Review Article

Future Journal of Pharmaceuticals and Health Sciences

Published by Pharma Springs Publication Journal Home Page: https://pharmasprings.com/fjphs

Pharmacological, Pharmacognostic and Phytochemical Review of *Capparis spinosa* L.

Archana B*[1], Pothireddy Bharath[2], Gundala Deepika[2], Kiran[2], Maheshwaram Dharani[2], Badi Pavani[2]

[1]Department of Pharmacology, St. Mary's Group of Institution, Deshmukhi (Village), Pochampally (Mandal), Yadadri Bhuvanagiri (Dist)-508284, Telangana, India
[2]St. Mary's Group of Institution, Deshmukhi (Village), Pochampally (Mandal), Yadadri Bhuvanagiri (Dist)-508284, Telangana, India

Article History:

Received on: 20 Oct 2021
Revised on: 25 Nov 2021
Accepted on: 26 Nov 2021

Keywords:

Capparis spinosa L., Phytoconstituents, Traditional Medicine, Global Warming

Abstract

Since ancient times medicinal plants have been used as therapeutic agents for the treatment of various diseases because they possess various bioactive components that promote the health of humans with minimal side effects. WHO reveals that 80% of the world's population depends on traditional medicine and China uses up to 50% of medicines as traditional medicine. Modern research acknowledged the importance of using various medicinal systems like Siddha, Ayurveda, and Unani in India and also acts as the vital sources for new drugs. As global warming is showing its negative effects there may be the loss of plant productivity due to high temperatures and severe drought conditions that affect global food security. Hence this review focused on a Xerophilous crop that was well adapted to severe drought and high temperatures namely Caper (*Capparis spinosa* L.) The review also focuses on the recent literature on phytochemical composition and pharmacological effects of Caper.

*Corresponding Author

Name: Archana B
Phone: +91 7416367155
Email: biradararchana07@gmail.com

eISSN: 2583-116X pISSN:

DOI: https://doi.org/10.26452/fjphs.v2i1.165

Production and Hosted by

Pharmasprings.com

INTRODUCTION

As global warming is showing its negative effects on growth and plant reproduction, many challenges arise for the propagation of various new varieties to withstand the drastic climatic conditions [1]. The decrease in plant growth may be due to physiological, cellular, and morphological damages, and sometimes elevated carbon dioxide levels modifies respiration and photosynthesis leading to reduced plant life [Figure 1, Figure 2] [2].

Capparis spinosa L. is an economical species in the Caparidaceae family with high medicinal values and plays a pivotal role in the traditional health care system [3]. The flower buds and fruits of this Mediterranean plant caper were used as a pickle. This plant is well adapted to severe climatic conditions affected by hyper-aridity. Caper can preserve water in the soil for longer periods and helps to maintain sustainable agriculture. These shrubs protect the soil from high temperatures by creating microclimatic conditions. The extensive root system of the caper can absorb water from deeper soils [4]. The roots, buds, and fruits of caper were highly economical in the food and pharmaceutical industries. The flower of caper is sweet-scented and can be used as an ornamental plant on walls and terraces with good sunlight [5].

Some studies have focused on the cultivation, nutritional quality, medicinal quality, phytochem-

istry, ethnopharmacology of caper [6]. Caper has huge potentialities with great demand in the international market. Therefore, it is necessary to improve and develop the species with more intensive research and promote the crop for high propagation and yields.

Origin and Distribution

Capparis spinosa Linnaeus belongs to the group of Capparis genus described by Carolus Linnaeus in his book "Species Plantarum". Capparis belongs to the Caparidaceae family and it is closely related to Brassicaceae and is a rich source of glucosinolates and flavonoids [7]. The genus includes 350 species distributed in tropical, subtropical, and Mediterranean regions. *Capparis spinosa* L. is considered as a hybrid between *Capparis Orientalis* and *Capparis sicula* [8]. The different names of caper include caprier (French), Kabbar (Arab), Alcaparro (Spain), Alaf e Mar (Persian). The consumption of Capparis species started 17,000 years ago that was discovered by the Old-World Paleolithic site in Egypt. Seeds of *Capparis spinosa* L. were found in Iraq around 5800 B.C. and Turpan district of China around 2800 B.C. [9]. Capparis is regarded as a native flora distributed in Africa and southwest Asia.

Figure 1: Circle of life to achieve quality life

Geographic Distribution

Capparis spinosa L. is distributed geographically from Morocco to the black sea, Atlantic Coast of Canary Island, East of Caspian Sea, Crimea, Armenia, Iran, Europe, North Africa, West Asia, Australia, and Afghanistan. The plant was expanded to the Mediterranean basin and Central Asia from the tropics. Geographic distributions of sub-species Spinosa were specific in North Africa, Sahara, Middle East, China, and subspecies rupestris was distributed in Italy, France, Spain, Croatia, Albania, Greece, Turkey, Libya, Tunisia, etc [10]. The plant

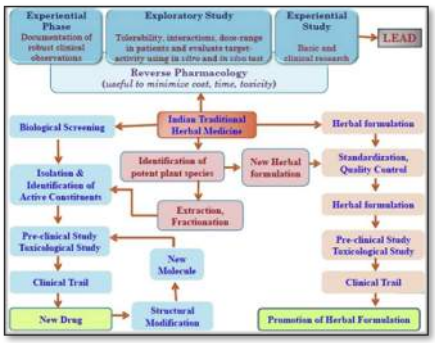


Figure 2: Drug discovery opportunities from Indian traditional systems

was harshly affected by the global warming in the Mediterranean region that led to improved agricultural techniques thereby increasing crop production. The current distribution and suitable climatic conditions for *Capparis spinosa* L. [Figure 3].

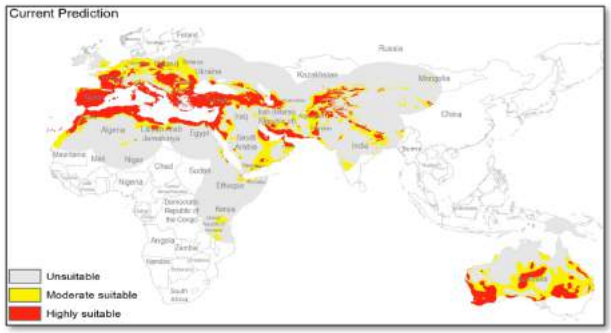


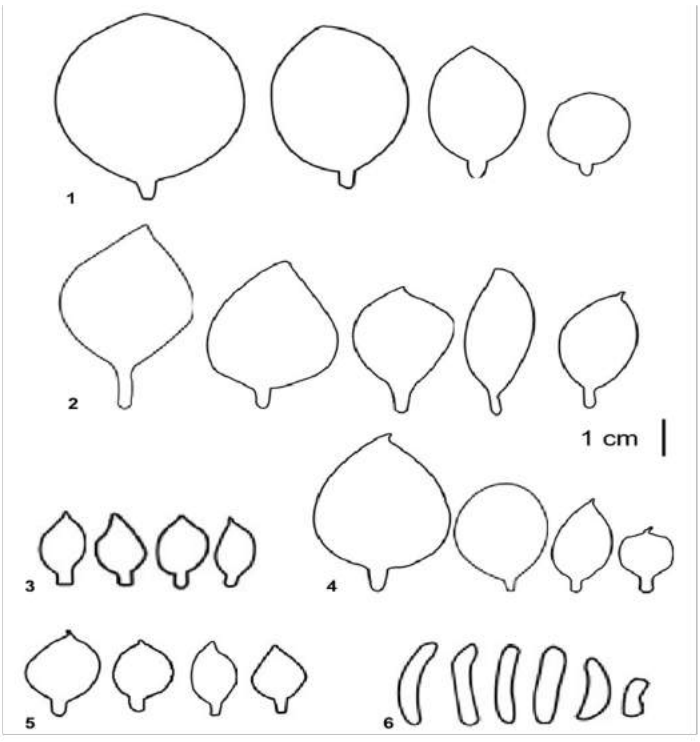
Figure 3: Current prediction of suitable climatic zones for *Capparis spinosa* L.

Botanical Description

Plesiomorphic features were seen in the species belonging to Capparis. Some literature mentioned the polymorphic aspects and heterogenicity in its morphological characteristics. It has numerous stamens with not galeate or slightly galeate and slightly zygomorphic [11].

Capparis spinosa is a perennial shrub erect and pendulous with branches. Branches may be green, red, or yellow with 4m long being unramified or multiramified. A tortuous or straight twig with or without simple hairs was seen with stipules somewhat curved, straight and spreading, antrorse or retrorse. The stipules may be orange, yellow, or green with 6 mm long and leaf stipules convert into spines giving the name "Spinosa". Rounded or ovate leaves, elliptical or obcordate, oblong or lanceolate with cordate or acute base and obtuse apex. Veins are not prominent with glabrous, pubescent, and dense textures. A grooved or entire petiole 2 cm long may be seen. Flowers are noctoflorous with four white or pinkish-white petals that are oblong or obovate. Numer-

Figure 4: ***Capparis spinosa*** **L.**



1. Capparis orientalis, 2. Capparis sinaica, 3. Capparis spinosa var. deserti, 4. Capparis spinosa var. Spinosa,

5. Capparis spinosa var. Canascens, 6. Capparis decidua

Figure 5: Leaf forms for the identification of various caper species

Table 1: Pests and Diseases of *Capparis spinosa* L.

Affected plant part	Pathogen	Category	Damage
Leaves	Caper Latent Virus Cucumber Mosaic Virus (CMV) Eggplant Mottled Dwarf Virus (EMDV) Co-infection CMV and EMDV	Virus	Clearing, yellowing veins, necrosis, shortened internodes, severe dwarfing, decreasing yields, curling leaves, chlorosis, mottled leaves, stunting of the plant.
	Phyllo tretalatevittata Kutsch Bemisiata baci	Insects & Pests	Circular gouges. Yellowish spots and deformation
Branches	*Sclerotium rolfsii* *Leveillula taurica*	Fungi	Yellowing and wilting of branches, necrosis, defoliation
Flowers	Albugo capparidis	Fungi	Whitre rust, hypertrophy of flowers, peduncles, floral abortion
Roots	*Acallesbarbarus Lucas*	Insects & Pests	Slender mines in the woods
Fruits	Bagrada hilaris Capparimyia savastani	Insects & Pests	Yellowing spots and Chlorosis Deformation and abortion
Fruits and Buds	Capparimyia savastani Asphondylia gennadii Capparimyia savastani *Pieris brassicae* L. *Pieris rapae* L.	Insects & Pests	Deformation and abortion

ous stamens with 5 cm filaments were seen with 3-6 mm Gynophore. Ellipsoidal fruit with numerous reddish-brown seeds was present. The plant may adapt to severe drought conditions by changing its leaf, stem, and root structure [Figure 4, Figure 5] [12].

Taxonomy

Based on the leaf and flower phenotypes the taxonomic studies of *Capparis spinosa* revealed many variations in different landmasses [13]. Due to this, the identification of *Capparis spinosa* became very complicated in the Mediterranean region. *Capparis spinosa* morphologically relates to *Capparis sicula* and *Capparis Orientalis* according to the literature. Recently the taxonomy of *Capparis spinosa* was revised and recognized as single species with four subspecies (*C. Spinosa subsp. Spinosa; C. Spinosa subsp. cordifolia; C. spinosasubsp. himalayensis; C. Spinosa subsp. rupestris*).*C. Spinosa subsp. spinosa and C. spinosa subsp. rupestris* has two varieties each namely var. *herbacea*, var. *atlantica* and var. *ovate*, var. *myrtifolia* respectively [14].

Cultivation and Production

The species of *Capparis spinosa* was well known as a drought-tolerant plant. This species will grow and flower in summer without competing for water with other species [15]. Annual temperature with 14^{o}C and annual rainfall with 200 mm are necessary and well adapted to xeric areas. The species can resist strong winds and temperatures as high as 40^{o}C [16]. Frost may disturb the vegetative period and survive in winter. Caper can be grown in low altitudes and at some places, it was grown well 1000 meters above sea level.

Caper adapts to calcareous or clay soils and has an efficient root system with nitrogen-fixing bacteria thereby it can grow well in poor fertile soils also. It can grow well in rocky, sandy, and salty soils with a low amount of organic matter in India. Caper can grow well in wall joints and monuments. Due to its

Table 2: Phytochemical constituents of *Capparis spinosa* L.

Plant Part	Name of the extract	Phytochemical constituents
Ariel Parts	EE/AF	Reducing sugar, flavonoids
	EE/BF	Tannins, flavonoids, alkaloids
	EE/AMF	Terpene, flavonoids
	EE/HF	Terpene
	ME	Quercetin 3-O-rutinoside, quercetin 3-O-glucoside, quercetin 3-O-glucoside-7-O-rhamnoside, Quercetin 3-O-[6‴ -a-L-rhamnosyl-6″-b-D-glucosyl]-b-D-glucoside
Leaves and Stems	EE	kaempferol 3-Rha-7-G, quercetin 3-Rut, quercetin 7-Rut, quercetin 3-G-7-Rhaw1
Roots	EE	Capparispine, Capparispine 26-O-b-D-glucoside, Cadabicine 26-O-b-D-glucoside hydrochloride
Leaves and Flower buds	AE	-Caffeoyl quinic acid, 1-Caffeoyl quinic acid, 5-p-Coumaroyl quinic acid, 4-Feruloyl quinic acid, Rutin, Quercetin 3-O-glc, Kaempferol 3-O-rutinoside, Methyl-quercetin-O-rutinoside, Kaempferol 3-O-glucoside, acids, flavonols
Shoots and Buds	EE/BF	4-coumaric acid, nicotinamide, cadaverine, isorhamnitine-3-O-rutinoside, rutin, stachydrine, 3-methyl-2-butenyl-b-glucoside
	EE/AMF	1-tetradecanol, methyl hexadecanoate, octadecanoic acid, 6,10,14-trimethyl-2-pentadecanone, b-sitosterol, glycerol monotetracostanoate, p-hydroxybenzaldehyde, ursolic acid, b-sitosterylglucoside, b-sitosterylglucoside-6′-octadecanoate Glucocapperin, glucoiberin, progoitrin, epiprogoitrin, sinigrin, gluconapoleiferin, glucoalyssin, gluconapin, 4-hydroxyglucobrassacin, glucobrassicanapin, glucobrassicin, gluconasturtiin
	ME	Phenolics, flavonoids, carotenoids

Continued on next page

Table 2 continued

Plant Part	Name of the extract	Phytochemical constituents
	EE/EF	Racemic benzofuranone
	EE/EF	Tetrahydroquinoline acid
	EE	p-hydroxybenzoic acid, 5-(hydroxymethyl)furfural, bis(5-formylfurfural) ether, daucosterol, a-D-fructofuranosides methyl, uracil, stachydrine
	EE/AF	Capparisine A, capparisine B, capparisine C, 2-(5-hydroxymethyl-2-formylpyrrol-1-yl) propionic acid lactone, N-(30-maleimidy1)-5-hydroxymethyl-2-pyrrole formaldehyde
	EE/EF	Protocatechuic aldehyde, E-butanediol acid, ethyl 3,4-dihydroxybenzoate, syringic acid, protocatechuic acid, vanillic acid, succinic acid, 4-hydroxybenzoic acid
	EE/AF	Cappariside, 5-hydroxymethylfurfural, 5-hydroxymethyl furoic acid, 2-furoic acid
	AE	Flazin, guanosine, capparine A, capparine B, 1-H-Indole-3-carboxaldehyde, 4-hydroxy-1H-indole-3-carboxaldehyde, chrysoeriol, apigenin, kaempferol, thevetiaflavone, 5-hydroxymethylfuraldehyde, vanillic acid, cinnamic acid
	ME	(6S)-hydroxy-3-oxo-a-ionol glucoside,Corchoionoside C, prenyl glucoside, indol-3-acetonitrile glycoside, capparilloside A, capparilloside B.

AE-Aqueous Extraction; EE-Ethanolic Extraction; EF-Ethylacetate fraction; BF-Butanol Fraction; HF-Hexane Fraction; AF-Aqueous Fraction; AMF-Aqueous Methanol Fraction, ME-Methanolic Extraction

low flammability, it can cut down forest fires and it can be utilized for landscaping and to reduce soil erosions [17]. *Capparis spinosa* can efficiently use high solar irradiance without the symptoms of photo inhibition and blooming was not affected by severe water deficit.

Seed Propagation

Seeds can be obtained by rubbing the fruit that contains 15-160 seeds followed by washing and drying in shade. Poor seed germination performance is seen due to high dormancy. Seeds will sprout after 20-50 days and the viability of seeds is 2 years when kept at 4^{o}C with less humidity. This traditional low germination technique is used in India, Armenia, Cyprus, Argentina, Italy, Spain, etc. Poor germination capacity of the caper is due to the presence of a hard coat on the seed and when the seed is in contact with water it limits the diffusion of oxygen to the seed. The rate of germination of seed directly depends on the seed maturity, weight, and fruit position. Different treatments like mechanical scarification, soaking in concentrated sulfuric acid, cold stratification, manipulating the light and moisture conditions may improve the rate of seed germination [18].

Asexual Propagation

Propagation using stem cutting may lead to rooting problems and damage but avoids high variability in terms of production. Hardwood or softwood stem cuttings with 1-50 cm length and 1-2.5 cm diameter can be used. February and March is the peak time for collecting the stems (Hardwood) and should treat with fungicides like capitol or capton keeping the stems outdoors with 3-4^{0}C covered with plastic or sand. Cuttings from semi-hardwood have low survival rates but basal softwood cuttings increase the root percentage and should be collected and planted during the germination period. Stem cuttings should be dipped in 1,500 – 3,000 mg/ml auxin solution for better rooting [19]. Grafting is less adopted and bark grafting showed good results in Spain. In-vitro propagation from nodal shoot segments, gamma irradiation of shoots increased rooting percentage [20]. To produce desirable seedlings micropropagation protocols can be efficiently used for transplantation.

Productivity

Capparis spinosa is a fast-growing plant and can survive in new climatic conditions. Hedge grow planting designs with square or rectangle with bush spacing 2.5 × 2.5m, or2.5 × 2m, 3 × 3m, 4 × 4, or 5 × 5m can be used for better results. It is a highly economical plant in Australia, Latin America that leads to an increase in cultivation and yield. It is cultivated at around 4000 ha in Spain and 1000 ha in Italy and other countries with a yield of 15-20,000 tonnes per year throughout the world. Caper can be produced along with vines, olives, almonds, etc [8]. The presence of stipular spines, high temperatures, dropping branches, small diameter of flower buds leads to an increase in the labor costs during the harvest. Depending on the age and growing environment, the yield of flower buds may increase from 1-9 kg/plant/year.

Diseases

Capparis spinosa L. is not a sensitive plant for diseases and pests. But some of the insects, virus, and fungi may attack and was not considered as a limiting factor because of low production density [21]. Various diseases of the plants were mentioned in Table 1 [22–24].

Phytochemical Composition

The biochemical contents of *Capparis spinosa* were affected by many factors like environmental conditions, geography, harvest date and time, genotype, preservation procedures, and methods of extraction [25]. Several studies report the presence of phenolics, alkaloids, flavonoids (kaempferol, rutin, quercetin), glucosinolates (glucobrassicin, glucoiberin, glucocapparin, sinigrin) antioxidants, carotenoids, terpenoids, and essential oils in different parts of the plant [Table 2] [26, 27].

Ethylacetate extract of roots and fruits shows a high content of flavonoids [28]. Glucosinolate content varies between 84-89% in various parts of the caper with the highest amount in young shoots. Traces of glucosinolates were seen in leaves. Seeds are rich in proteins, fibers, and oils with high contents of sterols, tocopherols, linoleic and oleic acids. The constituents present in the fruit were determined to have high biochemical content with organic acids, an antioxidant, and five alkaloid compounds. The tolerance of the plant at high temperatures is due to the presence of carotenoids and terpenoids like tocopherol that stabilizes the lipid core of the cell membrane. Some studies reported the isolation of hypoxanthine and uracil (adenosine nucleosides) from the fruits in china [29].

Essential oils were also extracted from leaves, roots, and fruits with 22 components yielded between 0.02-0.9 percent [Table 3] [30, 31]. Out of 22 components, 14 components were found in leaf with thymol, hexanal, butyl isothiocyanate, isopropyl isothiocyanate as major components. 4 components were detected in the fruit with methyl isothiocyanate and isopropyl isothiocyanate as major com-

Table 3: Components of essential oil in *Capparis spinosa* L.

Plant Part	Components	Percentage (%)
Floral buds and leaves (0.044% w/w yield)	Methyl isothiocyanate	92.06
	Sec-butyl isothiocyanate	0.25
	Butyl isothiocyanate	0.38
	Benzene acetaldehyde	0.23
	Benzene acetonitrile	0.4
	(E) β-Ionone	0.5
	Methyl methyl salicylate	0.17
	3-Hexenyl benzoate	0.74
	3-Hexenyl benzoate	1.75
Leaves (0.08% (v/w) yield)	Isopropyl isothiocyanate	11
	2-Hexenal	10.2
	Unknown	4.4
	γ -Terpinene	4.7
	n-Dodecane	1.8
	Carvone	2.3
	Thymol	26.4
	n-Tetradecane	4.3
	Geranyl acetone	3.5
	n-Hexadecane	5.5
	Dill apiole	2.4
	Palmitic acid	4.7
	n-Eicosane	3.5
Fruit (0.9% (v/w)yield)	Methyl isothiocyanate	41.6
	Sec-butyl isothiocyanate	2.2
	Isopropyl isothiocyanate	52.2
	Unknown	2.5
Roots (0.02% (v/w)yield)	Methyl isothiocyanate	53.5
	Sec-butyl isothiocyanate	0.6
	Isopropyl isothiocyanate	31.4
	Unknown	10.1
Ariel parts (0.067% (w/w) yield)	Methyl isothiocyanate	25.6
	Butyl isothiocyanate	16.55
	Benzene acetaldehyde	2.24
	Methyl isothiocyanate	28.92
	3-p-menthene	3.08
	3-methylthio-1-hexanal	2.03

Table 4: Pharmacologic effects of various parts of *Capparis spinosa* L. reported in various literatures

Plant Part	Pharmacologic effect
Fruit	Anti-diabetic, Anti-hyperlipidemic, Anti-Obesity, Anti-hypertensive, Anti-inflammatory, Diuretic, Antioxidant, Anti-cancer
Leaves	Anti-inflammatory, Anti-diabetic, Analgesic Anti-rheumatic, Gout Gastrointestinal infections
Stem barks, Aerial parts	Antimicrobial Diuretic
Flower buds	Antihepatotoxic, Gastrointestinal infections Eye infections, Anti-inflammatory
Buds and Roots	Antimicrobial, Diuretic, Counter irritant Fever, Paralysis, Analgesic, Carminative
Seeds	Antifungal

ponents. Methyl isothiocyanate and isopropyl isothiocyanate were also detected in roots. Thiocyanate and isothiocyanates are the breakdown products of glucosinolate. Myrosinase catalyzes methyl glucosinolate to form an intermediate called thiohydroximate which on rearrangement gives methyl isothiocyanate [32].

Pharmacological Effects

Capparis spinosa L. was used as a traditional medicine for fever, headache, toothache, menstruation, rheumatism, gout, skin diseases, convulsions, diabetes, liver disease, kidney disease, sciatia, hemorrhoids, ulcers, etc. Many studies have reported various pharmacological activities using various parts of *Capparis spinosa* L. Information regarding the health benefits of caper was yet to be concluded and only a few studies have been examined on human subjects [Table 4].

Antihyperlipidemic

A study with 1200 mg *Capparis spinosa* L. fruit showed a significant decrease in triglyceride levels in diabetic patients. The mechanism reported in the study explains the decrease in the activity of HMG Co-A reductase that plays a prominent role in the synthesis of cholesterol. Hence it can be used in fatty liver disease and plays an important role in inhibiting gluconeogenesis in the liver [33].

Antidiabetic

1200 mg of *Capparis spinosa* L. daily for 2 months showed a significant decrease in fasting blood glucose level in diabetic patients. The findings of the study demonstrated that there are no signs of adverse effects on hepatic and renal function. The anti-diabetic mechanism may be due to a decrease in the rate of absorption of carbohydrates in GIT. From the study, we can conclude that caper has anti-diabetic effects [34].

Antihypertensive

Powdered aqueous fruit extract of caper with 150 mg/kg on rats for 20 days showed a significant decrease in systolic blood pressure after 8 days. But there is an increase in the concentration of sodium, potassium, and chloride in urine after 20 days. Hence from the study, it can be concluded that *Capparis spinosa* L. decreases the systolic blood pressure by excreting various electrolytes and inhibiting angiotensin-converting enzymes.

Anti–Obesity

Powdered aqueous fruit extract of caper with 20 mg/kg on rats for 2 weeks showed significant loss of weight in high-fat diet-fed rats [35].

Anti-Microbial

Aqueous extract of *Capparis spinosa* L. roots showed inhibition in the growth rate of Deinococcus radiphilus and showed no effect on the growth rate of *E.coli*. In another study, aqueous extract of roots of *Capparis spinosa* L. showed antimicrobial activity when compared to ethanolic, methanolic, and ethyl acetate extracts. Authors reported the inhibitory effect on bacteria and fungal species of Staphylococcus, Streptococcus, Salmonella, Shigella, Klebsiella, Bacillus, Candida, Aspergillus [36].

Methanolic extract of stem bark and shoots showed an inhibitory effect on *Bacillus subtilis* and methanolic extract of fruit showed an inhibitory effect on *Pasteurella multocida*, *Staphylococcus aureus*, *Bacillus subtilis*, and *Escherichia coli*, Flowers and root methanolic extract showed the highest antibacte-

rial activity against *Escherichia coli*. In another study, caper leaves exhibited the highest antimicrobial activity on *Escherichia coli*, *Salmonella typhi*, etc [37]. From the studies, it was concluded that the extraction procedures and the solvents used for extraction play a prominent role in the antimicrobial activity of *Capparis spinosa* L.

Antihepatotoxic

A significant decrease in serum glutamyl pyruvate transaminase and serum glutamyl oxalacetate transaminase, total bilirubin, alkaline phosphatase was seen with aqueous extracts of aerial parts of Capparis spinosa when tested on paracetamol and carbon tetrachloride-induced hepatotoxicity on rats. Hydroalcoholic extract 0.2 and 0.4 g/kg of Capparis spinosa showed antihepatotoxic activity on diabetic rats after giving treatment for 4 weeks by reducing alkaline phosphatase and alanine aminotransferase [38].

Anti-inflammatory

A significant decrease in edema using the leaf extracts of *Capparis spinosa* L. was seen in the in-vivo albino mice model. The mechanism involved in the anti-inflammatory effect includes a decrease in immune cell infiltration and dermal thickness at the inflammatory site. In-vitro studies on human peripheral blood mononuclear cells showed anti-inflammatory effects using leaf extracts of *Capparis spinosa* L.

Root extracts of *Capparis spinosa* L. on induced rheumatoid arthritis and osteoarthritis on Sprague-Dawley rats showed analgesic activity due to the presence of spermidine alkaloids. Lyophilized methanolic extract of *Capparis spinosa* L. buds reduced the production of prostaglandins, nitric oxide, and reactive oxygen species on human chondrocytes exhibiting anti-inflammatory properties. Recent studies reported that aqueous extracts of fruits and stem leaves showed better anti-inflammatory properties than root extracts [39].

Antioxidant and Anticancer

The essential oil present in the flower buds and leaves of *Capparis spinosa* L. showed antioxidant activity in thiobarbituric acid reactive species assay and β-carotene bleaching method.

Methanolic extract of fresh berries of *Capparis spinosa* L. showed an antioxidant effect on liver hepatocellular carcinoma cells.

Essential oil from leaves and buds also showed the decreased activation of nuclear factor NF-Kappa B on colon cancer cells and showed anti-proliferative activity [40].

Other Pharmacological Effects

Decreased neurodegenerative effects were seen with aqueous extract of *Capparis spinosa* L. buds in induced lipopolysaccharide rats showing protection against learning, memory, and cognitive diseases. Caper extracts was used as traditional medicine for bronchorelaxant, antihistaminic, antimalarial, depurative and diuretic, counterirritant, cough, asthma, paralysis, gout, carminative, anemia, rheumatism, skin rashes, dry skin, cosmetics, gastrointestinal infections, kidney stones, eye infections, HIV etc. Caper can be used in food and culinary as pickles (flower buds), appetizer, flavor, pungency to sauces, salads, in pasta and pizzas. Capparis spinosa is safe to consume without any adverse effects according to the literature reported till today [41].

CONCLUSION

Many kinds of literature explain the pharmacological importance of *Capparis spinosa* L. due to its rich phytochemical constituents. This paved a path for many opportunities in the pharmaceutical and food industry. Research has been done on the whole plant with different solvents and different preparation methods that led to difficulty in the evaluation due to heterogeneous data. In the future, there is a major scope in evaluating its polyphenolic constituents that provide various health benefits.

ACKNOWLEDGEMENT

I would like to thank Principal sir (Dr. Kamal Hassan) St. Mary's Group of Institutions, Deshmukhi (Village), Pochampally (Mandal), Yadadri Bhuvanagiri(Dist), Telangana-508284, India.

Conflict of Interest

The authors attest that they have no conflict of interest in this study.

Funding Support

The authors declare that there is no financial support for the current study.

REFERENCES

[1] Clinio Locatelli, Dora Melucci, and Marcello Locatelli. Toxic Metals in Herbal Medicines. A Review. *Current Bioactive Compounds*, 10(3):181–188, 2014.

[2] Naohiko Ohama, Hikaru Sato, Kazuo Shinozaki, and Kazuko Yamaguchi-Shinozaki. Transcriptional Regulatory Network of Plant Heat Stress

Response. *Trends in Plant Science*, 22(1):53–65, 2017.

[3] Jocelyn C. Hall, Kenneth J. Sytsma, and Hugh H. Iltis. Phylogeny of Capparaceae and Brassicaceae based on chloroplast sequence data. *American Journal of Botany*, 89(11):1826–1842, 2002.

[4] Zuo Wei, Ma Miao, Ma Zhi, Gao Rongrong, Guo Yan, Jiang Wenwen, Liu Jing, and Tian Lili. Study of Photosynthetic Physiological Characteristics of Desert Plant Capparis spinosa L. *Journal of Shihezi University (Natural Science)*, 3, 2012.

[5] Stephanie Chedraoui, Alain Abi-Rizk, Marc El-Beyrouthy, Lamis Chalak, Naim Ouaini, and Loïc Rajjou. Capparis spinosa L. in A Systematic Review: A Xerophilous Species of Multi Values and Promising Potentialities for Agrosystems under the Threat of Global Warming. *Frontiers in plant science*, 8:1845, 2017.

[6] Seyed Fazel Nabavi, Filippo Maggi, Maria Daglia, Solomon Habtemariam, Luca Rastrelli, and Seyed Mohammad Nabavi. Pharmacological Effects of Capparis spinosa L. *Phytotherapy Research*, 30(11):1733–1744, 2016.

[7] Mohamed Abd. S. El zayat, Mahmoud El Sayd Ali, and Mohamed Hamdy Amar. A systematic revision of Capparaceae and Cleomaceae in Egypt: an evaluation of the generic delimitations of Capparis and Cleome using ecological and genetic diversity. *Journal of Genetic Engineering and Biotechnology*, 18(1):58, 2020.

[8] L. Tomassoli, A. Zaccaria, and M. Barba. Capparis spinosa– a new host of Cucumber mosaic virus in Italy. *Plant Pathology*, 54(2):263, 2005.

[9] Hong-En Jiang, Xiao Li, David K. Ferguson, Yu-Fei Wang, Chang-Jiang Liu, and Cheng-Sen Li. The discovery of Capparis spinosa L. (Capparidaceae) in the Yanghai Tombs (2800 years b.p.), NW China, and its medicinal implications. *Journal of Ethnopharmacology*, 113(3):409–420, 2007.

[10] S. Fici. Intraspecific variation and evolutionary trends in Capparis spinosa L. (Capparaceae). *Plant Systematics and Evolution*, 228(3-4):123–141, 2001.

[11] P. Legua, J. J. Martínez, P. Melgarejo, R. Martínez, and Fca. Hernández. Phenological growth stages of caper plant (Capparis spinosa L.) according to the Biologische Bundesanstalt, Bundessortenamt and CHemical scale. *Annals of Applied Biology*, 163(1):135–141, 2013.

[12] D. Rivera, C. Inocencio, C. Obón, E. Carreño, A. Reales, and F. Alcaraz. Archaeobotany of capers (Capparis) (Capparaceae). *Vegetation History and Archaeobotany*, 11(4):295–314, 2002.

[13] Cristina Inocencio, Diego Rivera, Ma Concepción Obón, Francisco Alcaraz, and Jose-Antonio Barreña. A systematic revision of capparis section Capparis (Capparaceae). *Annals of the Missouri Botanical Garden*, 93(1):122–149, 2006.

[14] Saikat Sen and Raja Chakraborty. Revival, modernization and integration of Indian traditional herbal medicine in clinical practice: Importance, challenges and future. *Journal of Traditional and Complementary Medicine*, 7(2):234–244, 2017.

[15] Sophia Rhizopoulou and George K. Psaras. Development and Structure of Drought-tolerant Leaves of the Mediterranean Shrub Capparis spinosa L. *Annals of Botany*, 92(3):377–383, 2003.

[16] O G Sozzi and A R Vicente. Capers and caperberries. pages 230–256, 2006. In Handbook of Herbs and Spices, ed K. V. Peter (Boca Raton, FL: Woodhead Publishing Limited; CRC Press).

[17] Anastasia Venieraki, Maria Dimou, Panagiotis Pergalis, Io Kefalogianni, Iordanis Chatzipavlidis, and Panagiotis Katinakis. The Genetic Diversity of Culturable Nitrogen-Fixing Bacteria in the Rhizosphere of Wheat. *Microbial Ecology*, 61(2):277–285, 2011.

[18] B. Pascua, San Bautista, N. Ferreros, S. López-Galarza, and J. V. Maroto. Analysis of germination of caper seeds as influenced by the position of fruit on the mother plant, fruit maturation stage and fruit weight. *The Journal of Horticultural Science and Biotechnology*, 78(1):39–45, 2003.

[19] Özlem Özbek and Aslı Kara. Genetic variation in natural populations of Capparis from Turkey, as revealed by RAPD analysis. *Plant Systematics and Evolution*, 299(10):1911–1933, 2013.

[20] Bassam Al-Safadi and Rana Elias. Improvement of caper (Capparis spinosa L.) propagation using in vitro culture and gamma irradiation. *Scientia Horticulturae*, 127(3):290–297, 2011.

[21] Alessandro Infantino, Laura Tomassoli, Ezio Peri, and Stefano Colazza. Viruses, fungi and insect pests affecting caper. *The European Journal of Plant Science and Biotechnology*, 1(2):170–179, 2007.

[22] S Colazza, S Guarino, and E Peri. Bagrada hilaris (Burmeister) (Heteroptera: Pentatomidae) phytophagus harmful to capers on the island of Pantelleria. *Informatore Fitopatologico*, 53:30–34, 2004.

[23] A K Gupta and L N Bhardwaj. Additional host of Leveillula taurica (Lev.) G. Arnaud from India. *Indian Phytopathology*, 51(1):104–106, 1998.

[24] Khadija El Azhary, Nadia Tahiri Jouti, Meryam El Khachibi, Mouna Moutia, Imane Tabyaoui, Abdelhalim El Hou, Hafid Achtak, Sellama Nadifi, Norddine Habti, and Abdallah Badou. Anti-inflammatory potential of Capparis spinosa L. in vivo in mice through inhibition of cell infiltration and cytokine gene expression. *BMC Complementary and Alternative Medicine*, 17(1):81, 2017.

[25] Nizar Tlili, Abdelhamid Khaldi, Saida Triki, and Sergi Munné-Bosch. Phenolic Compounds and Vitamin Antioxidants of Caper (Capparis spinosa). *Plant Foods for Human Nutrition*, 65(3):260–265, 2010.

[26] Tao Yang, Changhong Wang, Hongjuan Liu, Guixin Chou, Xuemei Cheng, and Zhengtao Wang. A new antioxidant compound from Capparis spinosa. *Pharmaceutical Biology*, 485(5):589–594, 2010.

[27] Xiao Pu Fu, Tao Wu, Miriban Abdurahim, Zhen Su, Xue Ling Hou, Haji Akber Aisa, and Hankui Wu. New spermidine alkaloids from Capparis spinosa roots. *Phytochemistry Letters*, 1(1):59–62, 2008.

[28] Manish S Bhoyar, Gyan P Mishra, Pradeep K Naik, and R B Srivastava. Estimation of Antioxidant Activity and Total Phenolics Among Natural Populations of Caper ('Capparis spinosa') Leaves Collected from Cold Arid Desert of Trans-Himalayas. *Australian Journal of Crop Science*, 5(7):912–919, 2011.

[29] Daymi Camejo, Ana Jiménez, Juan José Alarcón, Walfredo Torres, Juana María Gómez, and Francisca Sevilla. Changes in photosynthetic parameters and antioxidant activities following heat-shock treatment in tomato plants. *Functional Plant Biology*, 33(2):177, 2006.

[30] Suleiman Afsharypuor, Koorosh Jeiran, and Amir Arefian Jazy. First investigation of the flavour profiles of the leaf, ripe fruit and root of Capparis spinosa var. mucronifolia from Iran. *Pharmaceutica Acta Helvetiae*, 72(5):307–309, 1998.

[31] R Muhaidat, M A Al-Qudah, A Al-Shayeb, J H Jacob, H I Al-Jaber, E Hussein, and S T Abu Orabi. Chemical profile and antibacterial activity of crude fractions and essential oils of Capparis ovata Desf. and Capparis spinosa L.(Capparaceae). *International Journal of Integrative Biology*, 14(1):39–47, 2013.

[32] Sharanbasappa Durg, Veeresh P. Veerapur, Satrasala Neelima, and Shivsharan B. Dhadde. Antidiabetic activity of Embelia ribes, embelin and its derivatives: A systematic review and meta-analysis. *Biomedicine and Pharmacotherapy*, 86:195–204, 2017.

[33] Gene C. Ness. Physiological feedback regulation of cholesterol biosynthesis: Role of translational control of hepatic HMG-CoA reductase and possible involvement of oxylanosterols. *Biochimica et Biophysica Acta (BBA) - Molecular and Cell Biology of Lipids*, 1851(5):667–673, 2015.

[34] Zeggwagh Naoufel Ali, Mohamed Eddouks, Jean Baptiste Michel, Thierry Sulpice, and Lhoussain Hajji. Cardiovascular Effect of Capparis spinosa Aqueous Extract. Part III: Antihypertensive Effect in Spontaneously Hypertensive Rats. *American Journal of Pharmacology and Toxicology*, 2(3):111–115, 2007.

[35] A Lemhadri, M Eddouks, T Sulpice, and R Burcelin. Anti-hyperglycaemic and Anti-obesity Effects of Capparis spinosa and Chamaemelum nobile Aqueous Extracts in HFD Mice. *American Journal of Pharmacology and Toxicology*, 2(3):106–110, 2007.

[36] Mohaddese Mahboubi and Atefeh Mahboubi. Antimicrobial activity of Capparis spinosa as its usages in traditional medicine. *Herba Polonica*, 60(1):39–48, 2014.

[37] Farzad Mazarei, Hossein Jooyandeh, Mohammad Noshad, and Mohammad Hojjati. Polysaccharide of caper (Capparis spinosa L.) Leaf: Extraction optimization, antioxidant potential and antimicrobial activity. *International Journal of Biological Macromolecules*, 95:224–231, 2017.

[38] Mostafa Kazemian, Mansur Abad, Mohammad Reza Haeri, Mansoor Ebrahimi, and Reza Heidari. Anti-diabetic effect of Capparis spinosa L. root extract in diabetic rats. *Avicenna Journal of Phytomedicine*, 5(4):325–332, 2015.

[39] Mario Maresca, Laura Micheli, Lorenzo Di Cesare Mannelli, Barbara Tenci, Marzia Innocenti, Mohamad Khatib, Nadia Mulinacci, and Carla Ghelardini. Acute effect of Capparis spinosa root extracts on rat articular pain.

Journal of Ethnopharmacology, 193:456–465, 2016.

[40] Lei Yu, Jinghui Yang, Xin Wang, Bo Jiang, Yongxue Sun, and Yubin Ji. Antioxidant and antitumor activities of Capparis spinosa L. and the related mechanisms. *Oncology Reports*, 37(1):357–367, 2017.

[41] A Goel, A Digvijaya Garg, A Kumar, and A Garg. Effect of Capparis spinosa Linn. extract on lipopolysaccharide-induced cognitive impairment in rats. *Indian Journal of Experimental Biology*, 54:126–132, 2016.

Cite this article: Archana B, Pothireddy Bharath, Gundala Deepika, Kiran, Maheshwaram Dharani, Badi Pavani. Pharmacological, Pharmacognostic and Phytochemical Review of *Capparis spinosa* L.. Future J. Pharm. Health. Sci. 2022; 2(1): 9-21.