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A review on Chemical and Medicobiological Applications of Capparidaceae Family

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ABSTRACT
Medicinal plants are the nature's gift to human being to make disease free healthy life. It plays a vital role to preserve our health. Capparidaceae family comprises various important medicinal properties distributed in tropical and subtropical India, whose medicinal usage has been reported in the traditional systems of medicine such as Ayurvedha, Siddha and Unani. Plants belongs to the Capparidaceae family has been described as a rasayana herb and has been used extensively as an adaptogen to increase the non specific resistance of antioxidant and immunostimulant effects. The *C. sepiaria, C. spinosa, C. tomentosa* and *C. zeylanica* etc., belongs to this family is reported as used in traditional medicine. The diverse phytoconstituents and various medicobiological uses of the plants belonging to this family were reviewed here.
KEYWORDS: Caper bush, Capparidaceae, Chemistry, Pharmacology, Review

INTRODUCTION

Plants and their products are being used as a source of medicine since long. According to World Health Organization (WHO) more than 80% of the world's population, mostly in poor and less developed countries depend on traditional plant based medicines for their primary healthcare needs (1). India is richly endowed with a wide variety of plants having medicinal value. These plants are widely used by all sections of the society either directly as folk remedies or indirectly as pharmaceutical preparation of modern medicine.

CAPPARIDACEAE FAMILY

They are natives of warm regions, except North America. The genus includes more than 200 species (2). Some of the species derived as *Capparis aphylla, C. brevispina, C. cleghornii, C. decidua, C. divaricata, C. floribunda, C. fusifera, C. grandiflora, C. grandis, C. heyneana, C. humitis, C. mooni, C. olacifolia, C. ovate, C. parviflora, C. rotundifolia, C. roxburghii, C. sepiaria, C. spinosa, C. stylosa, C. tenera, C. tomentosa, C. zeylanica* Linn. etc., (3) and other species of *Capparis* are shrubby members of the family of Capparidaceae. It has vernacular names in most of the regional languages.

Taxonomical classification of Capparidaceae family *(4)*

Genus	*Capparis*
Kingdom	*Plantae*
Phylum	*Spermatophyta*
Sub-Phylum	*Angiospermae*
Class	*Mangoliopsida*
Order	Capparales
Family	Capparaceae (or) Capparidaceae
Species	*aphylla, decidua, divaricata, fusifera, grandis, grandiflora, humitis, humilis, ovate, roxburghii, spinosa, ternera, tomentosa, tomentella, zeylanica* etc.,

Local Names and Classical names of some available species *(4)*

Places/Species	***Capparis aphylla***	***Capparis decidua***	***Capparis heyneana***	***Capparis grandis***
Arabic	Hanbag, March, Sodab, Tundub	-	-	-
Bihar	Kari	-	-	-
Baluchistan	-	Kaler, karar	-	-
Bombay	Kari	-	-	-
Deccan	Karyal	-	-	-
Gujarat	Ker, Kera	-	-	-

Hindi	Karel, Karu, Kurrel, Lete, Satari	Kurrel, Karer (4) Karil, Ker (00)	-	-
Kannada	-	Nispatige (4)	-	-
Malta	-	Caper plant, capparo, cappara	-	-
Malayalam	-	Karimulli, Karimullu (4)	-	-
Marathi	Karil, Ker, Nepti, Nevati	-	-	Kauntel
Northern Baluchistan	-	Khawarg	-	-
Ormara	-	Kirap, krap	-	-
Persian	Sodab	Kabar, Kebir, Kurak	-	-
Portuguese		Alcaparra	-	-
Punjab	Delha, Kaira, Karil, Karir, karis, kerin, Kerin, Kirra, Pinju, tenti	Bander, Barar, Barari, Bassar, Bauri, Ber, Kabarra, Kabra, Kakri, Kanda, Kaur, Keri, Kiari, Taker	-	-
Russian	-	Kapersovyi kust,	-	-
Tamil	Kulaladondai, Sengam, Sirakkali	Kariramu, Engudanta (4)	-	-
Telugu	Kariramu, Enugadanta, Mumudatu	Kakilakshamu, Kariramu, Enugudanta	-	-
Tibet	-	Kabra	-	-
Turkish	-	Kabarish	-	-
Sanskrit	-	Karira, Gudhapatra	-	-
Sind	-	Kalvai	-	-
Spanish	-	Alcaparra, Alcaparro	-	-
Syria	-	Kabar	-	-
Urdu	-	Kabar	-	-

TRADITIONAL USES

More than 80% of the world's population still depends upon traditional medicines for various skin diseases (5). In the classical definition most probably plants are having the traditional uses in this world. From the ancient age plants are widely used for various diseases. But no proof is available in modern medicinal world. They are orally used the plant extract or in different forms such as choorna, rasayana, legiyum, kasayam etc., The Capparidaceae family also used for various diseases.

Capparis decidua

C. decidua is used for food preparations such as pickle and also treatment for cough, asthma, inflammation and fever. The Capparidaceae family shows the antibacterial activity against the *staphylococcus aureus, Streptococcus pyogenes, E-coli, Pseudomonas aeruginosa*. (6)

Capparis sepiaria

C. sepiaria dried leaves are baked and ground to a fine powder. Ash of cotton cloth is mixed with it and applied on aphthae affected area. The cure of aphthae might be due to the supplementation of vitamin-B complex (or) to quick healing and there by relieving of pain (7).

Capparis spinosa

Anti-diabetic, anti-fungal, anti-leishmania, expectorant, anti-spasmodic, analgesic, anti-inflammatory activity was observed and reported upon treatment with *C. spinosa* (8).

Capparis tomentosa

C. tomentosa is traditionally used for snake bites, leprosy, wound healing. *C. tomentosa* showed the activity at 4 mg/ml against *Staphylococcus aureus* and 1 mg/ml against *Streptococcus pyogenes* as an antimicrobial agent. (9)

Phytochemistry

The Capparidaceae family contains so many active constituents such as alcohol, alkaloids, amino acids, amyrin, anthocyanins, betulin, carbohydrates, flavonoids, glycosides, saponins, steroids, sterol and terpenes were reported in various researches. The various phytoconstituents are separated from the Capparidaceae family reviewed here.

Capparis humilis

C. humilis has many active constituents such as proline betaine (Figure 1), N-methyl proline (Figure 2), 3-carbomethoxy-N-methoxypyridinium (trigonelline) (Figure 3), quaternary ammonium compounds (Figure 4), glucosinolates (Figure 5), alkaloids, polyprenals (Figure 6), saccharose (Figure 7) and kaempferol-3,7-dirrhamnoside were reported by using NMR data was reported (10).

Capparis ovata

C. ovata has many active constituents such as crude oil, crude protein, carotenoid and dimethyl sulphate (DMS) (Figure 8) was reported (11).

Capparis sikkimensis

C. sikkimensis has many active constituents such as 3(4H)-one-6-methoxy-2-methyl-4-carbaldehyde was reported (12).

Capparis spinosa

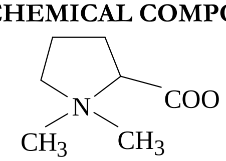
C. spinosa has many active constituents such as flavonoids such kaempferal (Figure 9) and quercetin (Figure 10). Nature fruits of *C. spinosa* have glucose as 1-H Indole-3-acetonitrile (Figure

11), capprilosides A (Figure 12). The aerial parts of the *C. spinosa* has capparilosides B (Figure 13), 6(S)-hydroxy-3-oxo-α-ionol-glucoside (Figure 14) is carchoionoside-C, 3-O-(6'''-α-L. rhamnosyl-6''-β-D-glucosyl)-β-D-glucoside was reported. ^{13}C-NMR spectrum confirmed that the compound is a triglycoside of quercetin is quercetin 3-O-gentiobioside (Figure 15); they are the constituents of the volatile oils of aerial parts of *C. spinosa*. The leaf oil composes of N-alkanes, phenyl propanoid (Figure 16), thymol (24.4%) (Figure 17), isopropyl isothiocyanates (11%) (Figure 18), 2-hexenal (13.2%) (Figure 19), butyl isothiocyanate (6.3%) (Figure 20), chlorophyll (Figure 21), proline (amino acid) (Figure 22) and starch (Figure 23) contents were reported. (13).

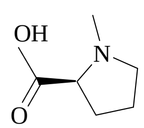
The leaves of *C. spinosa* have kaempferal, quercetin, isorhamnetin and their O-methyl derivative (Figure 24), thomnocitirin, rhamnetin (Figure 25) and rhamnozin (14). Flavonoids and glycosides were isolated and identified as kaempferal-7-rhamnoside (Figure 26), kaempferol-3-rutinoside (Figure 27), kaempferol-3-glucoside-7-rhamnoside, quercetin-3-rutinoside (Figure 28) and isorhamnetin-3-7-dirhamnoside (15), new spermidine alkaloids such as capparispine (Figure 29), capparispine-26-O-β-d-glucoside (Figure 30) and cabadicine-26-O-β-d-glucoside hydrochloride was reported from the roots of *C. spinosa*. Their structures were established on the basis of spectroscopic analysis, including 1D and 2D NMR experiments (16). The aldehydes (22.2%) and esters (21%) are the most abundant chemical classes, sesquiterpenes and ten monoterpenes were identified for the first time; among sulphur compounds (8.42%), methyl-isothiocyanate (Figure 31) was the major one, followed by benzyl-isothiocyanate (Figure 32) was reported. The application of this solvent free extraction technique combined with the GC-MS analysis, showed its potential as a simple routine method for analyzing food flavor (17). Two new (6S)-hydroxy-3-oxo-α-ionol (Figure 14) glucosides together with corchoionoside C ((6S, 9S)-roseoside) and a prenyl glucoside were isolated from mature fruits of *C. spinosa* was reported. The structures were established on the basis of spectroscopic, chiroptic and chemical evidence. In addition, the ^{13}C-resonance of C-9 was found to be of particular diagnostic value in assigning the absolute configuration at that center in ionol glycosides. The α-ionol (Figure 33) derivatives are metabolites of (+)-(S)-abscisic acid (Figure 34) was reported (18). The methanolic extract of the aerial parts of *C. spinosa* yielded the new flavonoid and quercetin scuh as 3-O-(6'''-α-L-rhamnosyl-6''-O-β-D-glucosyl)-β-D-glucoside, rutin (Figure 35), quercetin-3-O-glucoside (Figure 36) and quercetin-3-O-glucoside-7-O-rhamnoside were reported (19).

The *p*-methoxy benzoic acid (Figure 37) isolated from the methanolic soluble fraction of the aqueous extract of *C. spinosa* was reported (20). Two new glucose containing 1H-indole-3-acetonitrile (Figure 38) compounds, capparilosides A (Figure 12) and B (Figure 13) were isolated from mature fruits of *C. spinosa*. On the basis of spectral and chemical evidence, they were shown to be 1H-Indole-3-acetonitrile-4-O-β-(6'-O-β-glucopyranosyl)-glucopyranoside was reported (21). The leaf oil was composed of isothiocyanates (Figure 39), n-alkanes, terpenoids, a phenyl propanoid, an aldehyde and a fatty acid. The main components of this oil were thymol (Figure 17) (36.4%). Isopropyl isothiocyanate (Figure 18) (11%), 2-hexenol (Figure 19) (10.2%) and butyl isothiocyanate (Figure 20) (6.3%) was reported. The volatile oils of the ripe fruit and the root were composed mainly of the methyl isothiocyanate (Figure 31), isopropyl isothiocyanate (Figure 18) and sec-butyl isothiocyanates (Figure 41) was reported (22). Glucoiberin (Figure 42), glucocapparin (Figure 43), sinigrin (Figure 44), glucocleomin (Figure 45), glucocapangulin, glucobrassicin (Figure 46) and neoglucobrassicin (Figure 47) was isolated (16).

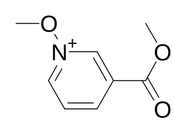
CHEMICAL COMPOUNDS



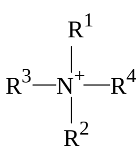
Proline betaine (1)



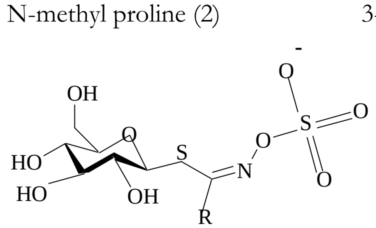
N-methyl proline (2)



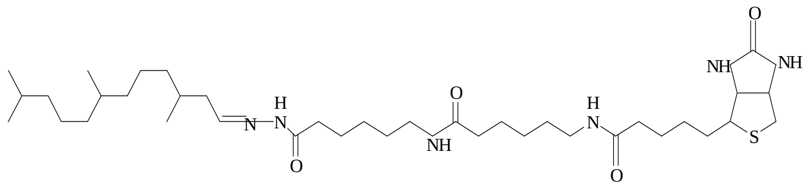
3-Carbomethoxy-N-methoxypyridinium (3)



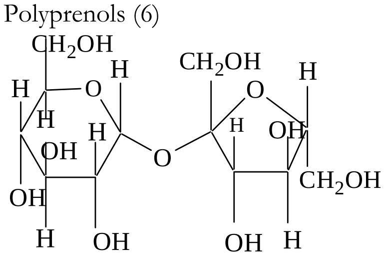
Quaternary ammonium compounds (4)



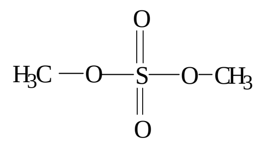
Glucosinolates (5)



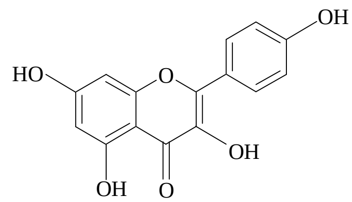
Polyprenols (6)



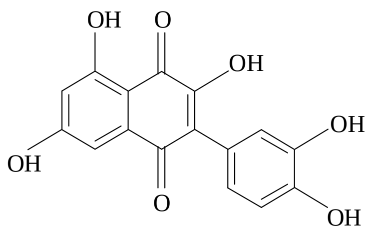
Saccharose (7)



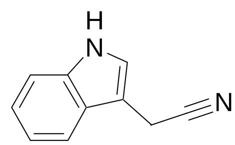
Dimethyl Sulphate (8)



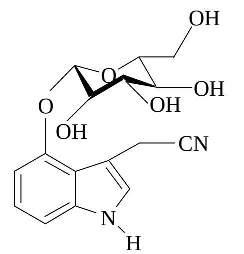
Kaempferol (9)



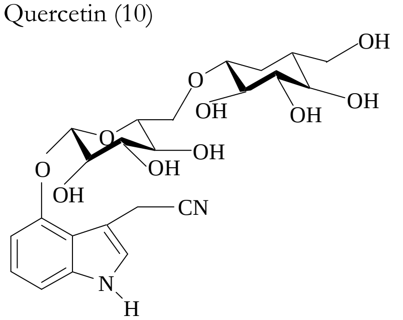
Quercetin (10)



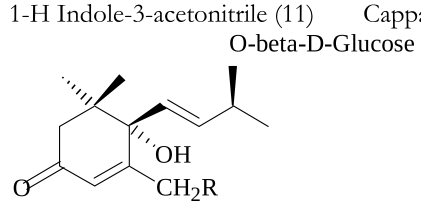
1-H Indole-3-acetonitrile (11)



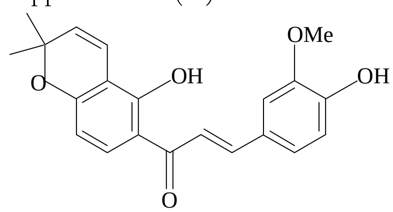
Cappariloside A (12)



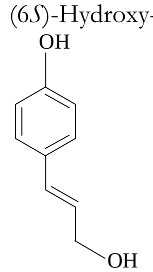
Cappariloside B (13)



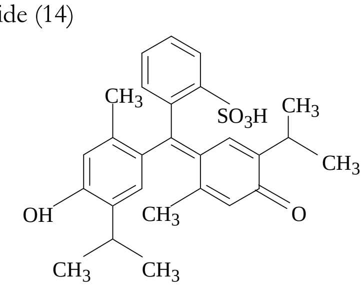
(6*S*)-Hydroxy-3-oxo-α-ionol-Glucoside (14)



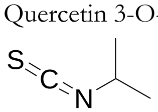
Quercetin 3-O-gentiobioside (15)



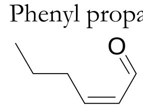
Phenyl propanoid (16)



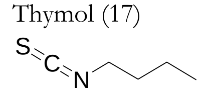
Thymol (17)



Isopropyl isothiocyanate (18)



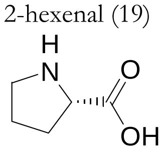
2-hexenal (19)



butyl isothiocyanate (20)

C_{55}— H_{72} —MgN_4O_5

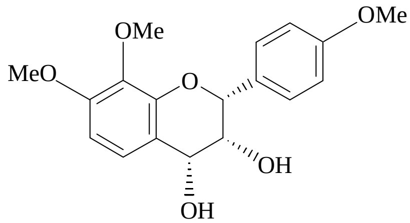
Chlorophyll-A (21)



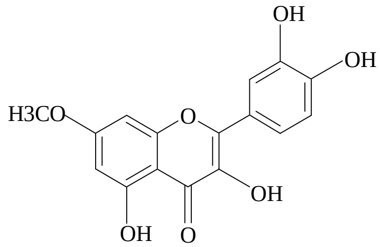
Proline (22)

$C_{12}H_{22}O_{11}$

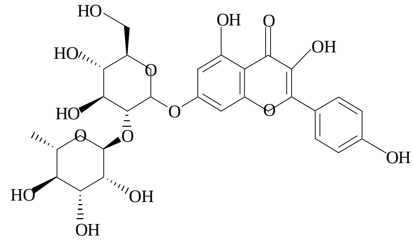
Starch (23)



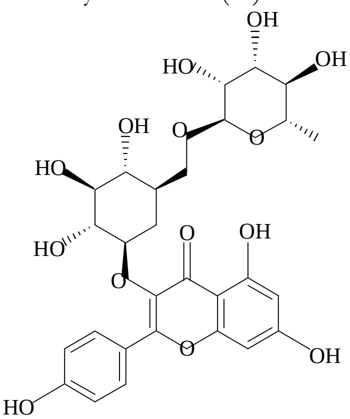
O-Methyl Derivative (24)



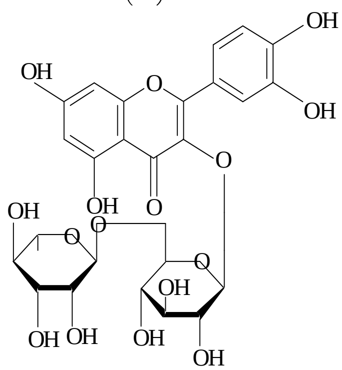
Rhamnetin (25)



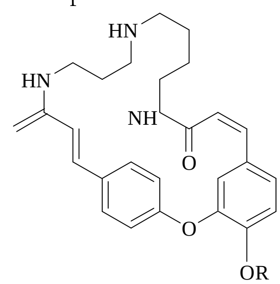
Kaempferol-7-rhamnoside (26)



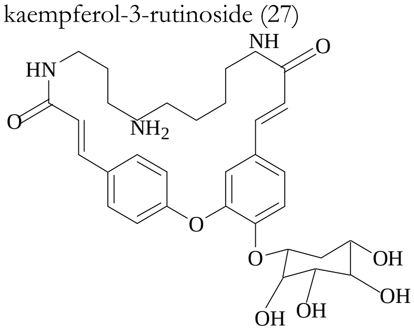
kaempferol-3-rutinoside (27)



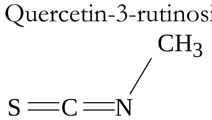
Quercetin-3-rutinoside (28)



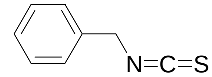
Capparispine (29)



Capparispine-26-O-β-d-glucoside (30)

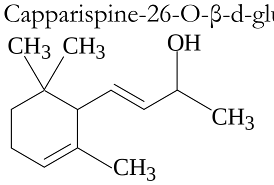


Methyl isothiocyanate (31)

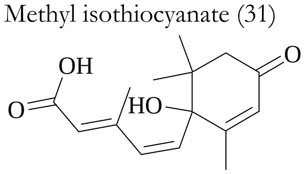


Benzyl-isothiocyanate (32)

$C_{27}H_{30}O_{16}$

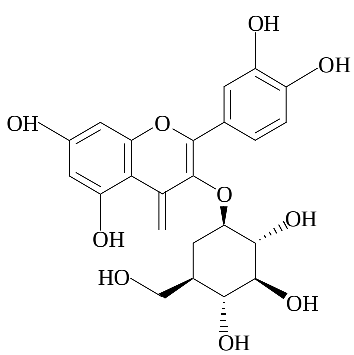


α-Ionol (33)

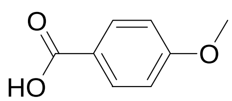


(+)-(S)-Abscisic acid (34)

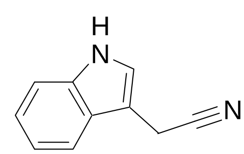
Rutin (35)



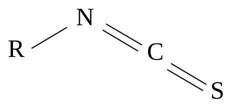
Quercetin-3-O-glucoside (36)



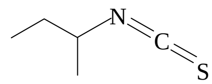
p-methoxy benzoic acid (37)



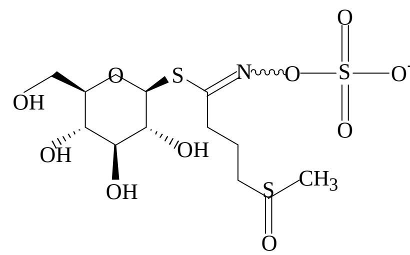
1H-indole-3-acetonitrile (38)



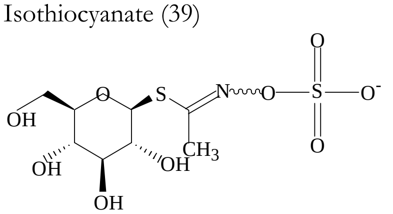
Isothiocyanate (39)



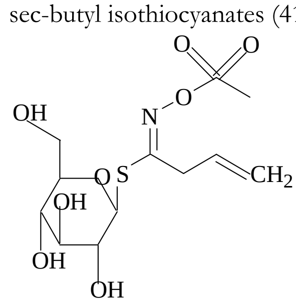
sec-butyl isothiocyanates (41)



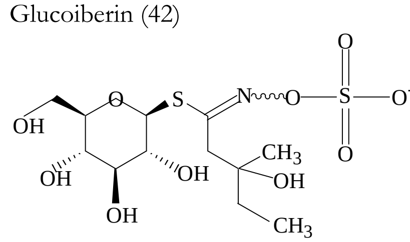
Glucoiberin (42)



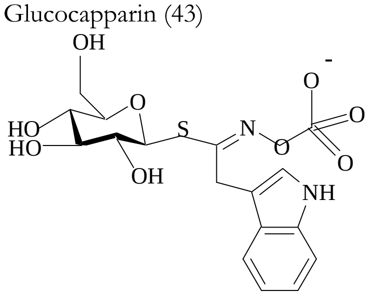
Glucocapparin (43)



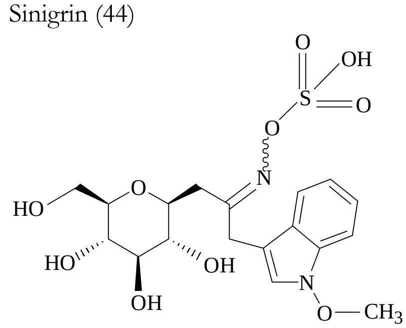
Sinigrin (44)



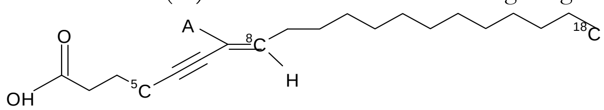
Glucocleomin (45)



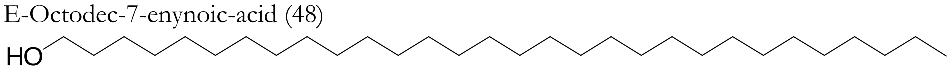
Glucobrassicin (46)



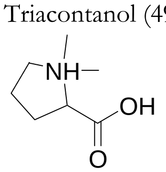
Neoglucograssicin (47)



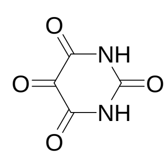
E-Octodec-7-enynoic-acid (48)



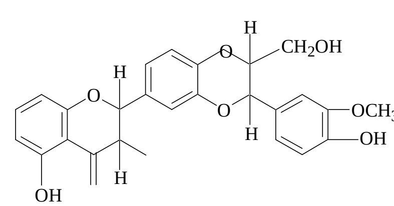
Triacontanol (49)



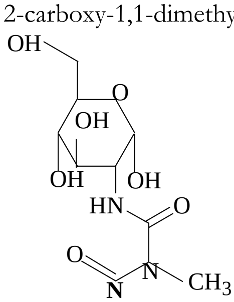
2-carboxy-1,1-dimethylpyrrolidine (50)



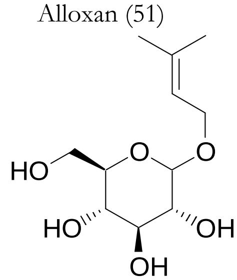
Alloxan (51)



Silymarin (52)



Streptozotocin (53)



3-methyl-2-butenyl-glucoside (54)

Wild plants play an important role in the diet of inhabitants in different parts of the world. These plants tend to be drought-resistant and are gathered both in times of abundance and times of need. Used in everyday cooking, these foods may be an important source of nutrients. The purpose of this study was to assess the mineral content of some edible wild leaves. Plants species(*Beta lomatogena* Fisch. Et Mey., *C. spinosa* L., *Chenopodium album* L., *Eryngium billardieri* Delar., *Falcaria vulgaris* bernh., *Ferula communis* L., *Gundelia tournefortii* L., *Lathyrus tuberosus* L., *Nalva neglecta* Wallr., *Methan arvensis* L., *Nepeta concolor* Bioss and Heldr., *Ocimum basilicum L*., *Papaver dubium* L., *Rheum ribes* L., *Rubus spp*., *Rumex crispus* L., *Rumex scutatus* L., *Scorzonera cana* (CA.Mey.) Hoffm, *Scorzornera latifolia* (Fish. and Mey.) DC, *Sorzonera* sp., *Sempervivum armenum* Bioss et., Huet, *Tragopogon spp*., *Urtica urens* L., were collected in late winter and spring and their mineral content. Moisture content, ash content and pH value were found reasonable as compared to some vegetables. However, protein content, nitrogen, potassium, calcium and magnesium content of wild plants were higher, while phosphorous, sulphur and sodium content were lower and iron, manganese, zinc and copper content were equal or higher than those of some commonly used vegetables such as spinach, pepper, lettuce, cabbage species (23).

Capparis zeylanica

C. zeylanica has reported fatty acids such as E-octodec-7-enynoic acid (Figure 48) isolated from chloroform extract of the roots of *C. zeylanica*. The above compound established by 1D and 2D NMR spectroscopy. Preliminary phytochemical screening of the extracts showed the presence of alkaloids, flavonoids, saponins, glycosides, terpenoids, tannins, proteins and carbohydrates was reported (24).

Pharmacological activity of capparidaceae family

Capparis decidua

Extracts of *C. decidua* stems and flowers showed insecticidal and oviposition inhibitory activities against *Bruchus chinensis*. The LC 50 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 LC 50 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 sub lethal doses of different extracts and pure compounds, as compared to control. The maximum oviposition deterrence index was found for extract CD1 followed in decreased order by CD2, CD3 and CD7. From extract CD1, two compounds were isolated and characterized as triacontanol (Figure 49) (C1) and 2-carboxy-1,1-dimethylpyrrolidine (Figure 50) (C2). When the females were exposed to sub lethal 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 labeled as CDF1 has been isolated and identified as 6-(1-hyroxy-non-3-enyl) tetrahydropyran-2-one. CDF1 has also shown insecticidal and oviposition inhibitory activities against Bruchus chinensis at low concentrations (25).

C. decidua is used for Diabetes mellitus. The elevated levels of blood glucose in diabetes produce oxygen free radicals which cause membrane damage due to peroxidation of membrane lipids and protein glycation. As the diabetogenic action of alloxan (Figure 51) is preventable by superoxide dismutase (SOD), Catalase (CAT), and other hydroxyl radical scavengers such as ethanol, dimethyl urea (26).

The fruit alcohol extracts of the plant *C. decidua* (Frosk. Edgew) was investigated for its anti-atherosclerotic activity. Hyperlipidemia was induced by atherodiet and cholesterol feeding animals. Rabbits were fed with *C. 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, phospholipid and atherogenic index, but found to increase the HDL to total cholesterol ratio as compared with hyper lipidemic 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 anti-atherosclerotic effects was reported (27).

Capparis moonii

The effect of the ethanol extract of *C. moonii* fruits was studied in carbon tetrachloride induced hepatotoxicity in rats. The hepatotoxicity was induced in rats with the administration of 1:1 (v/v) mixture of tetrachloride olive oil at the dose of 1ml/kg subcutaneously on day 7. The ethanolic extract of *C. moonii* (200 mg/kg) and the standard drug Silymarin (25 mg/kg) were given orally from day 1 to day 9. The results were comparable with the standard drug Silymarin (Figure 52). The extract of *C. moonii* produced significant ($p<0.001$) lowering of the elevated serum glutamic oxalo acetic transaminase (SGOT), serum glutamic pyruvate transaminase (SGPT), alkaline phosphatase (ALP) and a rise of depleted total protein when compared with the toxic control was reported (19).

Capparis spinosa

C. spinosa besides hyperglycemia the levels of plasma lipids are usually raised in diabetes mellitus causing a risk factor for coronary heart disease. Induction of diabetes-streptozotocin (Figure 53) was dissolved in 0.1 mM fresh cold citrate buffer at pH 4.5. 20 mg/kg drug is once daily for two weeks significantly decreasing the cholesterol. *C. spinosa* can also act by decreasing its cholesterol biosynthesis especially by decreasing the 3-OH-3-CH_3-glutpryl co-enzyme-A-reductase was reported (17).

Anti-hepatotoxic activity against carbon tetrachloride and paracetamol induced hepatotoxicity. *C. spinosa* forms of the constituent of polyherbal formulations to treat liver ailments. Treated the rats with *p*-methoxy benzoic acid (Figure 37) (30 mg/kg) resulted in 89.68%, 105%, 86.30%, 62.55% reduction in SGPT, SGOT, ALP and bilirubin levels as compared to chloroform to carbon tetrachloride and paracetamal groups was reported (28).

Investigation of *C. spinosa* of Jordanian origin lead to isolation of two new compounds sitosteryl glucoside-6'-octadecanoate and 3-methyl-2-butenyl-glucoside (Figure 54) linked scan MS measurements were used to propose a mass fragmentation pattern for the alkaloid cadabicine isolated here for the second time from nature was reported (44). They are used in flavoring agent, cosmetic and food industry. They are the efficacy of the CM-52 on liver cirrhotic patients a randomized couple blind placebo-controlled approach.

Each CM-52 tablet contains extract of

Ingredients	**Weight of mg content in tablet**
Capparis spinosa	65 mg
Cichorium intybus	65 mg
Solonum rigrum	25 mg
Cassia accidentallis	16 mg
Terminallia arguna	32 mg
Achillea millefolium	16 mg
Tamarix gallica	16 mg
Mandur bhasma	33 mg

LIV-52 has liver protective effect against; alcohol induced hepatic damage and hepatitis-B virus infection without any side effect. This decrease in serum ALT and AST levels in CM-52 treated patients in part may be due to the protective effect of this drug on liver cells following restoration of liver cell membrane and permeability was reported (29).

Capparis zeylanica

The Capparidaceae family is having the enlarged pharmacological activity. *C. zeylanica* is having the immunomodulatory activity of ethanolic and water extract was reported. The **e**thanol and water extracts of *C. zeylanica* leaves showed the dose dependent and significant ($P<0.05$) increases in pain threshold in tail-immersion test. Moreover, both the extracts (100-200 mg/kg) exhibited a dose dependent inhibition of writhing and also showed a significant ($P<0.001$) inhibition of both phases of the formalin pain test. The water extract (200 mg/kg) significantly ($P<0.01$) reversed yeast induced fever was reported. (30)

The present study was undertaken to explore the immunomodulatory activity of ethanolic and water extracts of *C. zeylanica* Linn. leaves on neutrophil adhesion test, humoral response to sheep red blood cells, delayed-type hypersensitivity, phagocytic activity and cyclophosphamide-induced myelosuppression. Pre-treatment of water extract (300 mg/kg, orally) of *C. zeylanica* evoked a significant increase in neutrophil adhesion to nylon fibers. The augmentation of humoral immune response to sheep red blood cells by ethanolic and water extracts (150-300 mg/kg) is evidenced by increase in antibody titers in mice. A dose related increased in both primary and secondary antibody titer was observed. Oral administration of ethanolic and water extracts of *C. zeylanica* leaves, at doses of 150 and 300 mg/kg in mice, dose dependently potentiated the delayed-type hypersensitivity reaction induced by sheep red blood cells. Immunomodulatory activity was also assessed by serological and hematological tests. *C. zeylanica* extracts prevented myelosuppression in mice treated with cyclophosphamide drug was reported (23).

Cyclophosphamide 30 mg/kg caused significant reduction in the hemoglobin, RBC, WBC and platelet count in rats. *C. zeylanica* evoked a significant increase in percent neutrophils. This may help increasing immunity of body against microbial infections. They are combined treatment of cyclophosphamide, ethanol and water extract of *C. zeylanica* restoration of bone marrow activity was reported (31).

Capparis zeylanica

C. zeylanica constitutes flavonoids have been known to possess anti-oxidant, anti-neoplastic, anti-ulcer, anti-inflammatory and anti-microbial activities. Various species of genus of *Capparis* are useful in cough, asthma, fever, cholera, inflammation, poultice in gout and rheumatism (32). Anti-allergic, anti-inflammatory, anti-oxidant, gout, astringent, diabetic (kidney disinfection) are found in fruits and roots of the *C. zeylanica* was reported (33).

OTHER PROPERTIES BELONGS TO THE CAPPARIDACEAE FAMILY

Capparis atamisquea

They analyzed the occurrence and number of viable seeds in droppings of the lizard Teius teyou and the influence of seed ingestion on the germination capacity of *Ziziphus mistol* seeds in dry Chaco forests of northwestern Argentina. Seeds were found in 59% of 60% droppings collected during the wet season, belonging to *Ziziphus mistol* (*Rhamnaceae*), *Celtis pallid* (*Ulmaceae*) and *C. atamisquea*. Seeds of *Z. mistal* accounted for 98% of all seeds found in droppings. Seeds found in the droppings were viable, suggesting that lizards are legitimate seed dispersers. Passage through the lizard's digestive tract did not enhance germination of *Z. mistol* seeds. Lizards appear to be efficient dispersers of *Z. mistol* given that they usually defecate in open areas, a favorable condition for the establishment of *Z. mistol* (34).

Capparis flexuosa

Screening of the dichloromethane partition of the ethanol extract of over 100 puerto Rican plants has been achieved resulting in 29 extracts active in the brine shrimp lethality assay ($LC\ 50 < 1000$ μg/ml). These were subjected to further biotesting in two cytotoxicity tests: against HeLa and CHO cells. The plants active in both cytotoxicity assays were: *Annona glabra* L., *Simarouba tulae* Urban, *Tithonia diversifolia* (Hemsl.) A. Gray, *Dendropanax arboreus* (L.) Decne. & Planch., *Piper jacquemontianum* Kunth, *Annona Montana* Mafad and *Polygala hecatantha* urban. The plants selectively active in the HeLa assay were *Cassine xylocarpa* (vent.) and *C. flexuosa* (L.) in the CHO assay in *Amyris elemifera* was reported (35).

Capparis spinosa

C. spinosa L. divided into several intra specific taxa showing plesiomorphic features and disjunctive distributions in the world. Leaf surface and pollen features were investigated in the whole group by SEM and light microscope observations.

The section is characterized by simple hairs, a reticulate to undulate cuticle, anomocytic stomata surrounded by a peristomal rim and trizonocolporate, prolate pollen grains. The characteristics of the indumentums appear constant, while the studied taxa are fairly differentiated with respect to cuticular patterns and dimensions of the stomata and show slight differences in pollen size and exine surface. This micromorphological evidence, coupled with other phenotypic features, supports the placement of this section at the base of the genus *Capparis* in the paleotropical area. Considering the striking geographic disjunction and symplesiomorphies of the group, its biogeographical and systematic aspects are reported (36).

Leishmania major promsatigotes are agglutinated and die in their vector, phlebotomus papatasi, after the sandflies feed on some plants that are found in their natural habitat. In *in-vitro* assays, extracts of *Ricinus communis* (Euphorbiaceae), *C. spinosa* (Capparidaceae), *Prosopis farcta* (Mimosaceae) and *Tamarix milotica* (Tamaricaceae) agglutinated and killed the parasites. This activity could be inhibited by specific carbohydrates, indicating that it was the result of various lectins in the extracts. An extract of *Solanum luteum* (Solanaceae) lysed the promastigotes under similar conditions and this cytotoxicity was not abated by the sugar tests. High mortality of promastigotes occurred in infected flies after they ingested an extract of *R. communis*, even when the extract fed to the flies has been pre-mixed with glucose, a carbohydrate that inhibited the agglutination caused by such an extract in vitro. The results indicate that the lectins and toxins found in the vegetation in L. major foci may decrease the transmission of the parasite (37).

Seed clumps of *C. spinosa* L. together with shoots, leaves and fruits of *Cannabis sativa* L. were unearthed in the *Yanghai Tombes*, Turpan District in Xin jiang, China. This is the first time that plant remains of *C. spinosa* have been discovered in china and the eastern part of central Asia. Based on the joint occurrence of *C. spinosa* and cannabis sativa and the pharmacological value of the seeds of *C. spinosa*, it is deduced that caper was utilized for the medicinal purposes (38).

Caper family

Caper plays an important role in human diet, since 100 of caper fruits contain 67 mg calcium 65 mg phosphor, 9 mg iron and 24.5 g protein. Size, shape and physical dimensions of caper fruits are important in sizing sorting and other separation process. Bulk and true densities of caper seeds are necessary to design the equipment for processing and staring such dryers and binds. Porosity of fruits is an important for packing. The moisture content of caper fruits affected physical properties. All physical properties except true density and porosity increased with increased moisture content. True density and porosity decreased with moisture content was reported (39).

Caper is an important plant because of its high adaptability to marginal agriculture fields that are not suitable for agricultural crops. Different parts of caper such as roots, fruits flowers and buds can be used to increase the inhabitant's income. The goal of this research is to determine germination rate and percentage of caper according to different duration of cold stratification (10, 20, 30, 40, 50 and 60 Days) treatments. Cold stratification procedures under greenhouse condition were applied for eliminating seed dormancy to find the most suitable germination conditions because the presence of seed dormancy causes difficulties in seedling production. The seed germination started and stopped 21 and 57 days after sowing, respectively. While the highest germination percentage (46.6%) was obtained in seeds that were cold stratified for 60 days, the lowest germination percentage (36.7%) was determined in control seeds (38).

Most studies of spatial memory in primates focus on species that inhabit large home ranges and have dispersed patchy resources. Researchers assume that primates use memory to minimize distances traveled between resources. They investigated the used of spatial memory in a group of six white faced sakis (*Pithecia pithecia*) on 12.8 ha-round island, Guri lake, Venezuela during a period of fruit abundance. The sakis movements were analyzed with logistic regressions, a predictive computer model that simulates movements. We considered all the resources available to the sakis and compared observed distances to predicted distances from a computer model for foragers who know nothing about the location of resources. Surprisingly, the observed distances were four times greater than the predicted distances, suggesting that the sakis passed by a majority of the available fruit trees without feeding. The odds of visiting a food tree, however, were significantly increased if the tree had been visited in the previous 3 days and had more than 100 fruit. The sakis preferred resources were highly productive fruit trees, *Capparis* trees, and trees with water holes. They traveled efficiently to these sites. The sakis choice of feeding sites indicate that they combined knowledge acquired by repeatedly traveling through their home range with 'what' and 'where' information gained from individual visits to resources. Although the 'sakis' foraging choices increased the distance they travelled overall, choosing more valued sites allowed the group to minimize intra group feeding competition, maintain inter group dominance over important resources and monitor the state of resources throughout their home range. The sakis foraging decisions appear to have used spatial memory, elements of episodic like memory and social and nutritional considerations was reported (40).

A collection comprising 14 isolates of *Pediococcus pentosaceus* and one *Pediococcus acidilactici* from the fermentation of caper fruits was studied. All isolates showed very similar fermentation profiles and produced a limited number of exoenzymes. All isolates carried large plasmids of diverse sizes between 20 and 55kb, while some also contained smaller plasmids between 10 and 16 kb. Cluster analysis of plasmid profiles revealed four main groups with various degrees of similarities. All amino acid decarboxylation tests were negative, suggesting that *Pediococci* are not involved in generation of biogenic amines. None of the isolates showed hemolytic activity. Antimicrobial resistance tests revealed that all isolates were sensitive to 11 different antimicrobials while being resistant to ciprofloxacin (MIC > or =2 mg/liter) and intrinsically resistant to vancomycin (MIC > or =16 mg/liter) and teicoplanin (MIC > or = 16 mg/liter) (41).

CONCLUSION

The main goal of the present comprehensive review was to present the research carried out with species of the *Capparis* genus, widely spread in world, in order to organize the data produced since the previous effort in surveying the bontanical family of Capparidaceae.

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