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Phytochemical and pharmacological aspects of *Capparis decidua* (Forsk.) edgew: A review

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Abstract

Capparis decidua (Forsk.) Edgew, commonly known as Kair (in Hindi), Caper berry (in English) and Karira (in Sanskrit), belongs to the family Capparidaceae. It is important medicinal plant, found in subtropical and tropical zones and other arid regions in southern Asia. Various phytoconstituents have been identified and isolated from different parts of *C. decidua* which includes alkaloids, glycosides, terpenoids, sterols, flavonoids, phenols and fatty acids. The roots of *C. decidua* are found to contain sitosterol and spermidine alkaloid, isocodonocarpine and three crystalline colourless and hygroscopic alkaloids, capparine, cappariline, capparinine. The plant has been used as carminative, tonic, emmenagogue, alexipharmic; improves the appetite; good for rheumatism, cough and asthma. Different parts of *C. decidua* are reported to have significant pharmacological activities like hypercholesterolemic, anti-inflammatory and analgesic, antidiabetic, antimicrobial, antihypertensive, antihelminthic & purgative activities. Recently Kair extracts are used for synthesis of metal nanoparticles that have significant cytotoxic, antimicrobial and enhanced antioxidant capacity. Owing to its various medicinal properties, this present review article is dedicated towards the various pharmacological and phytochemical aspects of *C. decidua*.

Keywords: *Capparis decidua*, Kair, pharmacological aspects, phytochemicals

Introduction

Medicinal plants are gaining much interest recently due to their special attributes as a large source of therapeutic phytochemicals that may lead to the development of novel drugs. Moreover due to increased concern of society with health and nutrition, medicinal plants have emerged as alternative to synthetic products. These are used not only in traditional medicine but also in a number of food and pharmaceutical products, due to their nutritional properties and bioactivity^[1]. *Capparis decidua* (Forsk.) Edgew, commonly known as Kair, is a very important medicinal plant and it belongs to the family Capparidaceae^[2]. Kair is a glabrous densely branched spinous shrub or small tree found in dry and bare habitat of Sind, Baluchistan, Egypt, Socotra, Arabia, Tropical Africa, Western and Central India and Pakistan^[3] and growing wild in Rajasthan, Gujarat, Punjab, Deccan Peninsula and Western Ghats of India^[4]. *Capparis decidua* is one of the most important floras among 44% of all species of vascular plants which come under 'biodiversity hotspots'. Being a desert plant, it possesses diverse chemical constituents, which are of great nutritional and medicinal value^[5] and can be used as a potential food supplement^[6]. It is an important non-conventional food source in India^[7]. Plant is a richest source of beta-carotene (14%), oils and fats and minerals^[8]. Plant contains generous quantities of alkaloids, fatty acids, terpenes, sterols, fiber and oils and has greater medicinal and nutritive values. Plant is used in traditional folk medicine as ailments to relieve variety of pains or aches such as toothache, cough and asthma healer. It is also used as an anti-rheumatic and anti-diabetic anti-rheumatic, antiarthritis and anti-gout agents. *C. decidua* contains chemical constituents, which include the saccharides and glycosides, flavonoids, alkaloids, terpenoids and volatile oils, fatty acids and steroids that possess enormous pharmacological effects and shows anti-inflammatory, odynolysis, anti-fungus, hepatoprotective effect, hypoglycemic activity, anti-oxidation, anti-hyperlipemia, anti-coagulated blood, smooth muscle stimulation, anti-stress reaction, and improves memory.

Phytochemistry of *C. decidua*

Various phytoconstituents have been identified and isolated from different parts of *C. decidua*

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which includes alkaloids, glycosides, terpenoids, sterols, flavonoids, phenols and fatty acids. The roots of *C. decidua* are found to contain sitosterol and spermidine alkaloid, isocodonocarpine [9].

Three crystalline colourless and hygroscopic alkaloids, capparine, cappariline, capparinine, are also isolated from roots [10]. Two sterols, one diterpene alcohol, two aliphatic constituents and one diterpenic ester were reported from *C. decidua* root barks. β -Sitosterol was isolated from the roots by extracting with ethanol and chromatographing the alcoholic extract on neutral alumina with the eluents benzene, ether, chloroform and methanol successively. The structures of the sterols were established as 24- β -methylcholest-7-ene-22-one-3 β -ol and 24- β -methylcholest-9(11)-ene-22-one-3 α -ol. The structure of diterpene alcohol was identified as 3-methyl-7-hydroxymethylene-10-(12, 16, 16-trimethylcyclohex-11-enyl) - dec-9-ene-5-one-8-ol. Butyl-3-oxoeicosanoate and 25-oxooctosan-1, 20-diol were the aliphatic constituents. The diterpenic ester was identified as 9-(11, 15, 15-trimethylcyclohex-11-ene-13-one-yl)-one-6-hydroxymethylene-7-one-yl, 4'-Me heptanoate [2]. From the root bark, spermidine alkaloids like Isocodonocarpine [11] Capparisinine [12, 13, 14] Capparadisine [15] were isolated.

Six oxygenated heterocyclic constituents capparisterpenolide (3-carboxy-6, 17-dihydroxy-7, 11, 15, 19-tetramethyleicos-13-ene-d-lactone) and deciduaterpenolides (d-lactone derivatives of 1, 3, 3-trimethyl-1, 4-cyclohexadien-6-one) A, B, C, D and E were isolated from alcoholic extract of root bark [16]. The root bark also contains alkaloids [17] 14-N-acetyl isocodonocarpine, 15-N-acetyl capparisine, Cadabicine, Stachydrine, Rutin, capparisine and codonocarpine [18]. Flower buds have Tocopherol, Vitamin C glycosides, alkaloids that are anti-oxidants and Isothiocyanates that are anticarcinogenic. Fruits possess Biflavonoids which shows Anti-hypercholesterolemic activity, Isoginkgetin, Ginkgetin shows anti-inflammatory, Daucosterol, Uracil, stachydrine shows Anti-arthritis activity. Mature fruit have Flavonoids, isoginkgetin, ginkgetin, isocodonocarpine show Anti-oxidant property, 5-(hydroxymethyl, Bis (5-formylfurfural) ether shows Anti-inflammatory property. Seeds have Fatty acids, tocopherols, sterols, proteins shows Nutraceutical property. Roots have Capparisinine, Capparisterpenolide that shows Anti-microbial property and Capparinenol-12, Capparinenol-13 shows Hepatoprotective action [19].

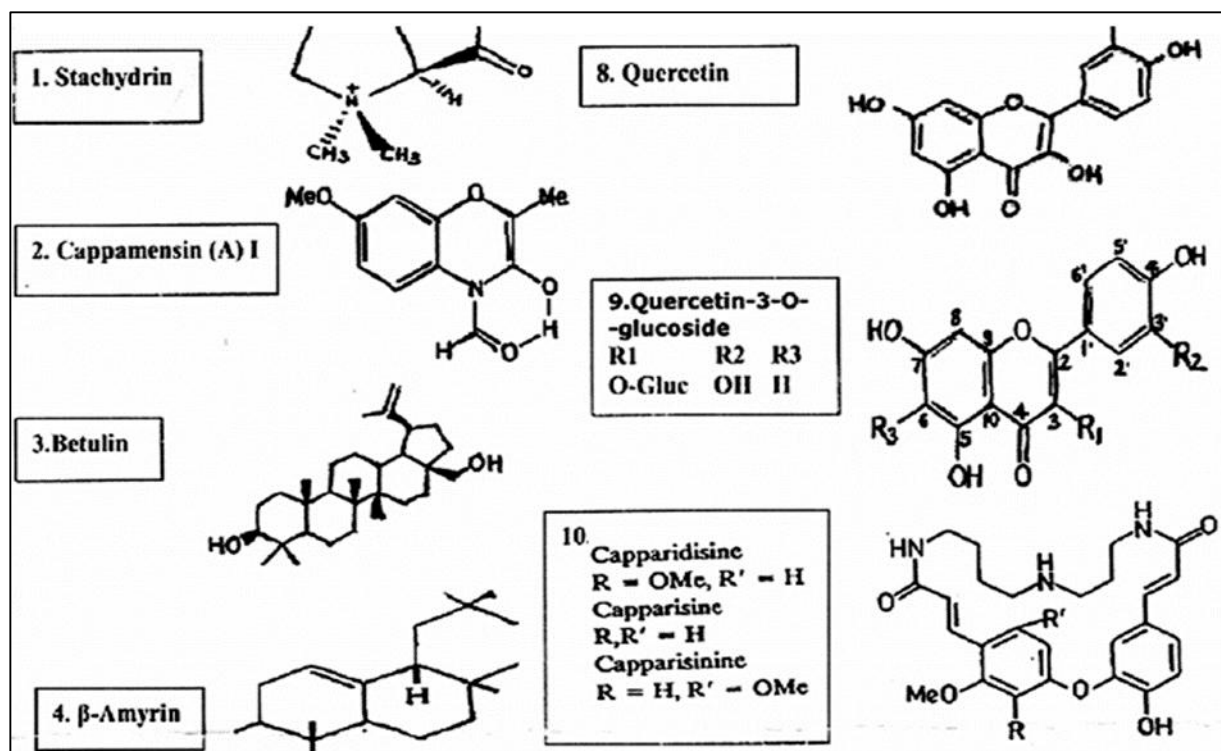


Fig 1: Phytochemicals from *C. decidua*

Medicinal importance of *C. decidua*

- The unripe fruits are considered anthelmintic and laxative and employed in the treatment of asthma, constipation, coughs, hysteria and other psychological problems [20].
- In traditional medicinal systems, it is regarded as laxative, astringent and vermifuge [21].
- The root bark is prescribed for the treatment of toothache, intermittent fevers, asthma, cough, inflammations and rheumatism [22].
- Fruits and seeds are regarded as diuretic, antidiabetic, astringent to bowels and said to be beneficial for cardiac troubles and seed oil is used to cure skin diseases [23].
- Fresh plant juice is used to kill ear worms in droplet form. [3].
- In Unani system of medicine, *C. decidua* is used as a tonic, aphrodisiac, carminative, emmenagogue, alexipharmic, appetizer, good for rheumatism, hiccough, lumbago, asthma and cough [24].
- The top shoots and tender leaves powder has been used to treat blister, boils, swellings, eruptions and as poison antidote [3].
- For the treatment of pyorrhoea, a decoction of ground stems and leaves has been used [25].
- Fruits of the plant are astringent and useful in heart problems.

- The tender flower buds and fruits have been used for making pickles. Traditionally Fruits are eaten either ripe or raw.
- Plant shows positive effects in treating facial paralysis, enlarged spleen and also used to kills intestinal worms [26].
- It is also useful in heart diseases, phthisis and scurvy.
- Root powder with water is given in hepatic disorders [27].
- For the treatment of haemorrhoids extract of root bark is given twice daily for 3 days [28].
- The plant has its medicinal properties in hypertension, diabetes, rheumatism and various gastric problems.
- Flower buds are used in stomach ache, paste of the root is applied on the scorpion bite.
- Stem coal powder is used for fractured bone treatment.[29]
- Decoction of stem bark (10-15ml) is given two times a day in all pulmonary/respiratory disorders including asthma.[30]
- The green immature fruits are considered antihelminthic and laxative and are employed in the treatment of asthma, constipation, coughs, hysteria and other psychological problems [20].
- The blanched fruit is used as a vegetable [31].
- The seeds oil is edible when processed and also used to cure skin diseases [23].

Nutritional importance of *C. decidua*

The continuously increasing population coupled with poverty presents the problem of malnutrition especially in rural areas. Despite the government's large expenses on the livelihood of common people, the provision of balanced food and modern healthcare to rural people is still a far-reaching goal. Hence, it is recommended that researchers should resort to forms of nutraceuticals mainly in the native plant species to overcome the constraints of human necessities. Phytochemicals and minerals ingredients are necessary for virtually all reactions to occur in the body. While each has its own unique properties, they work synergistically to ensure reactions in the body occur appropriately. *C. decidua* contains appreciable amounts of tocopherols and vitamin C, which react with most reactive form of oxygen and protect unsaturated fatty acids from oxidation. Unripe fruit (Teent) of *Capparis decidua* is a rich source of dietary fibers and is used to treat hypercholesterolemia. It significantly increased the fecal excretion of cholesterol as well as bile acids. The dietary fibre (42.88%) influenced total lipids, cholesterol, triglycerides and phospholipids of the liver to varying extents [32]. Fruit is a rich source of vitamin C, oils, minerals, sugar and protein (15.1%) that substantiate its nutritional value [33]. Its seed oil contains minor and major nutritional mineral contents such P, Na, Mg, Fe and Ca and fatty acids, which are important dietary constituents.

Table 1: Nutritional parameters of *C. decidua* parts [34]

Plant part	Nutritional parameter
Seed	Oil (20%) Crude protein (27.71±1.39) Total lipids (29.11±1.07) Total carbohydrate(25.42±0.26) Crude fiber(10.44±0.09) Essential Amino acids: Arginine (3.46±0.66) Histidine (4.05±0.29) Isoleucine (4.03±0.19) Leucine (6.41±0.22) Lysine (6.02±0.54) Methionine(0.75±0.62) Phenylalanine(5.51±0.11) Tryptophan (0.88±0.05) Valine (6.89±0.24) Threonine (3.64±0.07) Essential fatty acids: Linoleic acid (47.33±1.04) Linolenic acid (1.07±0.35) Arachidonic acid (0.78±0.11)
Flower	Oil (14%) Sugar (1.7%) Protein(8.06%)
Ripened Fruit	Carbohydrate (71%) Protein (15-18%) Fat (5%) Crude Fiber (1%) Ca (20%) P (360%) Zn (4%) Fe (6%) Mn (2%) β-Carotene (14%)
Ripened fruit dried	Crude protein (14.94 %) Total carbohydrate (73.48 %) Soluble carbohydrate (18.03 %) Moisture (69.66%) Phosphorus (219.05 mg/100g) Magnesium (49.16 mg/100g)

Iron (4.64mg/100g)
Zinc (0.31 mg/100g)
Copper (1.94 mg/100g)
Sodium (160.64 mg/100g)
Calcium (3.24%)
Starch (15.28 %)
Crude fiber (10.94 %)
Crude fat (5.38 %)

Pharmacological activities of *C. decidua* parts

Antioxidant activities

Three different aerial parts (leaves, flowers and fruits) of Kair were subjected to antioxidant activity screening, using different testing methods. The extracts of *C. decidua* showed potent antioxidant activity, reducing different types of radicals (Table 2). In fact, to varying extents, the tested extracts were able to reduce the stable 1, 1-diphenyl-2-picrylhydrazyl (DPPH) radical, reaching IC₅₀ values from 69.1 ± 1.3 µg/mL, for fruit extract, to 89.04 ± 1.75 µg/mL, for flowers extract. Although DPPH and ABTS (2, 2'-azinobis (3-ethylbenzo-thiazoline-6-sulphonic acid) diammonium salt) methods are based on the same principle, data obtained from ABTS assay were lower than those obtained from DPPH assay. This is probably due to steric

factors that are one of the major factors influencing the reduction of stable DPPH radical. Moreover, results obtained from Ferric reducing antioxidant power (FRAP) and Total radical-trapping antioxidant parameter (TRAP) assays are in agreement with values obtained from the above discussed assays. The superoxide radical scavenging assay (SRSA) is said to be more relevant than those methods described above, because it utilizes a biologically relevant radical source. This radical mediates inflammatory tissue injuries in arthritis, gout and gastric ulceration. Superoxide radical has a low reactivity and a low capacity to penetrate the lipid membrane layer, but it can generate hydrogen peroxide and highly reactive hydroxyl radical, via Haber-Weiss reaction [35].

Table 2: Antioxidant activity of methanol extract from different organs of *Capparis decidua*. Data are expressed as the mean ± standard deviation; values having different letters differ significantly ($p < 0.05$).

Plant parts	DPPH (IC ₅₀ , µg/mL)	ABTS (µmol TE/g)	FRAP (µmol TE/g)	TRAP (µmol TE/g)	SRSA (IC ₅₀ , µg/mL)
Flowers	89.04 ± 1.75 b	466.12 ± 1.08 b	1967.47 ± 4.69 b	55.72 ± 1.93 b	117.20 ± 1.29 b
Fruits	69.1 ± 1.3 c	501.17 ± 1.34 a	2388.02 ± 1.48 a	47.04 ± 2.08 c	93.04 ± 1.63 c

Zia-Ul-Haq *et al.* analysed the antioxidant activity of methanol extract from different parts of *C. decidua* and reported 407.72 & 286.51 mg CE/g phenolic compounds in fruits and leaves of *C. decidua*, respectively [35]. Mann *et al.* reported that in *C. decidua* total phenolics content ranged between 49 - 154 µg GAE/mg extract, total flavonoids content between 98.3 - 812.3 µg RE/mg extract and ABTS scavenging activity 9.3 - 28.0 IC₅₀ (mg/ml) in different solvents [36].

Anti-cancer activities

Some medicinal plants possess active principles which can be used for prevention or treatment of early stages of cancer. Moreover due to prevalence of poverty in developing countries, there is urgent need for alternative drugs which are of plant origin, non-toxic, inexpensive and easily accessible to common man. Rathee *et al.* isolated β-sitosterol triacontenate from *C. decidua* stem and tested its cytotoxic activity. Result of that study showed that cytotoxic activity of β-sitosterol triacontenate was found to be almost comparable to that of Paclitaxel (control) at concentrations 5µM and 10µM [37].

Anti-diabetic activities

The pharmaceutically important groups are the organic constituents which forms the basis of the pharmacological actions. The phytochemical screening of ethanolic and aqueous extracts shows the presence of alkaloids, carbohydrates, sterols, amino acids and proteins. biochemical assays pertaining to Blood Glucose Levels of different animal models reveals that the alcoholic extract (in the dose 500 mg/kg body weight) of stem of *C. decidua* was

found to have the significant antidiabetic activity and the aqueous extract was found to have moderate antidiabetic activity. However, longer duration studies of *C. decidua* and its isolated compounds on chronic models are necessary to develop a potent anti-diabetic drug [38].

Antimicrobial activities

Demand for herbal biocides is increasing in order to find effective alternatives to synthetic fungicides. In vitro evaluation of plants and plant products for antifungal property is the first step towards achieving the goal for developing ecofriendly management of fungi. *Capparis decidua* has a wide range of biological activity due to the presence of different types of bioactive phytochemicals like alkaloids, terpenoids, glycosides, flavonoids, fatty acids, etc in good quantity. The efficacy of wood, bark and seed extracts of *C. decidua* in inhibiting the growth of some detrimental seed-borne fungi (*Aspergillus niger*, *A. flavus*, *Fusarium moniliforme*, *Phytophthora sp.*, *Penicillium sp.* and *Mucor sp.*) as found in the study conducted by Yripathi *et al.* is suggestive of its promising antifungal activity which has not been reported so far. The study further revealed that the antifungal activity of the extracts enhanced by an increase in the concentration of the extract [39]. Active principle Oleiyl glucoside was isolated from the ethanolic extracts of *C. decidua* and it exhibited moderate activity against *C. albicans* bacteria [40]. various other studies that methanolic extracts of *C. decidua* flowers and roots successfully inhibited the growth of *Staphylococcus aureus*, *E.coli* population was effectively reduced by methanolic extracts of *C. decidua* roots and shoots.

Hepatoprotective activities

Oral administration of aqueous and methanolic extracts of *C. decidua* stems significantly decrease the level of serum aspartate amino transferase, alanine amino transferase, alkaline phosphatase and bilirubin activity^[41]. The ethanolic extracts of *C. decidua* significantly reduced the hepatotoxic effects and decrease the level of the enzymes SGPT (serum glutamate pyruvate transaminase), SGOT (serum glutamic oxaloacetic transaminase) and ALP (alkaline phosphatase), whose activity is induced by acetimide. The decreasing in the activity of these enzymes provoked by ethanolic extracts of *C. decidua* overcame that induced by several synthetic drugs^[42].

In nano-particle synthesis

Chemical and physical methods may successfully produce pure, well-defined nanoparticles, but these techniques are more expensive, energy consuming and potentially toxic to the environment. Biosynthetic methods can employ either microorganism cells or plant extract for nanoparticles production. An exciting branch of biosynthesis of nanoparticles is the application of plant extracts to the biosynthesis reaction. Simple and rapid biosynthesis of AgNPs using aqueous leaf extracts of *C. decidua* as reducing agents. This environmentally friendly method provides faster rates of biosynthesis and can potentially be used in various areas such as cosmetics, food, medicines and antibacterial agents. Moreover, very small size of silver nanoparticles may make it a good antimicrobial agent^[43]. The inhibitory effect of the synthesized nanoparticles from *C. decidua* extracts on bacterial pathogens was studied. The results indicated that the particles possessed maximum inhibitory activity on all the tested pathogens. It was also noted that the antibacterial action of the AgNPs was much greater than that of the standard antibiotic used (Cefotaxime). Among the 2 samples tested, sample B exhibited maximum inhibitory action on the bacterial pathogens with maximum ZOI of 12.5, 13, 10.5, and 13.5mm against *B. subtilis*, *E. coli*, *K. pneumonia* and *P. aeruginosa*, respectively. The ZOI of standard antibiotic was recorded as 10, 10.5, 13.5, and 14mm against *B. subtilis*, *E. coli*, *K. Pneumonia* and *P. aeruginosa*, respectively at a concentration of 250 μ g^[44].

Conclusion

We can conclude that *C. decidua* possesses very significant pharmacological properties and it can effectively substitute or replace certain chemicals in treatment of various ailments. Owing to its richness in nutritional parameters, it can be used to address the problem of malnutrition in rural areas of developing countries.

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