

## Nutraceutical Wild Fruit of India-*Capparis decidua* (Forssek.) Edgew. Caper Tree/*Karira*

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## Abstract

## Review Article

*Capparis decidua* (Forssk.) Edgew. (CD) commonly known as Caper tree/ *Karira* is a small much, branched shrub. It is an important species of desert and arid regions to the tropical and subtropical regions of India, Arabia, Pakistan and Africa including Egypt. It provides vegetative cover in dry, hot, sandy desert areas, improves soil, prevents soil erosion and promotes biodiversity. It is a source of food, fodder, fuel wood, timber, medicine and plays an important role in the rural economy of arid regions. Its hard, heavy and termite resistant timber is known as “Sandal Wood” of the desert India. Fruits are eaten raw, unripe fruits and flowers are used pickled used as vegetable, dried fruits are turned into a delicacy in Rajasthan. In many parts of India, Africa and East Asia fruit serves as source of survival and food during famines. Records of CD appear in Vedas, Ayurvedic treatises as Charaka and Sushrut Samhita and classical Sanskrit texts of Panini, Brihat Samhita of Varah Mihir, Upavana Vinoda and Vishvavallabha. The plant has been used as anti-inflammatory, anti asthmatic, analgesic, cardio protective anathematic, purgative, ant-helminthic, hepato protective, astringent, nutraceutical and antimicrobial in Ayurveda, Siddha, Unani systems of medicine since 2000 years. Plant seems to be a future green source of cosmetic, bio-inhibitor of metallic corrosion, nano-technology and bio diesel. The review presents the history, folklore, distribution, use as food, fodder, medicine in folk, animal and human health; it's pharmaceutical and therapeutic, cultural, ecological and miscellaneous uses and nutritional and nutraceutical value.

**Keywords:** History, names, uses, pharmacological testings, folklore.

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## INTRODUCTION

*Capparis decidua*(Forssk.) Edgew. (CD) commonly known as Caper tree/ *Karira*/*Kair*/*Ker* is a multipurpose perennial woody plant, of caper family (Capparaceae). The Genus *Capparis* owes its name to the Arabic word 'kabar' for capers, through Greek, *kapparis*, and species name is derived from *deciduus -a -um*, meaning not persisting, falling-off or deciduous. Out of 45 species, 26 occur in India [1]. It is a small much-branched shrub that provides food, fodder, fuel wood, timber, medicine and plays an important role in the rural economy of arid regions. Plant is used as diet supplement for goat, sheep, camel and other animals during scarcity period of grass. Its timber is hard, heavy and termite resistant and has earned epithet “Sandal Wood” of the desert in India.

### Habit and Distribution

CD is a shrub of dense tufts, but can also grow as a small tree (4–5 m high). Branches and twigs are

glossy dark green and bark turns whitish grey with age. Small, light brown spines occur in pairs on the branches at each node. Leaves are very minute (2 mm long) and emerge on young shoots, have very short life and plant looks leafless most of the time. Flowers are pink, red-veined; emerge in small groups along the leafless shoots at the axils of the spines. Fruit is small dull red berry, many-seeded ovoid and 1-2 cm in diameter, becomes blackish when dry. The seeds are 2–5 mm diameter, and are embedded in the pulp. It produces leaves, flowers and fruits twice or thrice in a year. Flowering and fruiting takes place in February-March and July-August. Summer months are peak flowering time and maximum mature fruits are available just before onset of monsoon. Flowering 1–2 months earlier to the onset of rainy season ensures availability of seeds for germination at the time of rainfall. Fruit yield varies between 2-20 kg per plant depending on age, genetic potential, and flowering season.

Harvesting fruits at right time and right stage of maturity is very important. This being 7-10 days after fruit set with 5-8 mm diameter during March-April [2]. The cured fruits can be prepared into vegetable curry, pickle or sun dried for use in the off season. Properly sun dried immature fruits of *kair* fetch in the urban retail market Rs. 800-1200 kg-1 depending upon the size. The smallest sized fruits fetch the highest price [2].

CD coppices well and readily produce root suckers. This adaptation ensures continuity of the species. The plant can afford this behaviour because of deep and extensive root system (up to four meters) and its ability to draw moisture from deeper soil layers [3, 4, 5]. CD is mainly propagated by seeds and root suckers under natural conditions [6, 7].

Sanskrit text *Namarupajnanam* (Characterization of Medicinal Plants) describes *Karira* as a plant of arid zone marubhurha, having small leaves on new shoots, the old branches staying leafless apatra, gudhapatra. Leaves and root are pungent and bitter (*katutiktaka*, *tiksnasar*). Branches are nodular (*granthila*) with sharp spines (*krakara*, *tiksnakantaka*). Round, soft fruits (*mrduphala*) and also flowers are used as vegetable (*sakpuspa*) [8].

It is a hardy species and grows preferably in dry, arid and exposed habitats like wastelands, ditches, drying ponds, cultivated lands, road sides and surrounding plains of hills on very shallow and soils affected by saline irrigation water, and in stabilized sand dunes [9]. It provides vegetative cover in dry, hot, sandy desert areas, improves soil, prevents soil erosion and promotes biodiversity [10, 11]. It is common in rangelands, barren fields, farm boundaries and wasteland in Rajasthan due to its excellent adaptations to survive under prolonged drought condition. Although it is well suited to areas with low rainfall (150 mm), *kair* can survive in areas with rainfall as high as 600 mm and temperatures from 16-50°C [3]. It grows in association with *Acacia senegal* (L.) Willd., *Calotropis procera* (Ait.) R. Br., *Grewia tenax* (Forssk.) Fiori, *Maytenus emarginata* (Willd.) Ding-Hou, *Ziziphus nummularia* (Burm.f.) Wt. et Arn., *Salvadora oleoides* Decne, *Prosopis cineraria* (L.) Druce.

CD is an important shrub species of desert and arid regions to the tropical and subtropical regions of India, Africa, Arabia, Pakistan and Egypt. It is distributed in tropical and subtropical regions of Chad, Egypt, Ethiopia, India, Arabia, Pakistan, Iran, Jordan, Mauritania, Niger, Nigeria, Senegal, Somalia, South Africa, Sudan and Egypt. In India it occurs in Gujarat, western Rajasthan, Uttar Pradesh, Madhya Pradesh, Haryana, Punjab and parts of Tamil Nadu, Karnataka and Andhra Pradesh [12].

## History

### Written Records

Records of CD as *Karira* appear in Yayurveda (1000 BC) and in Kāthaka samhita (1200- 800 BCE) [13, 14]. It finds mention as a nutraceutical fruit in ayurvedic treatises as Charka Samhita (700 BC), Sushrut Samhita (400 BC) and Madanpal Niganhtu (1100AD). References on CD occur in classical Sanskrit texts of Panini (500BC) and Brihat Samhita of Varah Mihir (505-587AD); Upavana Vinoda (1300AD), Vishvavallabh (1577AD) and Matsyapurana (earlier to 700AD). It is also recorded in epic poems of Ramayana (200 AD); and Mahabharata (400 AD) [15, 16]. CD also appears in Sanskrit text of Kadambari of Banabhatta {a courtier of King Harsha Vardhana who reigned from c. 606- 647 AD in North India first from Sthanishvara Thanesvar}), and later Kanauj and in Vakapati's historical poem in Prakrit Gaudovah or Gaudavadha, composed in 1887.

### Names and Synonymy

Its vernacular and common names are prevalent in 17 Indian, 5 Asian, 5 African and 6 European languages, dialects / countries (Table-1).

CD is referred as *Karira* in Yayurveda, Maitrayanī Samhitā, Taittirīya Brāhmaṇa (300-400 BCE), Taittirīya Samhitā, Śatapatha Brāhmaṇa (800 to 600 BCE), and Kāthaka Samhitā. Amarkosha (500-800 AD) lists three names (*Karir*, *Krakar* and *Granthila*) for it. While *Namarupajnanam* as mentioned earlier, provides nine names based on the plant characters [8]. CD is known by 29 names in Sanskrit, Tamil (25), Hindi (15), Telugu (3) and Urdu (4) (Table-1). Prevalence of large number of names in Indian languages/ dialects indicates its Indian nativity.

**Table-1: Names of *Capparis decidua* in various Indian and Foreign Languages**

<p><b>Sanskrit:</b> <i>Karira</i>*, <i>Apatra</i>, Chakrak, <b>Granthila</b>, <b>Gudhpatra</b>, Kantaki, Karaka, Kataphala, <b>Katutiktaka</b>, <b>Krakara</b>, Krakaripatra, Krakatha, Krishashakha, <b>Marubhuruh</b>, <b>Mrduphala</b>, Nigudhpatra, Nispatrak, Nispatrika, <b>Sakpushpa</b>, Shatakunta, Shonapushpa, Suphal, <b>Tikshnakantaka</b>, Teekshnakantaki, <b>Teekshnasar</b>, Ushnasundara, Vidahika, Vishvakpatra, maruruhu, mar vidahika, ubhuruha <b>31</b> * bold =names in [8]</p> <p><b>Bangla:</b> Karil;  <b>Bihar:</b> Kari;  <b>Gujarati:</b> Kerdo, <i>Kair</i>, Kera, Kerda,ker <b>5</b>;  <b>Haryana:</b> Tind (F), <i>Kair</i>;  <b>Hindi:</b> Karel, Karila, Kair, Kabra, Kachra, Karer, Karir, <i>Karira</i>, Karia, Kario, Karil, Karu, Ker, Kerro, Kurel, Kurrel, Pinju, lete, Satari, Teent, Tent, Tenti, Babula ki tenti <b>22</b>;  <b>Kannad:</b> Chippuri, Cippuri, Kaareela, Kareera, <i>Karira</i>, Kariuppi-gidda, Keraa, Kiruli, Niovate-gidda, Nispatley –gida, Nispatige, Shipri <b>11</b>;  <b>Kokani:</b> Kiral;  <b>Kutchi:</b> Davra;  <b>Malayam:</b> Karimulli, Karimullu;  <b>Marathi:</b> Nepati, Karil, Ker, Nevati;  <b>Odia:</b> Kirir, Krakara;  <b>Punjabi:</b> Bander, Barar, Barari, Bassar, Bauri, Ber, Kabarra, Kabra, Kakri, Kanda, Kaur, Keri, Kiari, Taker; Delha (F), Karia, Karil, Karin, Karis, Kerin, Kirra, Pinju, Tenti; <b>Rajasthan:</b>, Ke, Kair, Dhalu, Karea Kerro, Taint, Teent <b>8</b>;  <b>Sindhi:</b> Dorakiram, Kirab, Kiral, Kirid, Kirur Kirer <b>7</b>;  <b>Tamil:</b> Cattiputpam, cattiracoputpam, cinaikaravi, cinaikaravicceti, ciracukkilam, cirakakoli, cirakatantai, cirakkoli, ciratci, cutakkini, <i>Kariram</i>, kelal, kentikam, kuraram, Karyal, Kulaladondai, kulalatontai, marupurukam, palaccaka, sengam, senkam, sirakkali, vayacca, vayaccam, venu <b>25</b>;  <b>Telegu:</b> Enugadanta, <i>Kariramu</i>, Mumudatu <b>3</b>;  <b>Urdu:</b> Titali, karir, kachia phal, kabar, pichu, <b>5</b>  <b>Afganistan:Pusto</b> :Kira, Kreeta (Seraki); <b>Pakistan: Gunger; Balochistan:</b> Karar, <b>North Balochistan:</b> Khawarg, <b>Ormara Balochiatan:</b> Krap, <b>Gawadar Balochistan:</b> Kder; <b>Punjab:</b> Karri, dela; <b>Sindh:</b> Kareer, Kirer; <b>Chinese:</b> Wu ye shan gan; <b>Tibetian:</b> <i>Karira</i>, <i>Karira</i>, rgyasnalu, rgya sneu (p&amp; d), uboka (d), upotaka (p), upota kila Kabra; <b>Persian:</b> Bergesodab, Kebir, Kurake, Sodab Kabar, Kebir, Kurak  <b>Africa:</b> Swartsorm, Babejaanarm; <b>Alegeria:</b> Toundoub, Habriga (<b>Arabic</b>), Koussoms (<b>Berber</b>); <b>Arabic:</b> Hanbag, Kiabara, Margh, Sodab, Tundub, Murkheit, Kursan, Khiran, Khirar, Habriga, Sarwab, <b>Chad central:</b> <b>Arabic</b> Tountoub; <b>Egypt:</b> Bischarin tribe :Hanboaq, Sarwab, Khushmaun tribe: Tundhub, Balaha Tundhub (F); <b>Ethiopia</b> : Injet, Maluza , Yomonoxe; <b>Hebrew:</b> Retama caper, Tsalaf ratami; <b>Somali:</b> Meringa; <b>Syria:</b> Kabar;  <b>Europe: English:</b> Caper, Desert broom; <b>French:</b> Caprier sans feuilles, caprier; <b>Malta:</b> Caper plant, capparo, cappara; <b>Morocco:</b> Ignin; <b>Portuguese:</b> Alcaparra; <b>Russian:</b> Kapersovyi kust, <b>Spanish:</b> Alcaparra, Alcaparro; <b>Turkish:</b> Kabarish</p>
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## Origin

Archeological evidences in the shape of wood charcoal reveal that CD (*Capparis aphylla*), *Manikarna hexandra* and *Prosopis spicigera* were grown in Punjab since pre historic periods (Pre-Harappa phase, 2300-2000BC) [19, 20]. In North-western drier plains of India, 26 wild relatives of *Capparis* including those of CD have been recorded particularly in sand dunes habitat and rocky areas [21]. The archaeological evidences, historical records, philological evidence in the shape of innumerable names (Table-1) and frequent occurrences of CD in folklore and literature of Indian languages indicate and corroborate its Indian nativity.

## Uses

### Food

CD is nutrient rich indigenous plant whose flowers, flower buds and fruits are used as vegetable, in pickle making and as food [4]. Since ancient times, the people of arid and semi-arid regions of Afghanistan, Pakistan and North Western India have used caper berry pickle. Many ethnic groups of Rajasthan, Uttar Pradesh, Haryana, Madhya Pradesh, Gujarat and Maharashtra use fresh and blanched fruit as vegetable because of perceived belief of its nutraceutical value [22-24].

Fruits are cooked as vegetables alone and along with those of *Prosopis cineraria* and seeds of *Acacia senegal* and dried fruit form an important ingredient of the famous ‘‘Panchkoot’’ mixtures of dry vegetables of Rajasthan. The dehydrated fruits are extensively used as off-season vegetable and are highly priced [5, 25]. The raw fruits serve as food for survival in wilderness and used during the time of food shortages in India and Sudan [4, 26].

In Egypt, Khushmaun people of Mazza tribe cook and eat the fruit without seeds because these are considered to induce vomiting and Bischarin of Beja tribe eats ripe fruits for their nutritional value [27].

CD is also used in preparation of mouth freshener [28]. Folks in Rajasthan use dried and roasted seeds as a diet [29]. Caper sauce is a popular accompaniment to baked fish in the west, a practice which continued in colonial India [30]. People of Rajasthan and Haryana use its flower buds for food flavoring and fruit extract in the food processing industry as a flavor agent [29] and root ash as a source of salt [31]. In India, the stems are used to stupefy fish. The fruits and flower-buds are commonly pickled and used as a condiment [32].

## Fodder

The cattle relish perennial grasses from August to November, while in summer season, green shoots of *Calligonum polygonoides* and CD form browse of cattle which during other seasons are not liked by the animal [33]. The young twigs serve as a fodder for camels and goats. It is used as food of camel since ancient times. In Rajputana and Sudan, the plant is fed to animals as fodder [34, 35]. Its green and dried leaves are used as diet supplement for goat, sheep, camel and other animals during scarcity period of grass [36].

In Banaskantha, Gujarat, folks traditionally mix CD fruits with fodder to increase milk production in animal. Flavonoids, present in *Capparis* plants, possess oestrogen binding properties [37] and act as a galactagogue to increase milk production in animal.

The proximate composition of shoot shows: dry matter content (50.8%), digestible dry matter (49.7%), crude protein (12.1%; true protein, 9.5%; non protein nitrogen, 3.4%), crude fiber (29.6%), NDF (60.6%) and ADF (50.0%). The minerals constituents included Ca, Na, K, Zn, Mn, Fe, Cu, and Ni [38]. CD shoots being rich in protein content and having adequate amount of minerals are useful as fodder [39]. Livestock animals require protein for maintaining growth and reproduction, metabolism. Its deficiency leads to reduced appetite, low feed intake resulting in poor growth and development [40]. Gull et al. [38] maintains that Ca content of CD is lesser than other fodders but it can fulfill the livestock's requirement during periods of non-availability of any other fodder.

## Fuel Wood and Timber

Its timber is hard, heavy and termite resistant. The wood strength and durability is suitable for making water pipes, water troughs, small beams, rafts, knees of boats, tool handles, cart wheels, axles and combs. It also serves as material for making huts and fences. Wood being strong and durable is also used in making of agricultural implements and foundation around well [28, 41]. CD wood is used in carving and cobblers take advantage of its high quality imparted by less xylem fibres [35]. Mehars of Gujarat use stem for making lower portion (*phool*) of churning rod [42]. In Egypt the dried plant serves as fuel and wood is used in preparation of the *basuur* (camel saddle). Wood finds use as firewood and for preparing charcoal. CD wood has good fuel wood characteristics like calorific value, density, volatile matter and fuel wood index [43].

## Use in Agriculture

In cultivating land this plant is grown to form hedges for protection. Its prickly branches are used to make 'Kanti' to protect emerging seedlings of groundnut [44]. In Gujarat farmers spray boiled infusion of tender CD leaves to control aphids and sucking pests in crops [45]. As mentioned earlier, *Ker* wood resists the termite

attack, therefore, thinner branches are used for fencing the field and mulching.

## Medicine

### Ayurveda

CD finds reference in a number of Ayurvedic treatises and dictionaries. It is classified both as *ahara* (food, *saka/vegetable or phala/fruit*) and as a medicine. Mādhava Dravyagūṇa considers it as a food as well as a medicine. Aṣṭāṅga Hṛdaya and Madanapāla Nighaṇṭu categorised it as a vegetable (*Saka*) while Kaidav Nighantu and Amarkosha of Amar Singha treated under it herbal medicine. Caraka and Susrut Samhitas described it in *phalavarga* (Fruit section) and *tikta skanda* (Pungent/bitter Canto). Abhidhānaratnamāla and Matsya Puran classified in *kaṣāya skandha* (Caustic Canto) while Bhāvaprakāśa Nighaṇṭu dealt it in *vaṭādi varga* (Wind section) [46].

Fruits and flowers when taken internally subdue *vayu* (wind) and *pitta* (heat/energy/bile) and increase urine and stool [47]. Its fruits are *madhur* (sweet in taste), *kasaya* (caustic), *sita* (cool) and pacifiers of *pitta-kapha* [48]. Charak Samhita recommends regular use of leaves in diet for invigoration of eyesight. Its vegetable is useful in fevers, cough, hiccup and chronic skin and urinary diseases. In Kausika sutra the root and stem are prescribed as an anthelmintic [14].

Ayurvedic experts regarded the plant as acrid, laxative, counter-irritant and stimulant and often prescribed in heart diseases, colic pains, scurvy and phthisis [34]. They used the plant in flatulence, anorexia, respiratory disorders, skin diseases, in general weakness, as anthelmintic and as diuretic [49, 50]. The infusion of plant is used externally for eruptions, boils, joint diseases and internally in cough and as an antidote of poisoning. Juice of fresh plant kills worms in ear. It is a good substitute of senega [34, 51].

Classical uses of plant include cure of bleeding and dry piles, oedema, *vatrakta* (rashes, anaesthetic patches, and pain in joints), improving eyesight, and constipation [52]. The fruits are astringent and used as laxative in chronic constipation and are also useful in biliousness, cardiac troubles, halitosis and vitiated conditions of *Pitta* [52]. Fruits destroy foul breath, biliousness, urinary purulent discharge and help cure of cardiac troubles [28].

Roots are considered to be sudorific, thermogenic, expectorant, carminative, digestive, stimulant, antibacterial, aphrodisiac, anodyne, anthelmintic and are useful in arthritis, dyspepsia, constipation, lumbago, odontalgia, amenorrhoea and dysmenorrhoea [53]. While root bark is astringent, acrid, diaphoretic, alexeteric, analgesic, laxative, anthelmintic and useful for cough, asthma, ulcers, boils, vomiting, piles, inflammations and cleaning vagina [5].

Root bark powder or infusion is useful in gout, rheumatism, cough, dropsy, palsy, asthma, intestinal worms and intermittent fever. The powder is applied externally on malignant ulcer [34, 54].

CD is constituent of Ayurvedic formulations *Kottamchukkadi Choornam* (KC), and MAK5 (*Maharishi Amrit Kalash*). KC is applied externally for relief of pain in joints, arthritis and swelling and acts by balancing *Vata* and *Kapha*. MAK5 contains many herbs rich in antioxidants and reduces chemotherapeutic toxicity among women with breast cancer [55].

### Siddha System

Siddha Bhesja Manimalana recommends the use of tender stem, dried fruits with fatty curd in bleeding piles, alkali of fruit in dry piles, and powdered fruit in oedma, inflammations and skin infections due to vitiated blood. Oil extracted from fresh stem is rubbed on affected parts. The paste of root bark is applied to malignant tumours, boils, rheumatic swellings and gout. Infusion of root is taken internally as anti-toxic agent [56]. *Vatebhkesari Ras* containing CD tender stem is used in pneumonia, unconsciousness, cough, breathlessness, disorders of bodily humors, hiccup, flatulence, head pain, fever of *pitta* and gonorrhoea and as an aphrodisiac.

### Unani/Greek and Greco- Arab System

In Unani system of medicine, Karīra is used as a tonic, aphrodisiac, carminative, emmenagogue, alexipharmic, appetizer, rheumatism, hiccough, lumbago, asthma and cough [57]. Shoots of CD and *Peganum harmala* are used as anti-fertility drug; ground stem and leaves in alveolaris and pyorrhoea; root bark as antihelminthic and purgative; wood coal in muscular injuries. Leaves act as appetizer, help in cardiac troubles and fruits in biliousness [57, 58, 59].

It is a constituent in a number of Unani formulations as *Hab Hamal* (pills for conception), *Hab Mumsik Ambari* (aphrodisiac and retentive pills), *Hab Mumsik Tilai* (sexual debility and impotency), *Kushta Tamba Safaid* (fine powder of copper white), *Ma'jun (confection) Falak Sayr*, *Ma'jun Kalan*, *Ma'jun Masikal-Boul* (for strengthening of the urinary bladder, incontinence of urine, diabetes, weakness of the liver, enuresis), *Ma'jun Maurawweh ul-Arwah* (premature ejaculation, erectile dysfunction), *Ma'jun Muqawwi Wa Mumsik* (impotency), *Ma'jun Suranjan* (rheumatism, gout, sciatica, all types of aches), *Roghan Aqrab* (oil scorpion) – a pain killer, *Safuf Qinnab* (powder *Cannabis*), *Zimad Bars* compounds (medicine) [60].

### Folk Medicine

CD is widely used in folk medicine in India, Pakistan, Sudan, Algeria, Egypt, Libya, Morocco and

Tunisia. External or internal use of the plant and its parts help in checking a number of diseases.

The fruit is used for asthma, constipation, gastritis, and tuberculosis; flower for cough, jaundice and typhoid; stem for cough, eczema, cuts, injury, fracture, eye problems, gastritis and excessive mensuration; bark for arthritis and boils; root for body pain and skin problems; and leaves for dental problems, eczema and tuberculosis [61]. People take *Ker* mixed with sugar candy to stop blood from nose and in stool, dropsy; root oil for pain in ribs; root ash with ghee for joint pain; dried shoots with black pepper for spleen pain, powdered bark for constipation; wood ash for cough; wood ash mixed with ghee for relief from joint pains. While tying a tablet prepared by ground soft growing points and soft leaves is recommended for fever; *bafara* (steam) and application of leaf juice controls night blindness [62]. People consider the plant to possess hypoglycemic effect in diabetes and use green berries and flower buds as vegetable and curry to reduce blood sugar [34, 63]. The vegetable prepared from fruits in ghee is believed to be good for eyes [49].

In Bikaner, Rajasthan folks use it as a cure of stomach pain, arthritis, vomiting, piles diabetes and hypertension [28]. Folks employ the tender leaves for plastering boils, bark in intermittent fever and rheumatism, chew leaves for immediate relief in toothache, and take root powder for rheumatic pains [64]. Meenas use CD leaf for corneal opacity and roots for headache, tribals of southern Rajasthan apply root on scorpion bite, and take powdered coal from stem during fractured bone [65, 66]. They eat flower buds to relieve stomachache and flowers to soothe pain and increase erection [67].

In Haryana, the Khetawa Saperas of Jajhar District use *Kair* for curing piles [68]. Folks in Gujarat use CD in a number of problems as toothache (application of two drops of young shoot juice in ear), rheumatism and eczema (application of paste of bark of *kerda* and *mamejava* (*Enicostema littorale* Bl. on infected area). In Patan Gujarat, people use young root paste on scorpion bite, and fruit for cough and obesity [69]. In Cambay Taluka, folks use fruit powder orally for swelling, and piles [70].

In Sindh, Pakistan, people use whole plant in impotency, fracture of bones, wounds, alopecia, asthma, diabetes, skin infections (ring worm, eczema), toothache and ear pain [71]. Immature fruits are taken to cure stomach problems and bark poultice for the wound treatment [63]. In Dera Ismail Khan, folks use ground fruit and sugar for rheumatism and pain of the body while in Bannu folks take ash mixed with ghee the same purpose [34].

In Algeria, Egypt, Libya, Morocco and Tunisia folks use CD as an astringent, anthelmintic, diaphoretic, antiseptic, antiasthmatic, dental, antiinflammatory as well as a laxative. They treat tooth ache, cough, asthma, inflammation, wound healing, boils, swelling, rheumatism, arthritis, skin and cardiac problems with CD [72]. Moroccans use fruit powder for diabetics [73].

Sudanese employ CD to treat skin problems, arthritis, articular pains, scamp, kidney pain, lameness, muscular inflammation, myalgia, sciatic, joint pain, stiffness, cancer and sprained and aching joints, [74], stomach problems, jaundice, headache and infections of joints [4, 75]. They take decoction of CD flowers in sciatica, bark powder in cases of anorexia, indigestion and rheumatism [76] paste of young leaves and branches as plaster on boils and swelling [77, 78], decoction of fresh twigs against jaundice, the fumigation of the stems as anti-rheumatic. They use a poultice for swelling and joint pains and head-ache [79, 80] and roots to relieve fever, rheumatism and jaundice [81].

In Senegal people use plant as antipyretic and diuretic and take particularly in fevers, cysts and urogenital problems [82]. In Somalia people consume leaves to treat cough [83].

### Veterinary

CD offers many uses in animal ailments in Africa and Pakistan and India. It is used in anthrax, rheumatic pains, diarrhoea, scabies, ulcer, fractured bone and healing wounds and to de-worm animals.

Folks in Bannu, Pakistan, use the unripe fruit as anthelmintic for cattle and goats, a mixture fruit powder and sugar in rheumatism and diarrhoea and powder of tender branches mixed with wheat flour for pain [34, 63]. Tribes of Cholistan use fruits for treatment of diarrhoea, stomach ache, dysentery and loss of appetite [76]. In Euthpoia, folks use seed in anthrax and black leg disease [84] while tribes in Algeria, Egypt, Libya, Morocco and Tunisia use plant in scabies of camels [72].

Gujaratis apply powdered wood coal on the ulcer to minimise pain and help recovery [85], dry stem charcoal mixed with pure ghee to set the fractured bone of the animal [86] and a paste of tender branch in castor oil to heal maggot infested bleeding wounds in animals suffering from acute pain [87]. Folks tie floral primordia boiled in oil between the two halves of the animal hooves [88]. In Rajasthan, charcoal of roots mixed with sesame oil is given orally to animals for quicker healing of fractured bones, extract of fresh stem is applied on wounds for early healing and fruit is fed to goats to cure gastric problem [61].

### Scientific Studies

Multifarious folk and traditional uses of *Kair* as food and medicine generated scientist's interest in

number of countries. Studies have been conducted on its nutritional and photochemical contents to explore its potential.

### Nutritional Value

*Kair* is a potential source of basic nutrients such as carbohydrates, proteins, fibres, minerals and vitamins [89, 90]. Carbohydrates are the major constituent of CD fruits and buds followed by crude proteins and neutral fibres [91, 92, 93]. The ripened dry fruits contain 73.48 % carbohydrate, 14.94 % crude protein, crude fiber (10.94%, NDF 30.48%), 5.38% crude fat, 15.28% starch, 11.45% hemicellulose, 8.91% cellulose and 7.62% lignin. Available minerals include Phosphorus, Magnesium, Iron, Zinc, Copper, Sodium, Potassium, Manganese, Calcium, Selenium and Chromium [89, 94, 95]. Caper fruits and buds are as nutritious as many vegetables and fruits like banana and guava [96, 97]. In addition to the minerals, the fruit and aerial parts contain vitamin C, vitamin A ( $\beta$ -carotene), phthalic acid and oils [89, 96, 98, 99].

High quantity of Fe and Zn present in various parts is valuable to meet the deficiency in human nutrition. Iron is useful in prevention of anemia while Zn deficiency results in impeded growth and delayed sexual maturity [100,101]. Fruits are rich in K and possess optimum amount of Na. The plants containing higher calcium and potassium contents are valued both for livestock feed and human food [102]. Both K and Na play vital role in role in maintaining the body fluidic balance, blood pressure, in intestinal absorption and nerve transmission. K and Na jointly improve the cardiovascular system as both of these are interconnected with one another and ensure smooth blood flow [103].

CD fruits contain only traces of Mn. It plays role in energy production and in supporting immune system [104] and its overdose may induce unfavorable effect on central nervous system (CNS) of the human beings [105]. CD fruits contain low quantity of anti nutrients (mg /100g) such as phytic acid (112.8), polyphenol (2.3) and oxalates (310) and their levels can be reduced by dipping the fruits in salt water (common rural practice) and in fermentation process. Fermentation improves the nutritive value of the fruit by remarkably decreasing the anti-nutrients and enhancing availability of P and Fe [106].

CD seeds are rich source of all three major food components, i.e carbohydrates (25.42%), lipids (29.11%) and proteins (27.71%) and 20% of high quality edible oil [107]. Seeds possess sufficient amounts of both essential and non-essential amino acids as glutamic (24.01 %), aspartic acids (11.91 %), methionine (0.75 ± %), cysteine (0.34 %) and arginine (3.46%). Seed oil contains minerals such P, Na, Mg, Fe and Ca and fatty acids (linoleic acid and eicosenoic acid) [107]. Linoleic

acid prevents cardiovascular disorders such as coronary heart disease; atherosclerosis, as well as hypertension [108]. Arginine is involved in rapid regeneration of adenosine triphosphate, cell proliferation, vasodilatation, neurotransmission, calcium release and imparting immunity [109]. Seed oil is a healthy source of fatty acids and can be used in diet. The presence of reducing sugar, fats, vitamin C, antioxidants, alkaloids, and carotene makes it a dietary supplement [110].

The heavy metal contents of edible parts of CD (< 1mg kg-1. Cd, Co and Ni content) is less than the limits suggested by WHO for medicinal plants. High mineral and fibre content and low heavy metal and anti-nutrient content in edible parts make the fruits

suitable for food products [22, 38, 100]. These attributes make the plant all the more desirable to be included in healthy and green diet.

**Phyto-Constituents**

CD plant contains alkaloids, flavonoids, tannins, saponins, resins, glycosides, terpenoids, phenols, sterols, essential oils and vitamins that impart it with various pharmacological activities, medicinal properties and nutritive value. These activities include: antioxidant, anti-inflammatory, hepatoprotective, anticancer, analgesic, wound healing, anti hypercholesterolemia, anti-parasitic, anti-microbial, antiviral; anti-arthritic, insecticidal, anti-allergic and anti-cancer and anti-arthritic (Table-2).

**Table-2: Phyto-constituents and Pharmacological activity of Capparis decidua \***

<p><b>Antioxidants: Flowers and Leaves:</b> 3-methyl-2butenyl-3-beta-glucoside Ascorbic acid, Phthalic acid, Beta-sitosterlyglycoside 6' octadecanoate;</p> <p><b>Flower Buds:</b> <math>\alpha</math> and <math>\gamma</math> tocopherol, vitamin C, glycosides, alkaloids, Polyphenol (Cappaprenol-12, Cappaprenol 13, 14. Kampferol glucosides, Cappariside (4-hydroxy-5 methyl furan-3-carboxylic acid);</p> <p><b>Fruits :</b> Uracil, stachydrine, cadabicine P-hydrobenzoic acid; Glucosids – (6S) – hydroxyl-3-oxo-<math>\alpha</math>-ionl glucosides corchoionoside C (6S, 9S)- roseside) prenyl glucoside, capparilioside A;</p> <p><b>Mature fruits:</b> Hydrocinnamic acids Corchoionoside C, Prenyl glycoside; Phthalic acid, capparilioside, 4-hydroxy-5 methylfuran 3-carboxylic acid; Flavonoids (isoginkgetin, ginkgetin) isocodonocarpine;</p> <p><b>Seed:</b> Hydrocinnamic acids Corchoionoside C, Prenyl glycoside;</p> <p><b>Root and Stem:</b> Fatty acids, sterols, Lupin tercantanol, polyphenols</p>
<p><b>Anti-inflammatory: Mature Fruits:</b> 5-(hydroxymethyl, furfural, Bis (5-formylfurfural) ether;</p> <p><b>Flowers &amp; Leaves:</b> Isocodonocarpine, 3-O-(16''-alpha-L-rhamnoside-6 beta o glycosyl)-beta-D glycoside;</p> <p><b>Fruit:</b> Isoginkgetin, Ginkgetin, Sakuranetin, P- hydroxyl benzoic acid, 5-(Hydroxymethyl) furfural, Bis (5-formyl furfuryl) ether;</p> <p><b>Root bark:</b> Diterpene alcohol and ester(AI AN)</p>
<p><b>Hepatoprotective: Leaves &amp; Flowers:</b> Steroids; <b>Root &amp; Stem:</b> Cappaprenol-12, Cappaprenol-13;</p>
<p><b>Anticancer: Leaves &amp; Flowers:</b> Quercitin, stachydrine;</p> <p><b>Flower Buds:</b> Isothiocyanates;</p> <p><b>Fruits:</b> 1H-indole-3acetonitrile glycosides;</p> <p><b>Mature Fruits:</b> Daucosterol, <math>\alpha</math>-D fructofuranosides, methylstachydrine;</p> <p><b>Root bark:</b> 14 N- acetyl Isocodonocarpine, Cadabicine, Stachydrine, Rutin, Codonocarpine;</p> <p><b>Root:</b> Alkaloid capparine, Cappariline, Capparinine (Chahlia, 2009, Shikimate derivative, acyclic terpenoids, Cappaprenol -14, flavonoids, inodoles, phenolic acids, lectins;</p> <p><b>Stem:</b> Shikimate derivative, acyclic terpenoids, Cappaprenol -14, flavonoids, inodoles, phenolic acids, lectins</p>
<p><b>Analgesic: Leaves and Flowers:</b> 3-O-glycoside-7-0-rhamnoside, caretinoids</p>
<p><b>Wound healing, diuretic effects: Leaves and Flowers:</b> Vitamin C, lutin</p>
<p><b>Anti-hypercholesterolemia: Fruits:</b> Biflavonoids</p>
<p><b>Anti-parasitic: Root Bark:</b> Spermidine alkaloids, Isocodonocarpine</p>
<p><b>Anti-microbial: Stem buds:</b> 2-carboxy-1,1-dimethylpyrrolidine6-(1-hydroxy-non-3-enyl);</p> <p><b>Root Bark:</b> Capparisinine, Cappariserpenolide</p>
<p><b>Antiviral: Leaves and flowers:</b> Rutin, tocopherols, O-glycosides, quercitin</p>
<p><b>Anti-arthritic: Fruit:</b> Daucosterol, <math>\alpha</math>- D fructo furanosides methyl</p>
<p><b>Anti-allergic, anti-cancer: Stem buds:</b> Quarcitin, kaempferol, glycosides</p>
<p><b>Anti-inflammatory, analgesic: Root bark:</b> Diterpene alcohol and ester</p>
<p><b>Anti-oxidant, anti-arthritic: Fruit:</b> Uracil, stachydrine, cadabicine P-hydrobenzoic acid</p>

\*adapted from Upadhyaya [111]

Flower buds are endowed with tocopherol, vitamin C, glycosides, alkaloids that are anti-oxidants and isothiocyanates which are anticarcinogenic. Fruits contain biflavonoids which exhibit anti-hypercholesterolemia activity and daucosterol, uracil, stachydrine are anti-arthritic. Flavonoids, isoginkgetin (I), ginkgetin (G), isocodonocarpine possess antioxidant property; 5-(hydroxymethyl, Bis (5-formylfurfural) ether present in mature fruits have

anti-inflammatory property [111]. I and G act as anti-aging agent and also reduce the skin sebum level [112]. Phenolics of fruit impart wound healing, anti-bacterial, anti-viral activity [113].

Roots have Capparisinine and Cappariserpenolide that have anti-microbial property while Cappaprenol-12 and Cappaprenol-13 are hepatoprotective in action (Table-2) [111].

Capparidisine has a depressant activity and a has dose dependant effect on heart rate and on coronary flow [114]. Isocodonocarpine, and spermidine alkaloids occurring in stem and root bark are effective in treating asthma, inflammation, gout and cough [115, 116]. Flavonoids, steroids, triterpenes, diterpenes, alkaloids and tannins are potent analgesic and have antinociceptive activities [117]. Seeds possess fatty acids, tocopherols, sterols, proteins which are nutraceutical. Lactone flavnoids (sesquiterpine lactones: MW-6 and MW-11) present in aerial parts are potent antiplatelet [118]. Isothiocyanate aglycon (glucosinolate) in seeds shows significant antibacterial activity [119] against *Vibrio cholerae*, *V. ogava*, *V. inaba* and *V. eltor* cholera causing bacteria [120].

High level of saponin (glycosides) in fruit directly correlates with its use as a medicine for various ailments such as cancer, rheumatism [121]. The cytotoxic activity of  $\beta$  sitosterol triacontenate (ester) found in stem is as efficient as Paclitaxel used for chemotherapy in breast cancer [122]. Anti-invasive and

anti-metastatic nature of stachydrine, in fruits and different terpenoids of root bark and stem make CD, a competent candidate for use in the development of anticancer drugs [122-124].

**Scientific validation of Traditional uses**

A number of activities attributed to CD plant parts in various Ayurvedic treatises have been proved and authenticated by pharmacological tests. These include: *arsoghna* (anti piles), *śophaghna* (anti-inflammatory), *śvāśaghna* (antiasthmatic), *sarvashulanashak* (analgesic), *hr̥dya* (cardioprotective) anasthematic, purgative, ant-helminthic, *yakritjit* or hepatoprotective, astringent, neutraceutical and antimicrobial activities (Table-3A.) In addition, some of the folk uses as antidiabetic, anticancer, antiviral (herpes), and hypertension, have also been proven and authenticated (Table-3B.). However, some of Ayurvedic and folk (Table-3C), Ayurvedic and Greek uses (3E) have not been yet authenticated by pharmacological tests.

**Table-3A: Ayurvedic, Folkloric uses and Pharmacological activity of *Capparis decidua***

Ayurvedic and Unani /Greek uses	Folk Uses	Pharmacological
swashara 49, śvāśaghna (Antiasthmatic) 46	Asthma 72, 149	Antiasthmatic 129
Asthma chronic respiratory	Anti-rheumatism , 80 artheritis 28	
Purgative/laxative 49 Increases stool flow 53	Cathartic purgative 72	Purgative 130
<i>Hrdya</i> (Cardioprotective)46, 50	Cardioprotective 72	Hypolipidaemic 131, 132,133
		Antihyperlipidemic 132 , 133
		Anti-atherosclerotic 132
		Antispamatic, muscular contraction 142
yakrtajita (Hepatoprotective)*46	lever function,jaundice125, 126	Hepatoprotective 134, 135, 136
tonic	tonic	Nutraceutical
Antimicrobial#50	Skin infections 74,149	Antimicrobial 136
Antibacterial@53		Antibacterial 137
Anthelmintic cv#@50, 53	Antihelmenthic 72,127	Anthelmintic 120,130,138
Janthughna anti animal	Antiparasitic	Anti parasitic 139
Bronchial disorders Expectorant@53	Cures cough 72	Bronchodilatory 140
Discutient sothhara# 50	tumours10; inflammation 74	Anti inflammatory 140,141
tumour, swelling inflamation #50		
Anodyne vedanasthan#@50, 53	Pains: Ribs, Spleen, joint, 62; sciatica, toothache 72, 149; Stomach 28, 80, 149 ; Ear, Body 149	Analgesic and anti-nociceptive activity 117
Sarvashulanashak (Analgesic) 46, pain reliever 50, 53	analgesic72	
Astringent 53stops bleeding, makes skin less oily	Astringent 72	Antisebum cream 112
Haemostatic 50	Piles, Haemostaic 72	Ant platelet 118
Piles and Haemoroids 50	Blood in stool ;blood from nose	
Vraṇanāśaka (wound healing activities) 46	Plastering boils 63,149	
<b>3B. Folk uses Proved by Pharmacological testings</b>		
	Anti Diabetes 28,149	Antidiabetic (AD)142, Hypoglycemic 143
	Anticancer 74	Anticancer 122,123
		Antioxidant 133 , Anti-aging 124
	hypertension 28	Depressant 114
		Depressant & anticonvulsant 144
		Hypotensive, spasmolytic 145 low pressure
	Antifertility (male)	Rubifacient,vesicant, antisterogenic 146,147
	Antagalic headache 80	Antihypertension 148

	Halitosis fetid breath	Use in mouth fresheners 28
	Hypoglycaemic 33	Hypoglycaemic & AD 132
	Stomach problems 80 dysentery	Antiparasitic, antibacterial (Cholera) 120, 130
	Herpes 74	Antiviral 111
<b>3 C. Uses/ Activities Known in Ayurveda &amp; Unani and Folk Medicine, But not Proved</b>		
Ayurveda & Unani		<b>Folk Medicine</b>
Diaphoretic/sweat ( svedopaga) 50, 53; Sudorific, 53		Diaphoretic 72
potherb		potherb
scorpion bite		scorpion bite
Renal disinfectant, diuretic, Increases urine		Renal disinfectant diuretic 128, Urinary problems
Aphrodisiac 53; Stimulant 53+		impotency 8 128 sexual problems 8128
Eye diseases		Night blindness 128 Eye problems 33, 49, 63
Chardighna (Anti emetic) , vomiting 46		vomiting 28
intermittent fever		Intermittent fever 149
Carminative		Expelling gas from relieve, colic 53
<b>3 D. Activities Proved by Pharmacological Tests</b>		
Epilepsy Sedative and anticonvulsant effects 144 abnormal violent involuntary contractions		
<b>3 E. Ayurvedic and Greek Uses Only, not verified by Pharmacological Tests</b>		
Emmenagogue artavotpadaka 50; Amenorrhoea, dysmenorrhoea, painful menstruation 62, 63		
Chronic poison; Digestive 50 arucināsaka /Appetizer 46, 53; Thermogenic 53		

**Possible future uses**

**Broad Spectrum Pesticide**

CD exhibits broad spectrum biological activity due to presence of bioactive phytochemicals like alkaloids, terpenoids, glycosides, flavonoids and fatty acids. The plant shows activity against fungi, bacteria, virus, amoeba, insects, mollusks and helminthes [150, 151].

It is also highly toxic to white termite *Odontotermes obesus* [152]. Solvent extracts of CD are active against storage insects like *Sitophilus oryzae*, *Rhizopertha dominica*, *Callosobruchus chinensis*, *Tribolium castanaeum*. While stem and flower extracts show activity against beetle, *Bruchus chinensis*, a storage pest of pulses and crop pests like *Spodoptera litura* (cut worm of tobacco/ cotton leaf worm), *Heliothis armigera* (boll worm of cotton) and a mite *Tetranychus urticae* Koch, a common pest of a variety of plants [139, 153, 154].

CD also shows activity against vectors of human diseases such as yellow fever and fascioliasis. CD extracts show high toxicity against larvae of yellow fever mosquito, *Aedes aegypti* [154]. Alcoholic extract of flowers is lethal to snails, *Lymnaea acuminata* Lamark and their cercarial larvae [155]. Snail is a vector of liver flukes, *Fasciola gigantica* Cobbold and *F. hepatica* L. responsible for endemic fascioliasis in cattle and humans.

In addition to storage insect pest, CD is effective against storage fungi being antifungal against seed borne pathogenic fungi like *Aspergillus niger*, *A. flavus*, *Fusarium moniliforme*, *Phytophthora sp.*, *Penicillium sp.* and *Mucor sp* [156].

**As Antibiotic**

Alcoholic extract of fruit husks, seeds and flowers possess antibacterial activity [136]. The ethyl acetate extract of plant has anti-bacterial activity against Gram-positive and Gram-negative bacteria, the n-butanol extract displays inhibition against *Pseudomonas pneumoniae* and *Escherichia coli* while chloroform and ethyl acetate extracts are potent against *Giardia* with efficacy comparable to metronidazole drug. All extracts show no toxicity against brine shrimps and vero cell lines suggesting safety for traditional use [157].

**Prediction of antimicrobial/insectidal herb on basis of Ayurvedic determinants**

Review of literature on pharmacological testing reveals that CD possesses anti-worm and antimicrobial properties. *Karira* is *katu* (bitter) and *teekta* (pungent) in taste, *katu* (pungent) in the *Vipaka* (transformed taste /post-digestive effect), *ushna* (hot) in *veerya* (potency) and *laghu* (light, L) and *rooksha* (dry, D) in *guna* (quality) [46]. Plants with combination of LD, LDP (*teekshna*, penetrating), LPSo (soothing, *snigdha*), LDPM (mobile, sara) and LSo quality possess insecticidal and antimicrobial activities [158]. This prediction on basis of Ayurvedic determinants is corroborated by earlier findings [139, 157]. Similar predictions for *Vitex nirgundi* and *Cordia dichotoma* [159, 160] stand corroborated by pharmacological testings.

**Bio- inhibitor of Corrosion**

*Capparis decidua* extracts can work as non-toxic, biodegradable bio- inhibitor of Aluminium and copper corrosion and can replace toxic chemicals in use for this purpose [161]. Seed extract is an effective inhibitor for copper in acidic medium. The adsorption of *Capparis decidua* seeds is spontaneous, physical in

nature and is an effective eco-friendly corrosion inhibitor with significantly high inhibition efficacy (94.60%) for copper in 0.5 M HCl and can be a good replacement for many chemical constituents to be used as corrosion inhibitor [162].

#### Anti -aging Cosmetic

Seed, flower bud, flowers, leaf, stem and roots of CD contain antioxidants that act as anti-aging agents and can be used in anti-aging cosmetics [124]. A cream formulated from CD plant extract is useful for people having oily skin and problem of acne or seborrhea due to excessive secretion. This cream controls the excessive sebum secretion and is free of any adverse effects of strong antibiotics, steroids or products containing strong chemicals [112].

#### Source of Bio-diesel

CD seeds yield 63.75% percent biodiesel (in oil fraction). The optimum temperature for in-situ transesterification is 80°C. The agitation was achieved by keeping 300 rpm oscillations continuously for 60 minutes optimized time [163].

#### Use in Green Nanotechnology

Kumari et al., [164] synthesized green silver nanoparticles by using ethanolic extracts of the whole plant as a reducing agent. This is a convenient method, clean, environment-friendly, and better than the conventional chemical methods, provides faster rates of biosynthesis and can potentially be used in areas of cosmetics, food, medicines and antibacterial agents [165].

#### Natural pH Indicator

An ether extract of flowers may serve as a natural pH indicator and a substitute of synthetic indicators, with advantages of being low, cost, simple and without any risk of environmental pollution [166].

#### Recent Advances in Breeding and Improvement

CD is an open pollinated plant and wide genetic variability exists in the natural population. The plant shows marked diversity in plant types, spine, canopy (spread and compactness), flowering (time of flowering, colour of flower), and fruiting (size and colour of fruits) characters. A germplasm collection from rocky, gravely, sand dunes, natural rangelands and cultivated fields of arid regions (Jaisalmer and Barmer districts) of Rajasthan showed two distinct plant types as: shrub with large canopy spread and a small tree form having more than 5 m height with flowers of light red to scarlet red, and occasional plant with yellow flowers and mature fruits of variable size and colour. Forty-five collected accessions exhibited wide range of variability for fruit diameter, fruit weight, number of seeds per fruit, test weight and canopy characteristics [167]. CIAH (Central Institute of Arid Horticulture) with collaboration NATP-PBD of NBPGR, New Delhi (1999-2004)

collected 64 elite germplasm of *Ker* from semiarid and tribal area of Rajasthan and Gujarat. At present 32 types are conserved in the National Field Repository of CIAH at Bikaner. Krishna et al., [168] felt dire need to identify suitable types that are heavy yielding, possess large fruit size and high pulp content, rich in protein; with proper total soluble solids (TSS), tartness, less acid, with small and soft seeds. So far, a promising genotype CIAH-Thornless-1 has been identified [169].

#### Causes of Depletion in natural population

CD is at risk due to human as well as natural factors. Lack of seed production due to irrational picking of high value immature fruits is one of the major factors. Natural factors include the small period of seed viability, and natural competition faced with *Prosopis juliflora*, that regenerates faster and grows aggressively [170]. The plant has been listed as one of the endangered species in India [171].

Moreover, the conventional methods of propagation like grafting; layering and cutting are of limited applicability and involve risk of the exposure to pests, diseases, and soil or climatic stresses. In addition to short period of viability seeds have the shorter storage span due to desiccation-sensitivity and pathogenic infestation. Therefore, the tissue culture technique becomes important for mass propagation of plant and synthetic seed via encapsulation technology offers an important alternative.

A protocol for in vitro propagation of CD via tissue culture was developed to produce superior planting stock for various afforestation and reforestation programmes [172]. Recently, Ahlawat et al., [173] utilized synthetic seed by using the shoot tips and nodal segments from in vitro cultures for encapsulation. This technique seems practical for short term storage, and production of synthetic seed to be released for commercial purposes.

#### Folklore

Being a prominent and useful tree it has occupied a place in folk culture of desert areas. Caper has penetrated in local language in Rajasthan, Bundelkhand and Haryana, through riddles, sayings and folk songs. The references of its wood quality and thorn occur in proverbs in different social contexts. It has been used to convey the bad nature of a person, relationship of wife and co-wife, and bad behavior/attitude of mother-in-law. Though a thorny plant it attracted the attention of a number of poets of Bhakti sect and appears in writings and poems of Surdas, Raskhan, Rahim, Kabir and Tulsidas.

#### Use in Rites de passage

*Kair/Karir* is considered holy and is associated with the religious rituals of the local population of Thar Desert. It is found growing near or around religious

places. It is customary for a newlywed couple and new born to offer prayers in front of a *Kair* plant. Its stems find use in preparation of Turan during marriage ceremony and as firewood during havan (fire sacrifice) [61]. It is one of the 19 plant species on which 58 Sikh shrines have named. The naming of sacred shrines after trees is unique to the Sikh religion and at Gurudwara Karir Sahib in Littar, Ludhiana; devotees seek blessings for child [174]. It is also associated with graves and cremation ground [12].

### Religious Uses

Kaustaka Sutra mentions use of the powder of *Karira* fruits for *Kariri* ritual, performed to ward off drought [14]. In religious sacrifices, *saktu* of the fruits (powder of the dry and parched fruits) is used. In Mahabharata, the use of long bottle gourd, *Kalasaka* (curry leaf), *Slemastaka*, *Sudersana* (?), leaves of *Bamboo* or *Karira* is interdicted [13].

### Indicator of Groundwater in desert land

Upavana Vinoda mentions that the presence of *Karira* with *badri* (*Semecarpus mauritiana*) tree serves as indicator of underground water and presence of a *bilva* (*Aegle marmelos*) or *Karira* tree in combination with a *kakubha* (*Terminalia arjuna*) tree indicates very sweet water at a distance of two hands at the depth of twenty five man height. While an anthill in North of a *Karira* tree indicates sweet water to the south at a depth of ten man height [175, 176].

### Climate Indicator

*Kair* and *Kachri* (*Cucumis melo agrestis*) are considered as the climate indicators in arid zone. A fully *Kair* laden with thorn, flowers and fruits indicates drought and high temperature while in a good season it bears only average flowers and fruits. Similarly, in Gujarat, the farmers of Surender Nagar, Kheda, Bhavnagar and Ahmedabad use *kerda* in predicting weather, temperature and rainfall. They perceive that greater blooming deep pink flowers in colour the temperature will be more than 45°C and less rainfall [12].

### Indicator of Rain

A Bundelkhandi proverb indicates the signs of the approaching rain “*Bhal bhal bake papaiyo bānī, kūfl kair tañī kamalāñī, jal hal to ūge ravi jāñī pahrān māyan avsare pāñī*” [177]. If a crusted cuckoo moves around chirping, new leaf of *kair* withers, and there is intense heat of sun at Sunrise, then it should be understood that it will rain in a moment.

### Indicator of Cotton Yield

“*Akian, niman bajra, kairarian kopas*. Jo phale jal to *jowar* hone ki as” There shall be *bajra* (pearl millet) if there is *ak* (*Calotropis*), Cotton when there is *kair*, and there is *jal* fruit (*Salvadora*), there is hope of *jowar* (Sorghum) [178].

### Names after Karil

A number of villages owe their name to *Karir*. *Kair* village in Najafgarh District of Delhi state, *Karil* and *Tient* in Hatras District of Uttar Pradesh, *Kario Ki Dhani* in Danta Ramgarh Tehsil in Sikar District of Rajasthan are named after *Karir*. *Kair* is name of a village in Iran also.

Two Jat *Gotras* *Karil* and *Karir* of Rajasthan and Haryana and *Karerei/karai/karer* clan of Afghanistan owe name to this plant and it is a totem of *Karir gotra* [179]. *Karirs* get name from being living in the *Karir* forests on Saraswati River during Mahabharata period. Similarly, *Karils* were inhabitants of region surrounded by *Karil* trees [180].

### Defining area

CD has been used to demarcate Marwar because of its abundant occurrence. Being a desert tree growing under harsh conditions and area considered hard to live; is evident in the following pray.

A girl prays to his grandfather and says not to marry her in Marwar (Jodhpur area): O Grandfather, do not marry me to a person of Marwar, Even if I may remain unmarried. Houses inside deep desert, the land having snakes, Thorny *Karil* are its trees. *Ak* (*Calotropis*) and *phok* (*Calligonum polygonoides*) only provide shade, satisfy hunger by eating grass seeds [181].

Raja Bheem used names of plants to distinguish his land from that of enemy in Rajasthan and said “Wherever *Aonla* (*Cassia paniculata*) puts forth its yellow blossoms, the land is right ours: we want nothing more, let them enjoy their stunted *Babuls* (*Acacia*), their *Kureels* (*Capparis decidua*), the *ak* (*Calotropis procera*) but give us back our scared *Peepal* (*Ficus religiosa*) and *Aonla* of the border” [41]. Here plants are used to distinguish Mewar (Udaipur area) from Marwar, English rendering would be “*Cassia auriculata* characterises Mewar, whereas *Acacia nilotica* sp. India characterises Marwar”.

Likewise in Mathura is known for *Kair*, as the following couplet of Tulsidas indicates:

*Radhe Radhe rathat hain, Aak, Dhak aru kair, Tushi ya braj bhumi main kaha Ram se bair*. (It is said that once Goswami Tushi Dass visited Mathura. There he found every one worshipping Radhe Krishna, and nobody discussed or remembers Ram, since the three plants (*Ak*, *Calotropis procera*, *Dhak*, *Bauhinia variegata* and *Kair*), commonly grow in the area, so it is used as a metaphor to convey in sense everyone).

*Kahūm kahūm bhagwān kī gaī sitilapau nahi, Kābul meṁ mewā braj meṁ ṭenṭī khāī*. A person laments and says that at some places God’s irregular/ improper ways do not cease, He has provided grapes in Kabul and

tenti to Braj people. What kind of justice is this? *Kabul mem mewa kiyo kiyo braj mem karil* [182].

### In Folksongs

*Ker* appears in Huns songs of Rajasthan relating to the wishes of a pregnant lady. There are specific Huns songs associated with eatables as *Ghevar* (a Rajasthani cuisine sweet traditionally associated with the *Teej* Festival), *ker*, and water melon. The one on *Ker* runs as follows:

*Lagyou dhan nai palo ji maas, par chhaya suhavai*  
*O, mharai sasur ji rai haath ji*  
*Bhavai dhan nai fina roti dal, keriya to bhavai*  
*O Jachha rani nai chhappar valai taal ra*” [183].

A pregnant lady says to her husband “It is first month of pregnancy oh! Son of my father-in-law, my heart goes for few things. Husband replies that you are daughter of a big house. Oh! Lucky -future mother-to-be, I shall fulfil your heart’s wish. She doesn’t feel like eating tasteless bread and pulse and feel like eating the vegetable of *keri*. Husband replies I have acquired *keri* from village *Chappar vali taal*.”

### In Bhakti sangeet

Raskhan (Syed Ibrahim Khan (born 1548 A.D.) a Pushtun and devotee of Lord Krishna says “Raskhan Kabaum in amkhin som, braj ke ban bagh tadag niharaum; kotik hu kaldhaut ke dhām, karil ke kunjhan upar vāraum.” I want to gaze the forests and gardens of Braj with my eyes throughout my life time, so much so I want to sacrifice my hundred palaces made of gold for sake of thorny bushes of Karil. Uncountable palaces made up of Gold can be sacrificed upon bowery alcoves of Braj [184].

Oh Rahim! Where are those trees having good shade, in gardens we see *sehumr* (*milk -bush, Euphorbia tirucalli*), *kutaj* (*easter tree, Holarrhena antidysentrica*) and *karir*. *Rahiman ab ve vrish kham jinki chāmh gmbhir, bagan bich-bich dekhiyat sehumr, kutaj, karir*.

### Proverbs

*Baiñho chhāyā maim bhalām kair hī, rahño bhāyān maim hu bhalām bair hi*. Sit in shade even though of kair, and live with brothers even though envious.

*Kair ki thūmth tūt jyāgo, lulaigo nahin*. The wood of Karil will break but won’t bend. A bad fellow may afford a loss but does not leave his adamancy (unreasonable resistance) [185]. A variant of proverb is “*Kair kā kāth tūtai pañ lulai koñin*” [186]

A proverb is prevalent in Haryana, Punjab, Bundelkhand and Rajasthan describes the nature of karil thorn and compares it with the co-wife:

*Kanta bura krill ka, au badly ka gham*  
*Saukan buri hain chun ki, aur sanjhe ka kam*

Thorn of *Capparis*; Sun at the time of clouds; a co-wife (even of wheat flour), and partnership in business; these four things are bad. Another version of the proverb is available “*Kaño sāle karil kau, ur badarauṭā ghām, larkā sāle saut kau, ur sāje kau kām*- [187-190].

The tongue of the man of bad words is compared with thorns of caper “*Jhibh nai kair ko katau – jhibh ko kair ko kanto*- It is not tongue but thorn of *Capparis*. A speaker of bad words is cursed with these words. The bad tongue pricks like karil thorn [190].

Thore muhm mem kair rau kantau-Tere muhm merikair ka kanta- A speaker of bad words is cursed with these words. A person whose words prick like a karil thorn is cursed like that [190].

*Kāla muhm karil ke dānt. Face is black and has teeth of Karil* (karil prick of karil thorns are very painful [177].

A Bundelkhandi proverb persuades to work hard till your wish is not fulfilled. *Jaulaun phūle ketki taulon bilam karil*- Until your heart wish is not fulfilled up to then go on working something or other [182].

*Apat karir nā mahūlāi de doṣ basante*. When karir does not flower then what is fault of the spring season. If a bad person does not show good then why to find fault with a good person [191]. Another version of the Punjabi proverb runs as “*Karil jau na phūlau, basantu ca una ūllai mat and hatras*” If Karil does not flower in spring season, then why spring should not enjoy.

*Kair alo i balai, sasu sudi i ladai* [186]. In Punjabi it runs as *Karir gila vī saṛe, sas garibañī vī laṛe*-It known fact that only dry wood burns or catches fire- but karir is an exception as wet its wood burns. Karir is compared to a mother-in-law and an officer. Howsoever she may be kind, getting a chance she becomes angry and says hot and bad words. Whatever sort officer he gets angry on the subordinate. To show off right it is a natural human instinct.

*Karil kau kamṛo, sāḍhe sorā hāt lāmbo* [186]. Bundelkhandi version runs as “*Kair rau kamṛau giyo saḍhī solai hāth*” The thorn of karir is very small and soft. If it grows up to sixteen hand lengths then it is like a day -dream. It is said so for a person who talks gossips [182].

*Kair sūm chuṭa to kūmatiyo mem paḍiyau*- Out of *Karil* (which has two thorns) went into *Kumatiyo* (*Acacia senegal*) having shiny dark red spines in sets of three, with one thorn hooked like a parrot’s beak gum. Out of frying fan into the fire. From a bad situation to one that is worse.

*Dhān khāvai ke ker khāvai*- eats grain or *Capparis* –Said so to a person who acts like a foolish [190].

### A Bundelkhandi Riddle

*Ek rukh saraua. Larkan ki kilar bilar, pattan ki duniya* – Answer - *Karir* [182].

### Karil in Epic of Mahabharata

There are references to *Karir* in the great epic poem of Mahabharata. *Karna Parava* points out to tree species as *Sami* (*Prosopis cineraria* (L.) Druce), *Pilu* (*Salvadora olicoides* Dence) and *Karir* growing along the bank of Saraswati River, and forest having many pleasant paths of the above said trio and mentions other kinds of trees on the banks of the Saraswati [193].

### Discussion and Outlook

Hippocrates nearly 2500 years ago said so “Food is the medicine and medicine is the food” (Proper diet is the medicine and there is no medicine like proper diet). Even good medicines will not cure a patient without an appropriate accompanying diet. *Capparis* fits into the Hippocratic criteria of food being a nutraceutical food having therapeutics activity against a number of ailments.

Plant provides nutritious food and finds extensive uses in folk medicine and traditional systems of medicine in various countries. It can provide essential nutrients as carbohydrates, protein, fats, mineral and fibre in appreciable amounts. The mineral content of the plant is high while heavy metals (i.e., Ni, Co and Cd) in traces. Fruit is rich in K, Fe, Zn, has low content of Na and only traces of Mn and anti-nutritional factors making it a good source of nutrients and valuable to meet the deficiency of these minerals in human nutrition.

Many parts of the plant possess natural antioxidants and nutraceuticals (Table-2). The plant is endowed with phytoconstituents such as alkaloids, glycosides, terpenoids, sterols, flavanoids, phenols and fatty acids that lend the plant with medicinal values as hypercholesterolemic, anti-inflammatory, analgesic, depressant, antidiabetic, hypolipidaemic, antiatherosclerotic, anti-helminthic, purgative, hepatoprotective, antihypertensive, rubifacient and vesicant activity.

Although many of pharmacological activities attributed to plant (Table-3) has been authenticated, yet some traditionally and folkloric medicinal uses like aphrodisiac, diaphoretic, anti poison, diuretic, antiemetic and emmenagogue need investigation in this regard. *Capparis* also shows potential for use as a male contraceptive, anticancer, anti-aging and cosmetics [124,146]. In spite of the innumerable folk, traditional uses and pharmacological verifications, little attention

has been paid so far on the preclinical and clinical studies [31].

In addition to its nutraceutical value the plant may serve as future source of green bio-diesel, nanotechnology, inhibitor of metal corrosion and as an antibiotic.

CD possesses a broad spectrum activity against amoeba, fungi, bacteria, viruses, snails, termites, ticks and other insects. It qualifies as a good insecticidal plant and its active ingredients could be used for preparation of herbal or bio-pesticide formulations for control of flying and stored grain insects and termites. Certainly, CD may prove as a source of nutrition, medicine and herbal pesticides in future as envisaged earlier [139].

*Capparis decidua* is an important constituent of desert ecosystem. Plant offers multifarious uses as food, feed, fuel, wood, medicine and plays important ecological roles. Being tolerant to temperature, salt and drought stresses it provide vegetation cover and helps in arresting on sandy wastelands. The plant also improves the fertility of sand dunes and reduces alkalinity [3]. It has good soil binding capacity and can be used in landscape gardening, afforestation in semi desert area to prevent soil erosion [170].

Borrowing words of Meghwal and Tiwari [36] “Kair offers scope for commercial cultivation on marginal lands under rain-fed conditions because of its adaptability to grow in different soil types in arid areas with very low and erratic rainfall. It is a very strong candidate for use in both plantation forestry and agroforestry (as a woody component), and even for horticulture”.

Primary area of attention would be stabilising and sustaining natural population. The plant is overexploited due high economic value of immature fruits and are often harvested and sold at high prices. This practice puts seed production and progress of Kair at risk. Poor and lack of seed production continue to be the major cause for declining Kair population. The seeds have short period of viability and short storage span and propagation of plant through seeds is poor. The plant has been even listed as one of the endangered species of India [171].

There is dire need to awaken and educate the younger generations about the preservation, promotion and use of this precious little berry. This objective demands joint efforts of people, religious leaders, policy makers, scientists and NGO’s for protection of the species and save from undue importance given to import by western media and modern chefs. Our own valuable plants are losing ground due to lack awareness and information usefulness of small berries.

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