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Traditional uses, phytochemistry and pharmacological properties *of Capparis decidua* : An Overview

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ABSTRACT

Since ancient times, plants have been an exemplary source of medicine. Ayurveda and other Indian literature mention the use of plants in treatment of various human ailments. India has about 45 000 plant species and among them, several thousands have been claimed to possess medicinal properties. Research conducted in last few decades on plants mentioned in ancient literature or used traditionally for various disorders. This article aims to provide a comprehensive review on the Phytochemical and pharmacological aspects of Capparis decidua. Capparis decidua, climbing, thorny shrub, densely branched, spinous shrub or tree, up to 6 meters in height, is widely used in traditional medicinal system of India, has been reported to possess carminative, tonic, emmenagogue, aphrodisiac, alexipharmic; improves the appetite, antirheumatic, lumbago, hiccough, cough and asthma. It is known as a rich source of alkaloids, phenols, sterols and glycosides. The innumerable medicinal properties and therapeutic uses of Capparis decidua as well as its phytochemical investigations prove its importance as a valuable medicinal plant.

Keywords: *Capparis decidua*, Phytochemical constituents, Kurrel, Phytochemistry, Pharmacological activities.

INTRODUCTION

The Greek name *kapparis* is from the Persian kabar, “caper”. Pickled capers have been used as a condiment for over 2000 years. [1] The plant is commonly known as Caper berry in English, Karira in Sanskrit, Kerada in Gujarati, Karer or Kurrel in Hindi, Nispatige in Kannad, Nepati in Marathi, Kair in Punjabi, Shengan in Tamil and Enugadanta in Telegu, Titali in Urdu, belonging to the family Capparidaceae.

The plant usually grows in dry, exposed habitat, often on foothills, in wastelands. It is found in the deserts, especially of Rajputana, Punjab and Sind, [2] southwards to Karnataka and Tamil Nadu, [3] growing wild in Western Ghats, Rajasthan and Gujarat. [4] Caper buds are both wild-collected and cultivated; plants grown in cultivation tend to be spineless. It is cultivated in well drained, sandy soil in sun. It is propagated by seed sown in autumn or spring; by ripe woodcutting in summer at 19-24^0 C (66-75^0 F). [1]

The plant is a large, climbing, thorny shrub, densely branched, spinous shrub or tree, up to 6 meters in height (rarely 10 meters), with a clear bole of 2.4 meters. Tender branches with waxy bloom; bark grey, rough and corky, covered with straight or recurved, 3-7 mm long, paired thorns; leaves on young branches, caduceus, linear, 1-2 cm long, apex short, stiff, pale mucro like pickle, petioles very short, stipular thorns long, sharp, straight orange yellow; [5] flowers red or pink, rarely yellow, in lateral corymbs; berries globose or ovoid, 1-2 cm in diameter, dull red, [6] with a hard woody, 1-2 mm thick brownish rind, gynophores about 1.5-2 cm in length, arising from the swollen base of the thalamus; pedicel short and brittle; apex with a small point like scar of the style; taste bitter; odour strong and foetid, [4] seeds globose, 2-5 mm in diameter, [6] dried seeds are reniform, 4-5 mm in length, 3-4 mm in width, 1.5- 2 mm in thickness, covered with greyish white fleshy aril; surface shows fine network of uniformly developed shallow depressions throughout; testa very hard, black with pitted surface; hilum situated in a small depression on the edge of the seeds to the pointed end. [4]

It has been mentioned in Ayurveda that the bark has an acrid, sharp, hot taste; analgesic, diaphoretic, alexeteric, laxative, in dropsy ground, [7] anthelmintic; good in asthma, ulcers and boils, vomiting, piles and all inflammations. The fruit has a sharp hot astringent to the bowels; destroys foul breath, biliousness, and urinary purulent discharges; good in cardiac troubles. The root bark is pungent and is given in cases of intermittent fevers, asthma, inflammations and rheumatism. [7, 8] It is applied externally to ribs in case of pleurisy. [7]

Phytochemical screening of *Capparis decidua* revealed high contents of isothiocyanate glucoside, glucocapparin, stachydrine, n-triacontane, β-carotene and β-sitosterol. The presence of n-triacontanol, n-pentacosane and phthalic acid. [4, 6] The flowers yield a steam-volatile sulphur compound (0.4%), which is active against several microorganisms. [6]

Various preparations of *Capparis decidua* are powder and infusion of root-bark (1 in 10), dose: ½ - 1 ounce, juice of plant, [2] powder of Leaves & root- 50-125 mg. [3]

CLASSIFICATION

Domain - *Eukaryota*
Kingdom - *Plantae*
Subkingdom - *Viridaeplantae*
Phylum - *Tracheophyta*
Subphylum - *Euphyllophytina*
Class - *Magnoliopsida*
Subclass - *Dilleniidae*
Order - *Capperales*
Family - *Capparaceae*
Subfamily - *Capparoidae*
Tribe - *Capparae*
Genus - *Capparis*
Species - *Decidua*

QUANTITATIVE STANDARDS [4]

Foreign matter	–	NMT 2%
Ash	–	NMT 7%
Acid insoluble ash	–	NMT 0.9%
Ethanol soluble extractive	–	NLT 26%
Water soluble extractive	–	NLT 44%

Traditional uses

According to the Unani system of medicine the plant has been used as a carminative, tonic, emmenagogue, aphrodisiac, alexipharmic; improves the appetite; good for rheumatism, lumbago, hiccough, cough and asthma. [8]

The top shoots and young leaves are made into a powder and used as a blister; they are also used in boils, eruptions and swellings and as an antidote to poison. They are very efficacious in relieving toothache when chewed, [5] a decoction of ground stems and leaves is used for pyorrhoea. [6] The fruits are astringent, are useful in cardiac troubles. The young flower bud and fruits are pickled. Fruits are eaten either green or ripe. Useful in facial paralysis and solves problems of enlarged spleen, kills intestinal worms. [7] It is given in phthisis, heart diseases and scurvy. In Rajputana, the plant is a wholesome fodder for camels. Juice of fresh plant is dropped into the ear to kill worms. [2] Root powder is taken with water in liver problems. [9] The root bark extract is given twice a day for 3 days in the treatment of haemorrhoids. [10] The plant is used for its medicinal value in diabetes, rheumatism, hypertension and various stomach problems. Wood being very strong and durable is used to make the foundations around the wells and as fire wood. [11] Flower buds are eaten to relieve stomach ache; root paste is applied on scorpion bite; powdered coal from stem is taken during fractured bone. [12] The stem bark decoction (10-15ml) is administered twice a day in asthma and other respiratory disorders. [13]

The fruit extract produced significant hypocholesterolemic effect which appeared to be due to increase faecal excretion of cholesterol and bile acids which is attributed to its hemi cellulose content. The extract of defatted fruit inhibited the development of atheroma and prevented the accumulation of cholesterol and triglyceride in liver and aorta of rabbits. Powdered fruit reduced Alloxan induced lipid peroxidation and subsequently altered super oxide dismutase and catalase in erythrocytes, kidney and heart. It reduced oxidative stress in diabetes. The extract of the fruit produced antibacterial and antifungal activities. The extract of fruit pulp, seeds, and alkaloid isolated from the extract demonstrated anthelmintic activity and affected bowel movement. [4]

Activity of the seed volatiles against *Vibro cholera* has been recorded. Aqueous extract of the plant exhibits anthelmintic activity; seeds contain antibacterial principles-glucocapparin; isothiocyanate aglycone of glucocapparin. [3] The bark pout has anthelmintic, constipative and purgative. [14]

According to the well known versatile medicinal properties and pharmacological actions of *Capparis decidua*, the present article provides an updated account of different aspects of the phytochemical and pharmacological properties.

Phytochemistry

Various biochemical compounds, alkaloids, phenols, sterols or glycosides present in *Capparis sp.* might be medicinally important and/or nutritionally valuable.

The flowers, fruits, [15] stem [16] and seeds contains n-pentacosane, n-triacontane, [17] n-triacontanol, 2-carboxy-1, 1-dimethylpyrrolodine, 6-(1-hydroxy-non-3-enyl) tetrahydropyran-2-one, ß-sitosterol, ß-carotene, ascorbic acid, proteins, total carbohydrates, calcium, potassium, phosphorus, zinc, iron, manganese, glucosinolates.

The roots contain the indole bases capparin (m. p. 236-238^0), capparilin (m. p. 188-191^0) and capparinin (m. p. 229-231^0). The root bark contains *l*-stachydrine (m. p. 232^0), capparidisine (molecular formula $C_{27}H_{33}N_3O_6$, mol wt. 495). It is a macrocyclic alkaloid containing two methoxylated and hydroxylated trans cinnamic acid residues which are linked to each other through oxygen bridge and to spermidine through amide bonds. [18] Capparisin (molecular formula $C_{26}H_{31}N_3O_5$) has same skeletal system but one methoxy group less than capparisidine, capparisinine; it is an isomer of capparisidisine with a methoxy group at a different position. [18] n-Pentacosane, n-triacontanol, and β-sitosterol are present in plant. [6, 19, 20, 21] The presence of isorhamnetin, arabinose, galactose, alanine, carotenes, polyphenols and a number of phenolic acids is also reported in the plant. [6]

Six new oxygenated heterocyclic constituents, named capparisesterpenolide and decidua terpenolides A, B, C, D and E have been isolated from the alcoholic extract of root-bark of *Capparis decidua*. The structures of these compounds have been established as 7, 11, 15,19-tetramethyleicos-13-ene-17-ol-6,21-olide, 13-(15,19-19-trimethylcyclohex-14,17-diene-16-one-yl)-10-methyI-6- hydroxymethylenetridec-10-ene-7,8,12-triol-5 (20)-olide, 13-(15, 19-trimetyl cyclohex-14,17-diene-16-one-yl)-100 methyl-6-hydroxymethylene-tridec-6-ene-1,8,12-triol-5, (20)-olide, 14-(16,20, 20-trimethyl cyclohex-15,18-diene-17-one-yl)-tetradec-3-ene-13-ol-1(5), 8(24)-diolide, 14-(16, 20, 20-trimethyl cyclohex-15, 18-diene-17-one-yl)-11-methyl pentadec-1, 22-dihydroxymethylene-7-ene-13-one-6, 21-olide and 19-(21, 25, 25-trimethyl cyclohex-20) 30-diene-22-one-yl)-16-methyl-nonadec-8-ene-14-one-8-hydroxy methylene-18-ol-7, 26-olide-28 oic acid, respectively on the basis of chemical reactions and spectral data. [22]

The seeds yield a brownish yellow oil (20.3%) having the following characteristics: Acid value: 8.8; iodine value: 69.8; sap equiv: 290.0; unsapon matter: 1.2%. the fatty acid composition is as follows: palmitic, 21.1%; stearic, 7.7%; myristic, 0.6%; arachidic, 2.0%; oleic, 57.2% and linoleic, 11.4%. The oil is rich in oleic acid and suitable for both edible and non edible purposes. The unsaponifiable matter contains n-pentacosane, n-triacontanol and β-sitosterol. Presence of l–stachydrine is also reported. An isothiocyanate glucoside, glucocapparin has also been isolated, the aglycone of which shows high antibacterial activity (25 µg/ml). [6]

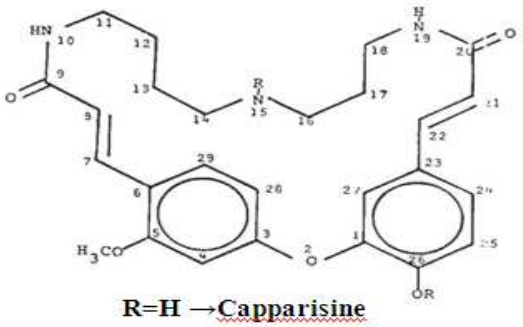
The fruit from Hissar (Haryana) contains (dry basis): moisture, 65; protein, 17; fat, 5; crude fibre, 1; total carbohydrate, 71; and ash, 6%; calcium, 210; phosphorus, 360; zinc, 4; iron, 6; manganese, 2; β-carotene, 21; ascorbic acid, 119; phytic acid, 68; and oxalic acid 0.1mg/100 gm. The root bark contains spermidine alkaloids, isocodonocarpine, 14-N-acetylisocodonocarpine and 15-N-acetylcapparisine (molecular formula $C_{28}H_{33}N_3O_6$) and their structures are isolated. [14] It is used for asthma, inflammation and gout. [9, 24]

A new spermidine alkaloid, isocodonocarpine, was isolated from the root bark of *Capparis decidua* and its structure elucidated by spectral studies including 2D NMR. [25]

Many different species and varieties of Capparaceae distributed in 17 genera have been examined for the presence of betaines and other quaternary ammonium compounds.

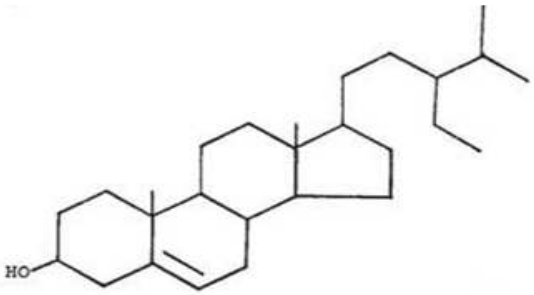
Prolinebetaine and/or 3-hydroxyprolinebetaine were detected in all the species examined of Capparis. [26]

STRUCTURES

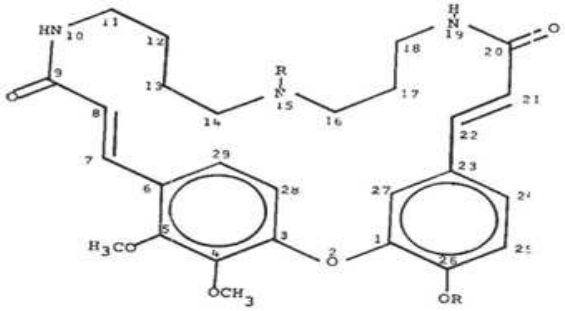


R=H →Capparisine

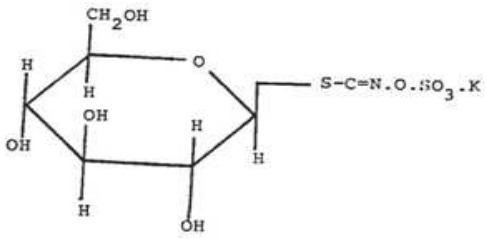
R= AC →Diacetyl capparisin



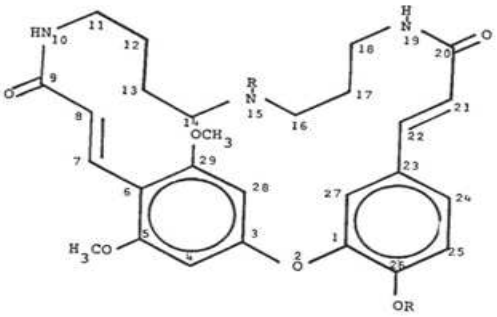
β - Sitosterol



Capparisidisine

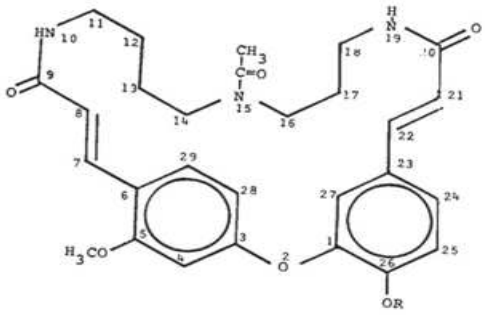


Glucocapparin



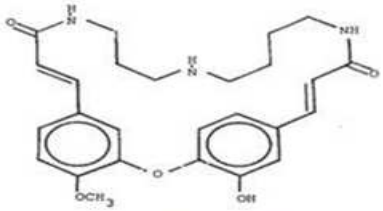
R=H → Capparisinine

R=Ac → Capparisinine diacetate

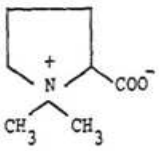


R=H →N-acetyl capparisine

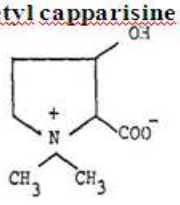
R=Ac → O-N-Diacetyl capparisine



Codonocarpine



L- stachydrine



3-hydroxy stachydrine

Pharmacological Activity

Sedative and anticonvulsant effects

An alcoholic extract of aerial parts of *C. decidua*, including flowers and fruits, was screened for central nervous system (CNS) activity using conventional behavioural animal models. In the open field test all doses of *C. decidua* extract tested decreased the number of rearings, grooming, and fecal bolus ($P < 0.001$) when compared with control. In the barbiturate-induced sleeping test a significant ($P < 0.001$) decrease in latency of sleeping and increase in sleeping time were observed at all doses (100, 200, and 300 mg/kg). *C. decidua* extract increased the percentage of animals exhibiting motor deficit in the rota rod test. In the pentylenetetrazole-induced seizures test the *C. decidua* extract dose-dependently decreased ($P < 0.05$) the number of animals with convulsions and increased convulsion latency ($P < 0.001$); none of the animals treated with extract died in the test. *C. decidua* extract decreased the duration of tonic hind leg extension in maximal electroshock-induced seizures ($P < 0.001$) when compared with control. The findings of the present animal study suggested that *C. decidua* has CNS depressant and anticonvulsant activities. [27]

Antidiabetic and antistress activity

Alloxan-induced diabetic rats were treated with insulin (i.p.) or with *Capparis deciduas* powder as a hypoglycaemic agent mixed with diet. The effect was assessed on lipid peroxidation (LPO) and the antioxidant defense system in rat tissues. The increased levels of blood glucose in diabetes produce superoxide anions and hydroxyl radicals in the presence of transition metal ions which cause oxidative damage to cell membranes. The heart tissue showed an increased lipid peroxidation (LPO) in diabetic rats while no significant change was observed in the liver and kidney. The treatment with *C. Deciduas* lowered LPO in these tissues even more effectively than insulin-treated rats. The superoxide dismutase (SOD) activity increased in the heart and kidneys in the diabetic group of rats probably to increase dismutation of superoxide anions. However, treatment with *C. deciduas* decreased SOD activity in the liver and kidney and was comparable to control rats. Catalase (CAT) activity was not significantly affected in any of the tissues in diabetic and insulin-treated animals, however, CAT activity markedly increased in tissues with *C. deciduas* treatment. Total and Se-dependent glutathione peroxidase (GSH-Px) in the heart was markedly lowered in diabetic rats which recovered with insulin as well as with C. *decidua* treatment. The increase in GSH-Px and CAT activity with *C. decidua* treatment may lower H_2O_2 toxicity and reduce oxidative stress in diabetes. However, glutathione (GSH) content in the heart and kidney and glutathione reductase (GSH-R) activity in all the tissues studied increased in diabetic rats while treatment with insulin lowered GSH content and GSH-R activity in these tissues. The treatment with *C. decidua* also decreased GSH-R activity in the kidney and heart which resulted in the decrease in GSH content in these tissues. The changes such as the increase in kidney and heart SOD may be an adaptive response in order to neutralize superoxide anions. The increase in GSH content and GSH-R activity in the tissue are in response to neutralize superoxide anions and to counteract oxidative stress in diabetes. Glutathione ***S***-transferase (GST) was not significantly affected in diabetic rat tissue, however, heart GST increased with antidiabetic treatments. The increase in glucose-6-phosphate dehydrogenase (G6PDH) in the kidney and heart of diabetic rats subsequently decreased with *C. decidua* treatment. The increase in G6PDH in tissues may increase NADPH generation required for GSH-R activity and GSH production. It is suggested that these changes initially counteract the oxidative stress in diabetes, however, a gradual decrease in the antioxidative process may be one of the factors which results in chronic diabetes. The data indicate that *C. decidua* may have potential use as an antidiabetic agent and in lowering oxidative stress in diabetes. [28, 29]

Streptozotocin-induced diabetic mice were treated with the alkaloid rich fraction for 28 days. On completion of the treatment, a range of parameters were tested including oral glucose tolerance test (OGTT), blood lipid profile, expression patterns of various glucose homeostatic enzyme genes and their activities. Results: Treatment of diabetic mice with alkaloid rich fraction for 28 days significantly inhibited the acute elevation of blood glucose level during OGTT and also reduced total cholesterol (TC) and triglyceride (TG) content ($p < 0.05$). Activity of glucose-6-phosphatase (G6Pase) was attenuated by 44%, also liver and muscle glycogen content showed significant improvement ($p < 0.05$). The expression of different target genes like G6Pase, phosphoenolpyruvate carboxykinase (PEPCK), aldose reductase and tumour necrosis factor-α (TNF-α) showed significant reduction whereas glucose transporter-4 (Glut-4), peroxisome proliferator activated receptor-γ (PPAR-γ) and glucokinase (GK) improved remarkably. Alkaloid rich fraction showed promising results in terms of anti-diabetic activities establishing its candidacy for further purification and characterization of the individual alkaloids, in order to understand their mechanism of action. [30]

The aqueous & ethanolic extract of *Capparis decidua* stem in Alloxan-induced diabetic rats was evaluated. Albino rats were rendered diabetic by Alloxan (150 mg/kg, intraperitoneally). The aqueous & ethanolic extracts were orally administered to diabetic rats at 250 and 500

Mg/kg doses daily for 21 days to determine antidiabetic activity. The fasting blood glucose level decreases by 58.5, 83.6 % (aqueous extract) and 60.2, 98.51 (ethanolic extract) after 21st day in diabetic rats treated with a different doses of 250 mg and 500 mg/kg body weight respectively. In conclusion, the present study using biochemical assays pertaining to blood glucose level of different animal models reveals that aqueous and ethanolic extract of stem has significant hypoglycaemic and antidiabetic potential. [31]

Hypocholesterolemic effect

Capparis decidua was processed and analyzed for proximate composition and dietary fibre constituents. Fifteen obese volunteer subjects having high blood lipid profile were selected for the experiment. Fasting blood samples were analyzed for total, LDL and HDL cholesterol initially before start of feeding experiment and at the end of experiment. *Capparis decidua* was processed and various products using its powder were standardized. The nutritional evaluation of *Capparis decidua* indicates that it contains a good amount of protein and fibre. A significant decrease in the total cholesterol (13%) and LDL cholesterol (16%) was noticed at the end of the experiment. However, no significant change in HDL cholesterol was witnessed. So results indicate that *Capparis decidua* supplementation may have an important role in nutritional management of hypercholesterolemia. [32, 33]

Anthelmintic activity

Most of the screenings reported are *in vitro* studies using some worm samples like Indian earthworm *Pheretima posthuma*, *Ascardia galli*, *Ascaris lumbricoids*, etc. Adult Indian earthworm, *Pheretima posthuma* has been used as test worm in most of the anthelmintic screenings, as it shows anatomical and physiological resemblance with the intestinal roundworm parasite of human beings. Because of easy availability, earthworms and A*scardia galli* worms are used as suitable models for screening of anthelmintic drug. These *in vitro* screenings are important as they give basis for further *in vivo* studies. The anthelmintic activity of ethanolic extract of root bark of *Capparis decidua* was evaluated against adult Indian earthworm *Pheretima posthuma* (annelida) because of its anatomical and physiological similarity with round worm parasite. The activity was found dose dependant,

comparable with Piperazine citrate 10mg/ml at the higher concentration of 100mg/ml of the extract used in the study. [34]

Antioxidant activity

Antidiabetic treatment with powdered fruit of *Capparis decidua* decreased Alloxan induced lipid peroxidation (LPO) significantly in erythrocytes, kidney and heart. Erythrocyte superoxide dismutase (SOD) activity decreased while the kidney and heart SOD increased in diabetic animals. These alterations in SOD were counteracted by insulin as well as with powdered fruit of C. decidua. Increased catalase (CAT) activity in erythrocytes, liver, kidney and heart with C. decidua treatment indicate that the treatment may neutralize H_2O_2 toxicity by its increased decomposition by CAT. Result shows that treatment with C. decidua lowers alloxan induced LPO and alters SOD and CAT enzymes to reduce oxidative stress. [35]

Antibacterial activity

Antibacterial activity was detected using the micro-dilution assay. The extracts were tested against Gram-positive: *Bacillus subtilis* and *Staphylococcus aureus* and Gram-negative: *Escherichia coli* and *Klebsiella pneumoniae*. The lowest MIC value (less than/or around 0.1 mg/ml) was observed with the dichloromethane root extract of *Capparis decidua*, against Gram-negative bacteria *Klebsiella pneumonia*. [36]

The aqueous extracts from the plant were screened by agar diffusion methods for their antibacterial activity against *Rathyibacter tritici*, a causal organism of tundu diseases of wheat. The plant showed the activity against the test bacteria. [37]

Antiatherosclerotic activity

The fruit alcohol extracts of the plant *Capparis decidua* (Frosk.) Edgew was investigated for its antiatherosclerotic activity. Hyperlipidemia was induced by atherodiet and cholesterol feeding to animals. Rabbits were fed *Capparis decidua* (500 mg/kg body weight) or pitavastatin (0.2 mg/kg body weight) in distilled water along with standard laboratory diet and atherodiet for 60 days. *C. decidua* fruit extract and pitavastatin were found to lower serum cholesterol, LDL-cholesterol, triglyceride, phospholipids, and atherogenic index, but found to increase the HDL to total cholesterol ratio as compared with hyperlipidemic control group. Pitavastatin or *C. decidua* fruit extract treated hyperlipidemic rabbits showed a decrease in the lipid profile of liver, heart, and aorta. The plant extract feeding brings about a definite regression of atheroma and hindered plaque formation in aorta as compared with the hyperlipidemic control group. Thus, this study demonstrates that *C. decidua* fruit extract possesses hypolipidemic and antiatherosclerotic effects. [31]

Hypolipidemic activity

High fat diet caused significant (8-fold) increase in serum total cholesterol in rabbits. Administration of *C. decidua* fruit extract (50% ethanolic) at the dose of 500mg/kg body weight significantly reduced serum total cholesterol (61%), LDL cholesterol (71%), triglycerides (32%) and phospholipids (25%). Similarly *C. decidua* shoot extract lowered serum total cholesterol (48%), LDL cholesterol (57%), triglycerides (38%) and phospholipids (36%).The cholesterol content of aorta was decreased by 44 and 28% in fruit and shoot extract treatment respectively. The HDL to total cholesterol ratio and atherogenic index was significantly decreased in plant extract treated groups suggesting antiatherosclerotic nature of these plant extract. These results reveal the hypolipidemic potential of *C. decidua* fruit and shoot. [38]

Capparis decidua contains 15.1% protein and 42.88% fibre. Being a rich source of fibre, the process for preparation of its powder and other recipes were standardized for feeding hyperlipidemic subjects. The diet of 15 hyperlipidemic adults (40-60 yrs.) was supplemented with it for three months and plasma triglycerides, total lipids and phospholipids were analysed before and at the end of the experiment. Significant reductions in plasma triglycerides, total lipids and phospholipids concentration were noticed. [39]

The effect of various extracts (50% ethanolic) of *Capparis decidua* on lipid profile of streptozotocin diabetic rats was studied. The extract was administered to the diabetic models for 30days. The extract produced a significant ($p<0.05$) dose-dependent decrease in the levels of total cholesterol (TC), Triacylglycerol (TG), low-density lipoprotein-cholesterol (LDL cholesterol), with a significant increase in the level High-density lipoprotein-cholesterol (HDL-C).The extracts of *C. deciduas* prove to have a hypolipidemic potential. [40]

Hepatoprotective activity

The aqueous and methanolic extracts of *Capparis decidua* stems locally known as altoundob were screened for their hepatoprotective activity against CCl_4-induced hepatotoxicity in rats. This plant is used in traditional system medicine in the treatment of jaundice. Yet, no systematic studies on its hepatoprotective activity have been reported. The hepatotoxicity produced by administration of CCl_4, in paraffin oil (1:9 v/v) at a dose of 0.2 ml kg-1 for 10 days, was found to be inhibited by simultaneous oral administration of aqueous and methanolic extracts of *C. decidua* stems (200, 400 mg kg-1 b.wt.) for 10 days, with evidence of decreased level of serum aspartate amino transferase, alanine amino transferase, alkaline phosphatase and bilirubin. In addition, the concurrent administration of both extracts with CCl_4, for 10 days masked the liver fatty changes induced by the hepatotoxic compound observed in the intoxicated control rats. The results were compared with the hepatoprotective effect of the standard drug silymarin. The preliminary phytochemical screening of the powdered plant showed the presence of alkaloids, flavonoids, tannins, sterols, saponins, cyanogenic glycosides and cumarins as major constituents of the studied extracts. The results of this study indicated that aqueous and methanolic extracts of *C. decidua* stems could afford a significant protection against CCl_4-induced hepatotoxicity in rats. [41]

Anti-Inflammatory Activity

In the cyclooxygenase assays, ethyl acetate twig extracts of *Capparis decidua*, showed inhibitory effect against prostaglandin synthesis by COX-2 ranging from 58 to 97% and weak (< 50%) or no activity against COX-1 induced prostaglandin production. The in vitro anti-inflammatory activity observed in this study support the utilization of the plants in traditional medicine as crude anti-inflammatory agents. [42]

Insecticidal and oviposition inhibitory activities

Extracts of *Capparis decidua* stems and flowers showed insecticidal and oviposition inhibitory activities against *Bruchus chinensis*. The LC50 values of these extracts were found to increase with the increase in the polarity of the extract at different exposure periods. For instance, after 96 h, the LC50 values were found to be 3.619, 7.319, and 10.151 µg for CD1, CD2, and CD3, respectively. Extract CD7 was effective only at higher doses. The toxicity was found to be dose and time dependent. The females laid lesser number of eggs, when exposed to sublethal doses of different extracts and pure compounds, as compared to control. The maximum oviposition deterrence index was found for extract CD1 followed in decreasing order by CD2, CD3, and CD7. From extract CD1, two compounds were isolated and characterized as triacontanol (C1) and 2-carboxy-1, 1-dimethylpyrrolidine (C2). When

the females were exposed to sublethal doses of these compounds, they laid lesser number of eggs as compared to the control. C2 was found to have a slightly greater oviposition inhibition effect than C1. From fraction CD7, one novel compound labelled as CDF1 has been isolated and identified as 6-(1-hydroxy-non-3-enyl) tetrahydropyran-2-one. CDF1 has also shown insecticidal and oviposition inhibitory activities against *B. chinensis* at low concentrations. [43]

Hypotensive activity and spasmolytic activity [42]

In anaesthetized rats, an ethanolic extract so obtained of *Capparis decidua* caused a fall in systolic, diastolic and mean blood pressure in a dose dependent manner. The administration of 1, 3, 10 mg/kg doses of the extract manifested decreases of 20%, 30% and 47% in mean arterial blood pressure respectively. It was then observed that hypotensive effect was short as far as onset of duration ultimately returning to normal within 2 min.

The effect on guinea pig atria:

Capparis deciduas ethanolic extract at 0.1 – 1 mg/ml concentration range caused a decrease in force and rate of atria contractions in a concentration dependent manner.

The effect on rabbit aorta:

The extract at the concentration of 0.5 mg/ml indicated a slight inhibition of rabbit aorta precontracted with norepinephrine of K^+. While at next higher dose at 1mg/ml produced further relaxation of aorta. The relaxant effect of the extract was found reversible as the contractile effect to NE or K^+ restored after washout and repeated management of spasmogens.

The effect on guinea pig ileum and rat uterus:

In spontaneous contracting rat uterus, the extract up to 0.5mg/ml was found devoid of any bioactive actions. Whereas it reduced amplitude and frequency of contractions at a concentration of 1mg/ml of the extract. The concentration of 3mg/ml of the extract completely abolished spontaneous movements of the uterus. This relaxant action of the extract was observed as reversible and the tissue regained its spontaneous activity 5 – 10 min after washout.

Therefore, it is a better option to use isolated tissue preparations for characterizing the mechanism of action. When tested on isolated rabbit aorta, the extract exerted a concentration-dependent inhibition of norepinephrine or K – induced contractions to a similar extent, consequently leading to understand its non specific inhibitory effect on smooth muscles of blood vessels. This effect of the extract was found valid when it was tested on guinea pig ileum where it inhibited ileum contraction induced by acetylcholine, histamine or serotonin at the same concentration. The non specific or general spasmolytic action of the extract was further displayed by its ability to abolish spontaneous contractions of rat uterus. On the whole it can be logically deduced that the alcoholic extract of *Capparis deciduas* produces non specific relaxant effects on cardiac and smooth muscle tissue and that this action is probably responsible for its hypotensive and bradycardiac effects observed in anaesthetized rats. Consequently it can be inferred that alcoholic extract has both the hypotensive and spasmolytic activities.

CONCLUSION

Plants have been used in medicine throughout the world and still continue to occupy an

important place in traditional as well as modern system of medicine. Modern synthetic medicines are effective in curing diseases but also cause a number of side effects leading to serious health problems. It is quite obvious that *Capparis decidua* is known to possess antidiabetic, sedative, anticonvulsant, hypolipidemic, hypocholesterlemic, hepatoprotective and anthelmintic activities. It is known as a rich source of alkaloids, phenols, sterols or glycosides which might be medicinally important and/or nutritionally valuable. It contains n-pentacosane, n-triacontane, n-triacontanol, 2-carboxy-1, 1-dimethylpyrrolodine, 6-(1-hydroxy-non-3-enyl) tetrahydropyran-2-one, ß-sitosterol, ß-carotene, ascorbic acid, proteins, total carbohydrates, calcium, potassium, phosphorus, zinc, iron, manganese, glucosinolates. The roots contain the indole bases capparin, capparilin and capparinin. The present review summarizes some important pharmacological studies on *Capparis decidua* and phytochemical investigations and isolated principles from them, which can be investigated further to achieve lead molecules in the search of novel herbal drugs.

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