskar Balakrishnan 115	
Antipyretic, antinociceptive	l	M		Maina 2015 240
Antipyretic, analgesic ant infl	Root	extraxct	bhaskar Balakrishnan 2009 153	
	leaf	AQE	Haiti <i>et al.</i> 204	
Anti inflamatory	DF	M		
Antiulcer	EEWP		Merai and Jadhav 219	
Constipation and Diarrhea	EEWP		Mehmood <i>et al.</i> 128	
Antiaging			Neikhum <i>et al.</i> 2021 175	
Antispasodic	RB	Aq		Oluch <i>et al.</i> 2020 241
Constipation and Diarrhea			Mehmood <i>et al.</i> 2014	

Table 4 a: Folk remedies use in Ayurvedic Practices and Pharmalogical Validation

Activity	Plant part	Ethnomedical uses	Ayurvedic Practice	Proving
Anticonvulsant epilepsy	Root Bark (RB)		Anonymous 1978 148	75,76
	CC ECR			Hegde K <i>et al.</i> , 2009 76
Diuretic#@	CS, EE	Sabots Kenya	Mutrajyan/ Tripathi 1978 144	Nedi <i>et al.</i> , 2004 230
	CC MLC			Saha <i>et al.</i> , 2010 218
Remittent fever	Leaf		Addis,150 Kirtikar, 1501Chunekar 1998 147	Taylor <i>et al.</i> , 1996; 135 Garg <i>et al.</i> 2 011 174
Antimalarial Ant plasmodial	RB CC	Meru & Kilifi tribe of Kenya	Ramatullah <i>et al.</i> , 29	CC Anupama, 78 Hegde et al Kirira <i>et al.</i> , 2006 237 Al Youssaf <i>et al.</i> , 2010 99
Tooth ache		CC Bangladesh	Pradant/ Tripathi 144	
Anthelmintic	CC		Itankar 126 Sharma <i>et al.</i> , 2001 90	CC John et al.217
		Sudan	Mehmood <i>et al.</i> 1996 127	
Respiratory			API 1999, 142 VK Singh 2003 143	Yadav <i>et al.</i> , 2019
Purgative	CC, CS		Tripathi 1978 144	68 Mehmood <i>et al.</i> , 127
Hepatoprotective	CC	60 West Ghat	Tripathi 1998 1454yakrit(liver)	61 Khan <i>et al.</i> , 222
Hepatoprotective	CC			Hegde and Joshi 2009 221 Balakrish 2009

Chronic Joint Pain 79	LFS CS	Kenya	Hegde and Joshi 2010	CS, Wambugu <i>et al.</i> , 2011 79
Wound healing#@	Root extract 77	77 Fowsiya,2017	Sanwal and Chaudhary 2011; 129 Singh and Dubey, 2012 117	Harwansh <i>et al.</i> , 2010 225
Table 4 b Validated Ethnomedical remedies				
Activity/ diseases	Plant part	Country	Reference	Validation by Pharmacological testing
Fungal infections@	Seed	Sudan	Safi, 2006 87	
	CC Fruit(F)			Mishra <i>et al.</i> , 2009 242
Diarrhoea#	Root extract E	Zimbabwe		Gerhardt & Namarudwe, 2016 102
Anti Herpes			Tolo <i>et al.</i> , 2006 232	51 Krishna, H.;2007 45 Bagla <i>et al.</i> 2012 243
Skin diseases	F	Sri lanka	Ayurvedic pharmacopeia 1969	Neimkhum <i>et al.</i> , 2021175
Wound healing#@	Root extract 77	77 Fowsiya,2017	Sanwal and Chaudhary 2011; 130 Singh and Dubey, 2012 111,	Harwansh <i>et al.</i> , 2010 225
Hypotensive	CC		Chatterjee 1965, 202 Shamim <i>et al.</i> , 211	61 CS Khan <i>et al.</i> , 223 Chatterjee 1965 202
Fever	leaf Ext Aq			Taylor <i>et al.</i> 1996; 136 Garg <i>et al.</i> 2011 174
TUFever@#	LD		Kirtikar150	
Anticonvulsant	EE CG			Hegde <i>et al.</i> , 2009
Antihyperglycemic l	cs	60 West Ghat		CS Gaurav <i>et al</i> 205, El Flicky <i>et al</i> 230 Sumbal &Ahmed 2012 213 CCE
Hepatoprotective Antiglycemic@		West Ghat	Itankar <i>et al.</i> 121	Rahman <i>et al.</i> 2011. 212,
Anti-cancer@	F	Nandi	Pascaline <i>et al.</i> 2010 92	Merai & Jadav CC 219

***Boiled with goat bone ** root boiled with soup; D= decoction; E= extract; F= fruit; L =leaf ; PL= plant ;PP = plant powder R= Root; S= stem ; # Used in Ayurveda @ validated in pre-clinical tests**

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