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A Brief Review Article on Caper Berries

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Abstract

One of the most popular medicinal plants, Caparisspinosa L., is widely used throughout the world to treat a variety of human ailments. With reference to C. spinosa's traditional usage, growing methods, and phytochemical components, this research attempts to critically analyze the pertinent scientific literature. Iranian diabetes patients customarily consume the fruit of the caper plant, Capparis spinosa L. No controlled human investigation has yet been done to evaluate its effectiveness in treating hyperglycemia in type 2 diabetic patients. The caper, or Caparisspinosa L., is an aromatic plant that grows in the majority of the Mediterranean basin and certain areas of western Asia. C. spinosa L. has been used in traditional phytomedicine for a very long time as a medicinal herb. Extracted from C.spinosaL are polyphenols and many bioactive compounds. Reveal a variety of medicinal qualities that have drawn attention to this plant as a potential health booster.

Keywords: Caper berries, Alkaloids, Flavonoids, Type 2 Diabetic, Antioxidant Activity

Introduction

Caper is a shrubby plant that is indigenous to the Mediterranean region (Capparis spinosa L.). It is a member of the genus Capparis and the family Capparidaceae, which together contain over 250 species used mostly for decorative, culinary, cosmetic, pharmacological, and therapeutic applications [1]. High morphological and ecological variety in Capparis spinosa has prompted some authors to distinguish a number of intraspecific variations and species [2–5]. It is well adaptable to hot temperatures, bright sunlight, and changing climates, and it plays significant socioeconomic roles in many countries' dry regions [6–8].

A shrub with high therapeutic value is the caper. This species is abundant in bioactive substances that can be employed for therapeutic, culinary, and ornamental purposes, including flavonoids, glucosinolates, phenolic acids, and alkaloids. Along this line, numerous health-promoting qualities of caper extracts, including antioxidant and anti-cancer activities, were scientifically proven [9]. Since it aids in retaining biodiversity, soil water, and prevents soil erosion, capers are also utilized for ecological purposes [10, 11].

The caper, also known as Capparis spinosa L., is one of the unusual shrub plants that offer a wide range of useful properties [12]. It is an

unusually limitless, xerophytic, and heliophilous plant that grows in the Mediterranean region [13, 14]. It must tolerate the harsh weather conditions in dry and semi-arid regions with high temperatures. In this way, it can serve a very important biological role in these locations to prevent soil erosion, but it can also be grown for other purposes.

The C.spinosa L. plant resembles a bush with long, flexible, and drooping branches that all emerge from a single, enormous strain. It is a thorny shrub with a wooden trunk. It is typically between 1 and 1.5 meters wide and 0.40 to 0.80 meters high [15]. The spiny leaf stipules of C. spinosa L. represent the spinosa species. The sections of twigs that initiate the flower buds are the terminal ends. The most famous parts of the plant are the closed flower buds, or capers, which are eaten by people. These flower buds should not be mistaken with the immature fruits, known as caper berries, which have a harsh flavor and a greenish appearance [16]. Typically, the fruit and flower buds are both salted, pickled, and used as ingredients, seasonings, sauces, or garnishes [17, 18].

Environmental Condition and Cultivation

Caper can grow on a variety of soil types, including alfisols, regosols, and lithosols, and is adaptable to poor soils. It is also common in rocky terrain and on mountains. It responds well to soils that are volcanic or alkaline. The pH of the soil can range from 6.1 to 8.5 [19-21]. Immediately following a rainstorm in April or May, caper plants proliferate widely before beginning to wither in September or October. It evolved defenses against high radiation and temperature, and it appears to be free of water stress or photo-inhibition symptoms [22, 23, 24].

From West Africa to the Norfolk Islands in the Pacific, the Capparis subgenus Capparis uses caper plants practically everywhere [25]. The majority of the species are valuable for food or medicine. Turkey, Morocco [20], Spain, Greece, France, and Italy (particularly Sicily and the Aeolian islands of Salina and Pantelleria in the Mediterranean) [26] are notable suppliers. Around 10,000 tonnes are thought to be produced on average each year: 3500-4500 tonnes in Turkey, 3000 tonnes in Morocco, 500–1000 tonnes in Spain, and 1000–2000 tonnes in other nations [19].

In the spring, treated seeds are planted in sandy soil covered by glass, and the plants are subsequently moved outside when the weather is warm and stable. Capers can also be grown from cuttings of short branches that are framed in a glasshouse and planted in a sandy soil [27]. Additionally, some growers (like as those in Italy) choose cultivars, particularly the spineless (high harvesting) varieties, in order to create a high-quality product. Additionally, they shorten the time between harvests to ensure the collection of little buds, and they employ some strategic marketing to raise the value of the product (quality labeling, product traceability, etc.) [28].

Phytochemistry

C. spinosa is unquestionably one of the medicinal plants that have been investigated the most in terms of its phytochemical components. Alkaloids, flavonoids, glucosinolates, phenolic acids, terpenoids, and other chemicals are present in the chemical makeup of the various components. A quick synopsis of the major chemical classes of the discovered chemicals is provided to help readers comprehend the plant's genuine

therapeutic potential even if this review does not aim to be an exhaustive review of the chemistry.

Alkaloids

A wide collection of secondary natural metabolites known as alkaloids are those that have one or more nitrogen atoms in their structure. The new tetrahydroquinoline acid (1) from the stems and fruits of the plant is one of the numerous alkaloids discovered from C. spinosa thus far [29]. Since it has a carbon skeleton that bears both amino and carboxylic acid groups, this substance can actually be thought of as a new amino acid. (2) has been obtained from fruits and is another modified amino acid or alkaloid [30].

Flavonoids

One of the most varied polyphenolic natural compounds; flavonoids are made up of two aromatic 6-membered rings connected by a 3-carbon chain, giving them a 15-carbon skeleton. The C6 aromatic ring and C3-side chains are produced biochemically using the shikimic acid pathway, whereas the other aromatic ring is produced using the acetate process. Flavonoids can be divided into a number of sub-classes according to the degree to which the linking chain is cyclized to produce the third ring, the location of the aromatic ring's attachment to the side chain, and the chemical makeup of the linking chain, including the presence or absence of double bonds and the pattern of oxidation, among other factors. These include neoflavonoids, isoflavonoids, chalcones, flavones, flavonols, and flavanones. Given that they have a variety of pharmacological actions, from antidiabetic [31, 32].

Chemical constituents

Although 145 different compounds were found in the volatile oils of C. spinosa, aldehydes (22%), esters (21%), and compounds containing sulfur (8.42%) were the main components. Additionally confirmed were the presence of sesquiterpenes, monoterpenes, and capric acid [33]. By using fractionation, total phenols and glucosinolates were extracted, and it was discovered that neither class of chemical compounds interfered with the other's activity. The mature fruits of C. spinosa were used to isolate new (6S)-hydroxy-3-oxo-ionol glucosides, corchoinoside C (6S, 9S)-roseoside, and prenyl glucosides [34]. Cappariloside A, stachydrine, an adenosine nucleoside, hypoxanthine, -sitosterol, vanillic acid, p-hydroxybenzoic acid, protocatechuric acid, daucosterrol, uracil, butanedioc acid, and uridine were also present in the fruits of C. spinosa [34].

Caper Berries Use in Treatment of Diseases

Type 2 Diabetic

In most countries, diabetes mellitus type 2 is one of the diseases with the highest prevalence and fastest rate of growth [35]. Several studies have demonstrated that, in addition to standard anti-diabetic medication, nutrition, herbal remedies, and complementary and alternative medicine therapies have positive effects and improve glucose homeostasis in diabetic patients [36, 37]. The caper, Cap-parisspinosa L., is a member of the Capparidaceae family and likely evolved in arid parts of central or western Asia [38]. Due to the perception that caper fruits and flower buds have hypo-glycemic and hypolipidemic effects, diabetic

patients use them as food [39-41]. Iranian diabetic patients take the pickled caper fruit at a dose of 2–8 g daily as a cure. Despite certain ethnobotanical surveys suggesting caper use in anti-diabetic compounds, folk medicine [39-41].

Antioxidant Activity

The antioxidant benefits of various caper sections, which may be beneficial in preventing several degenerative disorders, were studied. Antioxidant activity of an aqueous infusion made from Croatian caper flower tips was assessed both before and after in vitro digestion [42]. Before digestion, there was significant and dose-dependent antioxidant activity as determined by the 1,1-diphenyl-2-picrylhydrazyl (DPPH) method, -carotene bleaching method, and copper-induced oxidation of human low-density lipoprotein (LDL). Bioactive components such rutin, kaempferol 3-O-rutinoside, isorhamnetin 3-O-rutinoside, and derivatives of cinnamoylquinic acid may be responsible for this action. However, the majority of phenolic compounds degrade following in vitro digestion. The infusion's antioxidant activity consequently drastically declines. It's interesting to note that the type of initial matrix influences the loss of phenolic chemicals, with caper infusion being less susceptible to degradation [42].

Anticarcinogenic Activity

Methyl isothiocyanate, a byproduct of glucocapparin breakdown, predominated in the composition of the essential oil, whereas flavonoids in the water infusion were a good source of antiproliferative actions against colon cancer cells. Both the essential oil and the aqueous infusion inhibit the proliferation of HT-29 cells in a time- and dose-dependent manner, with the essential oil having slightly lower efficacy than the aqueous infusion (44.3% of inhibition after 72 h vs. 54.4%, respectively). Additionally, the effects on the activation of nuclear factor kappa B (NF-kB) were investigated. The effects of essential oil and aqueous infusion on NF-kB activity were dose-dependent, with the latter once more having a stronger effect than the former (54.8% of inhibition vs. 19.0%, respectively). Finally, a dose-dependent G2/M arrest is brought about by caper essential oil and aqueous infusion [43].

Immunostimulant and Antitumural Activity

By up-regulating the expression of unusual pro-inflammatory cytokines, methanolic extract of C. spinosa buds may help improve immune surveillance of human peripheral blood mononuclear cells against virus infection. It suppressed the replication of herpes simplex virus type 2 and increased the expression of pro-inflammatory cytokines like interleukin-12, interferon, and tumor necrosis factor [44]. Additionally, C. sikkimensis roots were used to identify an inhibitor of in vitro tumor cell multiplication [45]. More recently, a protein with strong anti-proliferative effects on tumor cells and HIV-1 inhibitory effects was discovered. From C. spinosa seeds, transcriptase and modest antifungal activity have been extracted [46]. These significant biological activities were most likely caused by the significant amount of antioxidants, which have high anti-disease activity. In fact, it has been noted that certain carotenoids can prevent chemically induced carcinogenesis in the buccal pouch of hamsters [47]. Tocopherols are crucial in the prevention of cancer [48]. Phenolic substances have anti-tumor

properties [49]. Some aldehydes that function as a replication inhibitor for tumor cells in vitro may also be responsible for the biological actions outlined above [45].

Traditional Uses

The fruits and flower buds of capers, which are typically salted and pickled, are rich in nutrients and serve as significant food supplements for humans. Caper fruits, for instance, provide 9 mg of iron, 65 mg of phosphorus, 67 mg of calcium, and 24.5 g of protein per 100 g, in addition to 3 mg of dietary fiber, 5 mg of carbs, 0.9 mg of fat, and 4 mg of vitamin C. Fruit extracts and caper buds can both be utilized as taste enhancers [50].

For a very long time, C. spinosa L. has been used in traditional phytomedicine to treat a wide range of illnesses [51]. In ancient Egypt and Arab societies, the roots were used to heal liver and renal ailments [52]. To treat paralysis, ancient Romans utilized the buds of C. spinosa L. [53]. Different preparations from the root powder have been used traditionally to treat osteoarthritis and rheumatic joint inflammation in numerous countries in the Mediterranean basin [54]. Caperbuds are still used to treat eye infections in some parts of Morocco, and the dried fruits can be eaten internally with a glass of water to lower blood pressure and manage diabetic complications [55, 56].

Different C. spinosa components have been widely utilized in traditional medicine to treat a variety of human ailments [57, 58, 59]. According to reports, rheumatism, digestive issues, headaches, renal and liver disease, as well as toothaches, have all been treated using the aerial portions and roots of C. spinosa [60, 58, 61, 62, 63]. Arabian traditional medicine has proposed using the leaf, roots, and buds of C. spinosa to cure a variety of human illnesses, including spleen disorders, stomach issues, skin disorders, earaches, renal disorders, and hepatic disorders[64,65,66]. It has also been suggested for the treatment of convulsions, paralysis, and gum issues [67, 68, 66]. Its fruits have historically been used to cure rheumatism, diabetes, headaches, and fever [67, 68, 66]. The roots, fruit, and bark of C. spinosa have also reportedly been employed in Iranian traditional medicine as diuretics, tonics, and antimalarials [69, 70, 71]. Additionally, C. spinosa leaves have been utilised for centuries as analgesics, hemorrhagic, rheumatic, and anti-inflammatory drugs [66]. Additionally, C. spinosa is said to have positive effects on coughs and asthma [68]. Additionally, C. spinosa flowers have been touted as erection-inducing stimulants [68].

Conclusion

One of the most significant and widely available edible plants is C. spinosa. Numerous pieces of scientific evidence indicate that C. spinosa has a variety of pharmacological effects. The objective of this paper was to review the material that is currently accessible on the pharmacological effects of this species. In conclusion, although if many of them exist in low amounts, especially after fermentation, the positive benefits of C. spinosa are due to the high number of bioactive natural products, especially polyphenolic compounds. Furthermore, there are no scientific studies on the negative effects of its intake.

As a huge spontaneous plant, the Capparis species has a variety of uses in traditional

medicine. The pharmacology and chemistry of this plant have recently undergone substantial research. Numerous advantageous substances have been found in the various Capparis sections, both fermented and non-fermented, according to chemical analyses. The ancient applications are supported by biological investigations that have found strong anti-Type 2 diabetes, antioxidative, anticarcinogenic, antiinflammatory, antiarthretic, immunostimulant, and antitumor action. Nevertheless, clinical testing is required to confirm the use of this species in medical practise, despite the significant and varied pharmacological investigations that are now accessible.

References

1. *Fici, S. Intraspecific variation and evolutionary trends in Capparis spinosa L. (Capparaceae). Plant Syst. Evol. 2001, 228, 123–141.*
2. *Zohary, M. The species of Capparis in the Mediterranean and the Near Eastern countries. Bull. Res. Counc. Isr. 1960, 8D, 49–64.*
3. *Inocencio, C.; Rivera, D.; Concepción Obón, M.; Alcaraz, F.; Barreña, J.-A. A systematic revision of Capparis section Capparis (Capparaceae) 1, 2. Ann. Mo. Bot. Gard. 2006, 93, 122–149.*
4. *Danin, A. Capparis in the East Mediterranean countries. Fl. Medit. 2010, 20, 179–185.*
5. *Gristina, A.S.; Fici, S.; Siragusa, M.; Fontana, I.; Garfì, G.; Carimi, F. Hybridization in Capparis spinosa L.: Molecular and morphological evidence from a Mediterranean island complex. Flora Morphol. Distrib. Funct. Ecol. Plants 2014, 209, 733–741.*
6. *Jiang, H.E.; Li, X.; Ferguson, K.D.; Wang, Y.F.; Liu, C.J.; Li, C.S. The discovery of Capparis spinosa L. (Capparidaceae) in the Yanghai Tombs (2800 years b.p.), NW China, and its medicinal implications. J. Ethnopharmacol. 2007, 113, 409–420.*
7. *Faran, M. Capparis spinosa the plant on the wall. In Medicinal and Aromatic Plants of the Middle-East (Medicinal and Aromatic Plants of the World); Yaniv, Z., Dudai, N., Eds.; Springer: Dordrecht, the Netherlands, 2014; pp. 59–65.*
8. *Rhimi, A.; Hannachi, H.; Hjaoujia, S.; Yousfi, H.; Boussaid, M. In vitro germination and seedling development of Tunisian caper (Capparis spinosa L.). Int. J. Agron. Agri. Res. 2017, 10, 1–8.*
9. *Kereša, S.; Stankovi´c, D.; Lodeta, K.B.; Jer˘ci´c, I.H.; Bolari´c, S.; Bari´c, M.; Mihovilovi´c, A.B. Efficient protocol for the in vitro plantlet production of caper (Capparisorientalis Veill.) from the East Adriatic coast. Agronomy 2019, 9, 303.*
10. *Lakrimi, M. Le caprier. Transfert Technol. Agri. 1997, 37, 1–4.*
11. *Moghaddasi, S.M.; Haddad Kashani, H.; Azarbad, Z. Capparisspinosa L. propagation and medicinal uses. Life Sci. J. 2012, 9, 684–686.*
12. *Mansour R Ben, Jilani IBH, Bouaziz M, et al. Phenolic contents and antioxidant activity of ethanolic extract of Capparis spinosa. Cytotechnology 2016; 68: 135–142*
13. *Mohammad SM, Kashani HH, Azarbad Z. Capparis spinosa L. Propagation and medicinal uses. Life Sci J 2012; 9: 684–686*
14. *Aichour R, Charef N, Baghiani A, et al. Immunomodulatory effects of Algerian caper. Int J Pharm Pharm Sci 2016; 8: 51–54*
15. *Chedraoui S, Abi-Rizk A, El-Beyrouthy M, et al. Capparis spinosa L. in A Systematic Review: A Xerophilous Species of Multi Values and Promising Potentialities for Agrosystems under the Threat of Global Warming. Front Plant Sci 2017; 8: 1845*
16. *Fici S. A taxonomic revision of the Capparisspinosa group (Capparaceae) from eastern Africa to Oceania. Phytotaxa 2015; 203: 24*
17. *Inocencio C, Alcaraz F, Calderón F, et al. The use of floral characters in Capparis sect. Capparis to determine the botanical and geographical origin of capers. Eur Food Res Technol 2002; 214: 335–339*

18. *Saadaoui E, Guetat A, Tlili N, et al. Subspecific variability of Tunisian wild populations of Capparis Spinosa L. J Med Plants Res 2011; 5: 4339–4348*
19. *Janick J, Paull RE. The encyclopedia of fruits and nuts. Edited by Janick J, Purdue University, USA, and Paull RE., University of Hawaii at Manoa, USA; 2006. pp. 228-231.*
20. *Özcan M, Akgül A. Influence of species harvest date and size on composition of capers (Capparis spp.) flower buds. Nahrung 1998; 42: 102–5.*
21. *Pugnaire FI, Esteban E. Nutritional adaptations of caper shrub (Capparis ovata Desf) to environmental stress. J Plant Nutr 1991; 12:151–61.*
22. *Levizon E, Drilias P, Kyparissis A. Exceptional photosynthetic performance of Capparis spinosa L. under adverse conditions of Mediterranean summer. Photosynthetica 2004; 42:229–35.*
23. *Tlili N, Nasri N, Saadaoui E, Khaldi A, Triki S. Carotenoid and tocopherol composition of leaves, buds and flowers of Capparis spinosa grown wild in Tunisia. J Agric Food Chem 2009; 57: 5381–5.*
24. *Rhizopoulou S. Physiological responses of Capparis spinosa L., to drought. J Plant Physiol 1990; 136:341–8.*
25. *Rivera D, Inocencio C, Obon C, Carrefio E, Reales A, Alcaraz F. Archaeobotany of capers (Capparis) (Capparaceae). Veg His Archaeo 2002; 11:295–313.*
26. *Rivera D, Alcaraz F, Inocencio C, Obdn C, Carrefio E. Taxonomic study of cultivated Capparis sect. Capparis in the western Mediterranean. In: Andrews S, Leslie AC, Alexander C, editors. Taxonomy of Cultivated Plants. Kew, England: Royal Botanic Gardens; 1999. p. 451–5.*
27. *James A, Duke CRC. Handbook of Medicinal Spices Green Farmacy Garden, Fulton, Maryland. Fulton, Maryland, USA: USA Green Farmacy Garden; 2002. p. 85–9.*
28. *Giuliani A, Padulosi S. Enhancing the value chain for markets for traditional producers of (neglected and underutilized) aromatic, vegetable and fruit species in the Near East: a pilot study in Syria. Proceedings of ICARDA International Conference on Promoting Community-driven Conservation and Sustainable Use of Dryland Agrobiodiversity", Aleppo, Syria; April 18-21 2005.*
29. *Zhang S, Hu DB, He JB, Guan KY, Zhu HJ. 2014. A novel tetrahydroquinoline acid and a new racemic benzofuranone from Capparisspinosa L., a case study of absolute configuration determination using quantum methods. Tetrahedron 70: 869–873.*
30. *Fu X, Aisa H, Abdurahim M, Yili A, Aripova S, Tashkhodzhaev B. 2007. Chemical composition of Capparis spinosa fruit. Chem Nat Compd 43: 181–183.*
31. *Habtemariam S. 2011. A-glucosidase inhibitory activity of kaempferol-3-O-rutinoside. Nat Prod Commun 6: 201–203.*
32. *Habtemariam S, Varghese GK. 2014. The antidiabetic therapeutic potential of dietary polyphenols. Curr Pharm Biotechnol 15: 391–400.*
33. *Arena A, Bisifnano G, Pavone B, Tomaino A, Bonina FP, Saija A, Cristani M, D' Arrigo M, Trombetta D (2008). Antiviral and immunomodulatory effect of a lyophilized extract of CapprisspinosaL. Buds. Phytother. Res., 22(3): 313-317.*
34. *Calis I, Kuruüzüm-Uz A, Lorenzetto PA, Rüedi P (2002). (6S)-Hydroxy-3-oxo-α-ionol glucosides from Capparisspinosafruits. Phytochemistry, 59(4): 451-457.*
35. *Gerstein HC, Miller ME, Byington RP, Goff DC, Bigger JT, Buse JB, et al. Effects of intensive glucose lowering in type 2 diabetes. New England Journal of Medicine 2008;358(24):2545—59.*
36. *Hasani-Ranjbar S, Larijani B, Abdollahi M. A systematic review of Iranian medicinal plants useful in diabetes mellitus. Archives of Medical Science 2008;4(3):285—92.*
37. *Nahas R, Moher M. Complementary and alternative medicine for the treatment of type 2 diabetes. Canadian Family Physician2009; 55(6):591—6.*
38. *Inocencio CF, Alcaraz F, Calderón C, Obón D, Rivera R. The useof floral characters in Capparis sect. Capparis' to determinethe botanical and geographical origin of capers. European Food Research and Technology 2002; 214(4):335—9.*
39. *Yaniv ZA, Dafni J, Friedman D, Palevitch B. Plants used for thetreatment of diabetes in Israel. Journal of Ethnopharmacology1987; 2:145—51.*

40. *Bnouham M, Mekhfi H, Abdelkhaleq LA, Ziyyat A. Ethnophar-macology forum. Medicinal plants used in the treatment ofdiabetes in Morocco. International Journal of Diabetes andMetabolism2002; 10:33—50.*
41. *Afifi-Yazar FU, Kasabri V, Abu-Dahab R. Medicinal plants fromJordan in the treatment of diabetes: traditional uses vs. in vitro and in vivo evaluations part 2. Planta Medica2011; 77(11):1210—20.*
42. *Siracusa L, Kulisic-Bilusic T, Politeo O, Krause I, Dejanovic B, Ruberto G. 2011. Phenolic composition and antioxidant activity of aqueous infusions from Capparis spinosa L. and Crithmummaritimum L. before and after submission to a two-step in vitro digestion model. J Agric Food Chem 59: 12453–12459.*
43. *Kulisic-Bilusic T, Schmöller I, Schnäbele K, Siracusa L, Ruberto G. 2012. The anticarcinogenic potential of essential oil and aqueous infusion from caper (Capparis spinosa L.) Food Chem 132: 261–267.*
44. *Arena A, Bisignano G, Pavone B, Tomaino A, Bonina FP, Saija A, et al. Antiviral and immuno modulatory effect of a lyophilized extract of Capparis spinosa L. buds. Phytother Res 2008; 22:313–7.*
45. *Wu J-H, Chang F-R, Hayashi K, Shiraki H, Liaw C-C, Nakanishi Y, et al. Antitumor agents. Part 218: Cappamensin A, a new in vitro anticancer principle, from Capparis sikkimensis. Bioorg Med Chem Lett 2003; 13: 2223–5.*
46. *Lam S-K, Ng T-B. A protein with antiproliferative, antifungal and HIV-1 reverse transcriptase inhibitor activities from caper (Capparis spinosa) seeds. Phytomedicine 2009; 16:444–5.*
47. *Chang JM, Chen WC, Hong D, Lin JK. The inhibition of DMBA-induced carcinogenesis by neoxanthin in hamster buccal pouch. Nutr Cancer 1995; 24:325–33.*
48. *Hensley K, Benaksas EJ, Bolli R, Comp P, Grammas P, Hamdheydari L, et al. New perspectives on vitamin E: γ-tocopherol and carboxyethyl hydroxychroman metabolites in biology and medicine. Free Radic Biol Med 2004; 36:1–15.*
49. *Ihme N, Kiesewetter H, Jung F, Hoffmann KH, Birk A, Muller A, et al. Leg oedema protection from a buckwheat herb tea in patients with chronic venous insufficiency: a single-centre randomised, double blind, placebo-controlled clinical trial. Eur J Clin Pharmacol 1996; 50: 443–7.*
50. *Aliyazicioglu R, Tosun G, Yaylı N, et al. Characterısatıon of volatıle compounds by spme and gc-fid/ms of capers (Capparis spinosa L.). African J Agric Res 2015; 10: 2213–2217*
51. *Mansour R Ben, Jilani IBH, Bouaziz M, et al. Phenolic contents and antioxidant activity of ethanolic extract of Capparis spinosa. Cytotechnology 2016; 68: 135–142*
52. *Benzidane N, Charef N, Krache I, et al. In Vitro Bronchorelaxant Effects of Capparis Spinosa Aqueous Extracts on Rat Trachea. J Appl Pharm Sci 2013; 3: 85–88*
53. *Zhang H, Ma Z. Phytochemical and Pharmacological Properties of Capparis spinosa as a Medicinal Plant. Nutrients 2018; 10: 116*
54. *Maresca M, Micheli L, Di Cesare Mannelli L, et al. Acute effect of Capparis spinosa root extracts on rat articular pain. J Ethnopharmacol 2016; 193: 456–465*
55. *Jouad H, Haloui M, Rhiouani H, et al. Ethnobotanical survey of medicinal plants used for the treatment of diabetes, cardiac and renal diseases in the North centre region of Morocco (Fez–Boulemane). J Ethnopharmacol 2001; 77: 175–182*
56. *Eddouks M, Maghrani M, Lemhadri A, et al. Ethnopharmacological survey of medicinal plants used for the treatment of diabetes mellitus, hypertension and cardiac diseases in the south-east region of Morocco (Tafilalet). J Ethnopharmacol 2002; 82: 97–103*
57. *Eddouks M, Lemhadri A, Michel JB. 2004. Caraway and caper: potential anti-hyperglycaemic plants in diabetic rats. J Ethnopharmacol 94: 143–148.*
58. *Mishra S, Tomar P, Lakra N. 2007. Medicinal and food value of Capparis—a harsh terrain plant. Indian J Trad knowledge 6: 230–238.*
59. *Polat M. 2007. Capparis spinosa L. (Capparidaceae): a review. Afyon Kocatepe Üniversitesi Fen VeMühendislik Bilimleri Dergisi 7: 35–48.*
60. *Esiyok D, Otles S, Akcicek E. 2004. Herbs as a food source in Turkey. Asian Pac J Cancer Prev 5: 334–339.*

61. *Sher H, Alyemeni MN. 2010. Ethnobotanical and pharmaceutical evaluation of Capparis spinosa L, validity of local folk and Unani system of medicine. J Med Plants Res 4: 1751–1756.*
62. *Zhou H, Jian R, Kang J, et al. 2010. Anti-inflammatory effects of caper (Capparis spinosa L.) fruit aqueous extract and the isolation of main phytochemicals. J Agric Food Chem 58: 12717–12721.*
63. *Lansky EP, Paavilainen HM, Lansky S. 2013. Caper: The Genus Capparis. CRC Press: Boca Raton, FL.*
64. *Al-Qura'n S. 2009. Ethnopharmacological survey of wild medicinal plants in Showbak, Jordan. J Ethnopharmacol 123: 45–50.*
65. *Sher H, Alyemeni MN. 2010. Ethnobotanical and pharmaceutical evaluation of Capparis spinosa L, validity of local folk and Unani system of medicine. J Med Plants Res 4: 1751–1756.*
66. *Tlili N, ElfallehW, Saadaoui E, Khaldi A, Triki S, Nasri N. 2011. The caper (Capparis L.): ethnopharmacology, phytochemical and pharmacological properties. Fitoterapia 82: 93–101.*
67. *Rivera D, Inocencio C, Obón C, Alcaraz F. 2003. Review of food and medicinal uses of Capparis L. Subgenus Capparis (capparidaceae). Economic Bot 57: 515–534.*
68. *Jiang HE, Li X, Ferguson DK, et al. 2007. The discovery of Capparis spinosa L. (Capparidaceae) in the Yanghai Tombs (2800 years bp), NW China, and its medicinal implications. J Ethnopharmacol 113: 409–420.*
69. *Miraldi E, Ferri S, Mostaghimi V. 2001. Botanical drugs and preparations in the traditional medicine of West Azerbaijan (Iran). J Ethnopharmacol 75: 77–87.*
70. *Ahvazi M, Khalighi-Sigaroodi F, Charkhchiyan MM, Mojab F, Mozaffarian VA, Zakeri H. 2011. Introduction of medicinal plants species with the most traditional usage in Alamut region. Iran J Pharm Res 11: 185–194.*
71. *Mosaddegh M, Naghibi F, Moazzeni H, Pirani A, Esmaeili S. 2012. Ethnobotanical survey of herbal remedies traditionally used in Kohghiluyehva Boyer Ahmad province of Iran. J Ethnopharmacol 141: 80–95.*