

Medicinal Properties and Therapeutic Potential of *Fagonia arabica* Linn: A Comprehensive Review

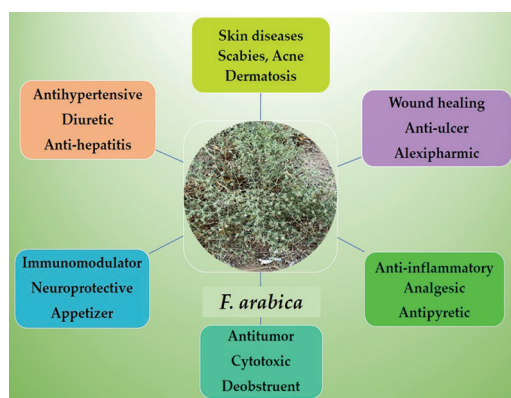
Ibrahim Ahmed Shaikh^{1,2}, Hanish Singh Jayasingh Chellammal^{2,3},
Noordin Othman^{4,5}, Basheerahmed Abdulaziz Mannasaheb^{2,6},
Gurmeet Kaur Surindar Singh^{2,3}

¹Department of Pharmacology, College of Pharmacy, Najran University, Najran 66462, Saudi Arabia, ²Faculty of Pharmacy, Universiti Teknologi MARA, Selangor, Malaysia, ³Brain Degeneration and Therapeutics Group, Universiti Teknologi MARA, Selangor, Malaysia, ⁴Department of Clinical and Hospital Pharmacy, College of Pharmacy, Taibah University, Al-Madinah Al-Munawwarah, Saudi Arabia, ⁵Department of Clinical Pharmacy, School of Pharmacy, Management and Science University, University Drive, Shah Alam, Malaysia, ⁶Department of Pharmacy Practice, College of Pharmacy, AlMaarefa University, P.O. Box 71666, Riyadh 11597, Saudi Arabia.

Abstract

Fagonia arabica, commonly known as “Dhamasa,” is revered in Ayurveda for its multifaceted medicinal properties. Widely used in South Asia and the Middle East, it has been a staple in traditional medicine systems such as Ayurveda and Unani. In this review, a comprehensive search was performed using various scientific databases, including PubMed, Scopus, and Google Scholar. Keywords such as “*Fagonia Arabica* Linn,” “therapeutic potential,” “medicinal properties,” and “phytochemical constituents” were employed to ensure a comprehensive retrieval of relevant literature. The extensive literature analysis showed that *F. arabica* has been long utilized in Middle Eastern and South Asian populations for the treatment of a variety of illnesses, as well as in Ayurvedic and Unani medicine. The plant exhibits a rich history of ethnopharmacological uses across diverse geographic regions. From being a diuretic in India to treating skin diseases and wounds, *F. arabica*'s applications are varied. In Pakistan, it is employed for treating hepatitis, and fever, and even serves as an immunomodulator. The plant's extensive use encompasses regions such as Libya and Saudi Arabia, where it is used as an antihypertensive, antibacterial, and antioxidant. The chemical composition of *F. arabica* includes flavonoids, triterpenoidal glycosides, and saponins. These compounds contribute to the plant's antioxidant activity, making it a potent natural remedy. *F. arabica* has a spectrum of pharmacological activities, including anti-inflammatory, anti-allergic, neuroprotective, and cytotoxic activity. The plant's role as an immunomodulator, deobstruent, analgesic, neuroprotective, and hepatoprotective adds to its pharmacological significance. *F. arabica* stands as a medicinal marvel with a rich history of traditional use and a promising array of pharmacological benefits.

Key words: Cytotoxic, *Fagonia arabica*, herbal medicine, medicinal properties, neuroprotective



Graphical Abstract: Traditional therapeutic applications of *F. arabica*

INTRODUCTION

Fagonia arabica also known as “Dhamasa,” has been known to treat several ailments in the Indian traditional system of medicine known as Ayurveda. It acts as

Address for correspondence:

Gurmeet Kaur Surindar Singh, Faculty of Pharmacy,
Universiti Teknologi MARA, Selangor, Malaysia.
Email: gurmeet9952@uitm.edu.my

Received: 28-07-2024

Revised: 17-08-2024

Accepted: 30-08-2024

blood purifier and decomposes blood clots to save from brain hemorrhage and heart problems. It has been suggested that its flowers and leaves have used in the treatment of several diseases including cancers and thalassemia.^[1,2] Furthermore, it is used for cooling effect, treats all types of hepatitis, strengthens the liver, helps in the treatment of body pains, allergies, heals pimples, and other dermatology problems.

F. arabica has a history of traditional use in various communities, particularly in South Asia and the Middle East. Different communities and cultures have utilized this plant for its medicinal properties. In the South Asian communities, *F. arabica* is widely used in traditional medicine systems throughout South Asia. It has been used in countries such as India, Pakistan, and Bangladesh by various indigenous communities and traditional healers. Decoction of whole plant is used for treating pimples, itching, fever small pox, skin diseases, and hepatitis.^[3] Meanwhile in the Middle Eastern communities, *F. arabica* has a history of traditional use in Iran and Saudi Arabia. In these regions, it may be known by different local names.^[2,4] In the Indian system of medicine, *F. arabica* is utilized in Ayurvedic medicine, where it is known as “Dhamasa” or “Dhamasa Pushpi.” It is used for its potential health benefits in Ayurvedic remedies.^[5-8] *F. arabica* is also used in Unani medicine, which is a traditional system of medicine practiced in many parts of South Asia, particularly in India and Pakistan.^[9,10] Table 1 provides a comprehensive overview of the historical and traditional applications of *F. arabica*, a medicinal plant, across a wide range of geographic regions around the world.

The importance of conducting this comprehensive review stems from the need to provide an up-to-date and in-depth exploration of the therapeutic potential of *F. Arabica* Linn. While existing reviews have touched on its medicinal properties, there remains a notable gap in the coverage of recent scientific findings and the identification of emerging therapeutic applications. This review seeks to bridge this gap by consolidating the most recent research findings on *F. Arabica*, shedding light on its multifaceted therapeutic properties, and unveiling any novel insights that have emerged in recent years.

For the purpose of this review, a comprehensive search was performed using various scientific databases, including PubMed, Scopus, and Google Scholar. Keywords such as “*Fagonia Arabica* Linn,” “therapeutic potential,” “medicinal properties,” and “phytochemical constituents” were employed to ensure a comprehensive retrieval of relevant literature. While this review does not adhere to a strict systematic review methodology, it aims to provide a thorough and updated overview of the vast therapeutic potential that *F. Arabica* offers, based on the most recent scientific evidence available.

F. ARABICA LINN: A BOTANICAL OVERVIEW AND HABITAT

F. arabica is a species of flowering plant belonging to the family *Zygophyllaceae*. *F. arabica* is native to arid and semi-arid regions of the world, particularly in the Mediterranean Basin, North Africa, and the Middle East. It thrives in sandy

Table 1: Ethnopharmacological uses of *Fagonia arabica* across diverse geographic regions

Serial number	Ethnopharmacological uses	Part used	Country	References
1	Diuretic	Whole plant	India	[11]
2	Skin diseases, Abscesses, Scabies, dermatosis, ulcers	Whole plant	India	[12]
3	Wound healing, scrofulous gland wounds	Whole plant	India	[12]
4	Treat snake bites, tumors, and swelling of neck	Applied as paste of twigs	India	[9,10]
5	Anti-inflammatory	Whole plant	India	[13]
6	Mouth sores	Whole plant	India	[14]
7	Analgesic, antipyretic	Whole plant	India	[13]
8	Treatment of liver cancer	Whole plant	India	[15]
9	Treatment of hepatitis, fever, inflammation, itching, pimples	Decoction of whole plant	Pakistan	[16]
10	Treatment of dermatosis, smallpox, endothermic reactions in body	Decoction of whole plant	Pakistan	[17]
11	Treatment of stomatitis	Decoction of whole plant	Pakistan	[18]
12	Used as deobstruent	Decoction of whole plant	Pakistan	[19]
13	Erysipelas, alexipharmic, antipyretic, dysentery, urinary tract infections, anti-tumor, blood purifier, anti-inflammatory	Decoction of whole plant	Pakistan	[20,21]
14	Immunomodulator, analgesic, appetizer, management of neurological and endocrine disorders	Decoction of whole plant	Pakistan	[22,23]
15	Used as antihypertensive, analgesic, anti-inflammatory	Decoction of whole plant	Libya	[24]
16	Antibacterial and antioxidant	Areal parts (whole plant)	Saudi Arabia	[25]

and rocky soils, often found in deserts, steppes, and coastal areas. This plant is highly adaptable to harsh conditions and is considered a xerophyte, meaning it is well-suited to survive in dry environments.

BOTANICAL CLASSIFICATION

Kingdom: *Plantae*
Clade: Angiosperms
Clade: *Eudicots*
Order: *Zygophyllales*
Family: *Zygophyllaceae*
Genus: *Fagonia*
Species: *Fagonia arabica* L.

GENERAL DESCRIPTION AND ORIGIN

The genus *Fagonia* includes many herbs, shrubs, and shrublets, which typically reach a maximum height of 75 cm and breadth of 100 cm. The floral structures include petals that possess a pinkish-purple color, accompanied by distinct, aromatic spines.^[1,26,27] The genus in question encompasses both annual and perennial plant species, characterized by glabrous shrublets that possess sessile glands. The internodes serve as the connecting segments between the cylindrical branches of the woody stem. The leaves of this particular genus exhibit a range of characteristics, including lanceolate or oblong shapes, as well as being either unifoliate or trifoliate. In addition, these leaves include a distinct spine-like structure.^[28] Potentially useful as a medicine, *F. arabica* can be found in arid and mountainous regions of South Asia, the Middle East, Central Europe, North Africa, California, and Chile [Figure 1]. This flower is a member of the *Zygophyllaceae* family, specifically the *Fagonia* genus. It is common in the calcareous rocks across the Mediterranean and can reach heights of 1–3 feet. Within these particular locations, a diverse range of *Fagonia* species are found.^[29] *F. arabica*, *Fagonia cretica*, *Fagonia brugie*, *Fagonia mycorrhizal*, and *Fagonia indica* are widely recognized as the predominant species within the genus *Fagonia* that have been extensively employed in traditional medicinal practices.^[30] *F. arabica* has several vernacular names for example, in Hindi/Urdu, it is called dhamasa or suchi booti; in English, it is called Cretan prickly clover, Khorasan thorn, and virgin's mantle; in Persian, it is called badavard; in German, it is called *Fagonie* or *Fagonia*; and in Arabic, it is called shawka al-Baidaa or shukaaa. In traditional medicine, the whole herb is ground into a powder. Dried samples of plant material had also been used in studies by researchers.^[10]

CHEMICAL COMPOSITION OF GENUS FAGONIA

Fagonia species have been reported to contain a variety of phytoconstituents, including carbohydrates, flavonoids,

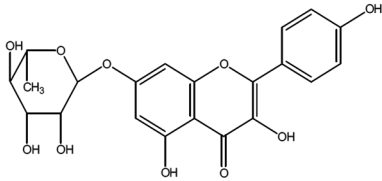
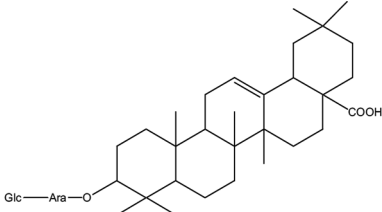
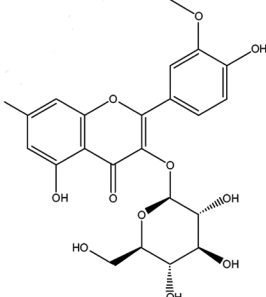
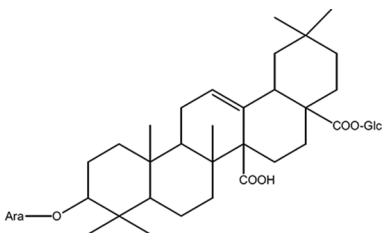
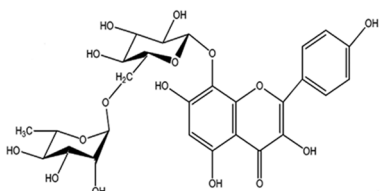

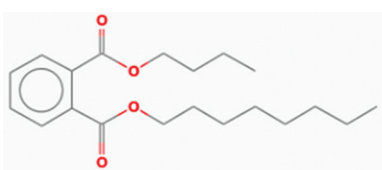
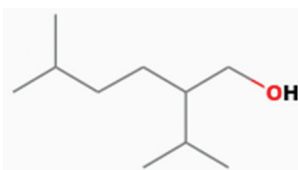
glycosides, steroids, saponins, alkaloids, triterpenoids, amino acids, chlorides, sulfates, anthraquinones, iridoids, cyanogenic glycosides, and coumarins.^[31,32] For example, *F. cretica* contains alkaloids, cardiac glycosides, saponins, and coumarins.^[27] Sapogenins, saponins, glycosides, and flavonoids can be found in the plant species *F. indica*.^[33] The *F. mollis* stems, leaves, and flowers also contain saponins (Melek *et al.*, 1996). It has been documented that other species, such as *F. thebica*, *F. glutinosa*, and *F. isothricha*, contain flavonoids as well.^[34,35] Tannins, saponins, flavonoids, terpenes, alkaloids, proteins, hederagenin, ursolic acid, pinitol, etc. have all been reported as chemical constituents in the Genus *Fagonia* by various researchers.^[1,36-39] Numerous researchers have noted glycosides, flavonoids, triterpenes, saponins, sulfur compounds, and numerous other significant medicinal phytoconstituents, particularly with regard to *F. arabica*.

El-Negoumy *et al.* reported six typical flavonoids with rutenoside and glucoside linkages to isorhamnetin and herbacetin.^[39] Phytoconstituents with rhamnoside linkages to kaempferol and acetin, collectively known as flavonoid glycosides, were discovered by El-Wakil in a water-methanol extract of *F. Arabica*.^[40] Some phenolic compounds in the plant have been reported to have antioxidant activity.^[4] Four triterpenoidal glycosides were found in the aerial parts of *F. arabica*, with glucopyranosyl and arabinopyranoside links to oleanolic acid and quinovic acid.^[39] Novel sulfated triterpenes and sulfated triterpene glycosides were isolated from whole plant extracts by Perrone *et al.*^[41] A study reported that *F. arabica* contained both mono- and didesmosidic saponins.^[39] Miyase *et al.*, reported seven novel triterpenoidal saponins that combine oleanolic acid and ursolic acid with xylopyranosyl, glucopyranosyl, and arabinopyranosyl linkages.^[42] The chemical structure of major phytochemicals found in *F. arabica* is depicted in Table 2.

PHARMACOLOGICAL ACTIVITIES OF GENUS FAGONIA

It has been reported that various *Fagonia* species have various medicinal properties. Anti-inflammatory,^[43] anti-allergic,^[44] neuroprotective,^[45] androgenic,^[24] endocrinological,^[46] and cytotoxic effects,^[29] have been previously reported. Additional activities of the genus *Fagonia* were reported by another author, and this included clot lytic, analgesic, antioxidant, hepatoprotective, and antihemorrhagic properties.^[46] Various pharmacological activities, including those on the blood, central nervous system, and endocrine system, have been reported by several researchers.^[47-50] *F. arabica* infusions are used to treat stomatitis. In addition to its deobstruent properties, this plant is used for blood purification.^[19] Skin conditions, chicken pox, tumors, and neck swelling are cured with this plant.^[10,51] The plant's dried tops have diuretic properties.^[46,52]

Table 2: Chemical composition of the major phytochemicals present in *Fagonia Arabica*

Serial number	Phytochemicals name	Chemical structure
1	Kaempferol-7-O-rhamnoside	
2	3-O-β-D-glucopyranosyl-(13)-α-L-arabinopyranoside oleanolic acid	
3	Isorhamnetin-3-glucoside	
4	3-O-α-L-arabinopyranosyl-quinovic acid 28-O-β-D-glucopyranoside	
5	Herbacetin 8-rutinoside	
6	n-Hexadecanoic acid	
7	1,2-Benzenedicarboxylic acid, butyl octyl ester	
8	1-Hexanol, 5-methyl-2-(1-methylethyl)	

EFFICACY AS AN ANTIOXIDANT

The researchers have found phenolic compounds in the plant that have antioxidant activity.^[2,53] The antioxidant activity of the plant was reported by another researcher, who also confirmed the analgesic, anti-inflammatory, and antipyretic effects found in the plant. During ischemia, *F. arabica* has been shown to scavenge free radicals and reduce oxidative stress-mediated cell injury.^[38] Another study found that *Fagonia schweinfurthii* has significant hepatoprotective activity. This effect could be attributed to the extract's ability to inhibit lipid peroxidation and increase anti-oxidant enzymatic activity.^[13] In a recent study, Rugaie *et al.*, investigated the antioxidant potential of *Fagonia mollis* growing in Qassim Region of Saudi Arabia.^[54] The ethanolic extract showed significant total antioxidant activity, ferric-reducing antioxidant power, metal chelating activity, and DPPH radical scavenging activity.^[54] In another study, Mansoor *et al.*, synthesized silver and graphene oxide doped manganese oxide nanocomposites (NCs) using *F. arabica*. The antioxidant activity of the NCs showed a higher scavenging potential than the standard ascorbic acid.^[55] In addition, the ethanolic extract of *F. arabica* showed moderately strong reducing power and DPPH scavenging activity,^[56] ferric reducing antioxidant potential, DPPH scavenging, and significant total antioxidant capacity confirmed by Phosphomolybdate assay.^[57] Furthermore, Ahmad *et al.*, reported that the administration of *F. arabica* extract in male mice showed a mitigating effect on the mutagenic and biochemical consequences induced by the anticancer medication Mitomycin C. This effect was achieved by the enhancement of the endogenous antioxidative defense system of the cells, as well as the reduction of lipid peroxidation and scavenging of free radicals, hence exhibiting significant antioxidant properties.^[58]

INHIBITION OF THROMBOSIS

An *in vitro* clot lysis model showed that *F. arabica* had a thrombolytic activity of 75.6%, suggesting that it could be developed into a medicine for patients with atherothrombotic diseases.^[5,59] *F. arabica* combined with fish extract from *Heteropneustes fossilis* was studied by another researcher, who found that the combination was more effective than either plant extract alone.^[60,61] Thrombolytic activity of this plant was also reported in human umbilical cord cells using thrombin-inducing tissue plasminogen activator and plasminogen activator inhibitor-1.^[7,62] In a study conducted by Chaudhary *et al.*,^[63] it was shown that *F. arabica* exhibited a noteworthy level of clot lysis, amounting to 68%. This finding was found to be equivalent to the clot lysis efficacy of streptokinase, a widely recognized thrombolytic medication, which demonstrated a percentage of 92.54%. This study suggests the potential for discovering new thrombolytic medications.^[64]

NEUROPROTECTIVE POTENTIAL OF *F. ARABICA*

Recent studies have focused on the potential neuroprotective properties of *F. arabica* plant extract. Neuroprotection refers to the ability of a substance to prevent damage to the brain or promote the survival of neurons. This is an important area of research because many neurological disorders, such as Alzheimer's disease, Parkinson's disease, and stroke, involve the death or dysfunction of neurons. Several studies have reported the neuroprotective activity of *F. arabica* plant extract. A study by Satpute *et al.*, depicted that *F. arabica* exhibits significant antioxidant properties and demonstrates neuroprotective effects against chemical-induced ischemia in PC12 cells. It helps maintain cellular energy levels and mitochondrial integrity while reducing oxidative damage.^[18,65]

A study by Anjum identified the neuroprotective compounds present in *F. arabica* extract.^[66] The study identified several flavonoids, including quercetin, kaempferol, and luteolin, as the main active compounds responsible for the neuroprotective activity of *F. arabica* extract. The researchers suggested that the neuroprotective effect of *F. arabica* extract could be attributed to the synergistic action of these flavonoids. Another study by Rawal *et al.* investigated the neuroprotective potential of *F. cretica*. The herb reduced oxidative stress-mediated cell damage during oxygen-glucose deprivation, exerted the effects at the cytosolic and gene expression levels, and maybe a useful therapeutic agent against ischemic brain damage.^[45]

The neuroprotective activity of *F. arabica* extract has been attributed to its antioxidant and anti-inflammatory properties. Oxidative stress and inflammation are two major factors that contribute to neuronal damage and death. Antioxidants are substances that can neutralize free radicals, which are highly reactive molecules that can damage cells and tissues. Anti-inflammatory compounds can reduce the production of inflammatory mediators, which can contribute to tissue damage and cell death. In addition to its antioxidant and anti-inflammatory properties, *F. arabica* extract contains several flavonoids that have been shown to have neuroprotective effects. Flavonoids are plant-derived compounds that have antioxidant, anti-inflammatory, and neuroprotective properties. Quercetin, kaempferol, and luteolin are three flavonoids that have been identified in *F. arabica* extract and have been shown to have neuroprotective effects in various studies. While the studies conducted so far have reported promising results, more research is needed to fully understand the potential neuroprotective properties of *F. arabica* plant extract. In particular, studies in humans are needed to determine whether *F. arabica* extract is safe and effective for the prevention or treatment of neurological disorders. Nonetheless, the findings of these studies suggest that *F. arabica* plant has the potential to be developed into a neuroprotective agent.

F. ARABICA IN REPRODUCTIVE HEALTH

In a recent research conducted by Wazir *et al.* in 2022, they investigated the potential fertility-enhancing effects of the aerial parts of *F. arabica* in both male and female rats. The findings revealed that when orally administered, *F. arabica* demonstrated remarkably significant improvements in fertility in both male and female rats, notably increasing sperm count in males and the number of offspring in females when compared to the control group.^[67] Reproductive difficulties can arise from various factors, such as hormonal imbalances, oxidative stress, infections, and other underlying health conditions. Phytomedicines offer a holistic approach to managing these problems by addressing the root causes and promoting overall reproductive health. They are known to have fewer side effects compared to synthetic drugs and can be used as complementary or alternative therapies in reproductive medicine.

One study by Aziz *et al.*, highlighted the potential of phytomedicines in resolving reproductive issues.^[68] The study reported that phytomedicines were effective in addressing weaknesses in sexual activities, menstrual problems, infections, and reducing the risk of abortion. This suggests that these natural remedies can provide a comprehensive approach to improving reproductive health.

In the treatment of infertility, combining phytomedicines with assisted reproductive techniques may enhance the chances of conception. The study mentioned the evaluation of *F. arabica*, a plant known for its medicinal properties, in male and female rats. *F. arabica* extract exhibited antioxidant properties due to its phenolic constituents. Antioxidants play a crucial role in reducing oxidative stress caused by reactive oxygen species, which can damage sperm, eggs, and reproductive tissues. By reducing oxidative stress, *F. arabica* may help improve fertility in both males and females. Flavonoids are vital polyphenol compounds that may be responsible for the plant's fertility-enhancing action.^[69]

UTILIZED FOR ENVIRONMENT SAFETY (NON-PHARMACOLOGICAL USE)

Using the mass loss test, the potentiodynamic polarization method, and the electrochemical impedance spectroscopy method, researchers were able to determine that adsorption of the *F. arabica* extracts on the Cu surface was the primary mechanism by which the extracts inhibited corrosion. This research demonstrates that this extract is a valuable, eco-friendly, and inexpensive inhibitor of corrosion for Cu.^[70] From the reported data, we may conclude that the genus *Fagonia* is home to many species, many of which contain phytoconstituents and pharmacological activities that are important for medicinal purposes; however, very little research work has been done on *F. arabica* to scientifically validate the traditional applications of the herb. Therefore, the species has a lot to offer to researchers in the future.

THE POTENTIAL SIDE EFFECTS OF F. ARABICA

There is limited information available on the potential side effects of *F. arabica* extract, as most of the studies conducted so far have focused on its therapeutic benefits. However, some preliminary studies have suggested that *F. arabica* extract may have some side effects. A study conducted in Iraq reported that *F. arabica* extract caused a decrease in blood glucose levels in diabetic rats.^[71] While this may be beneficial for people with diabetes, it could also cause hypoglycemia (low blood sugar) in some individuals, particularly those taking medication to lower their blood sugar. In addition, *F. arabica* extract may interact with certain medications, particularly those that are metabolized by the liver. For example, there are several reported herb-drug interactions that can influence the activity of cytochrome P450 enzymes, which are responsible for metabolizing many medications.^[72]

F. arabica extract has been traditionally used for its various pharmacological properties, and several studies have investigated its potential therapeutic benefits for various health conditions. However, it is important to note that most of these studies have been conducted in animal models or *in vitro*, and more research is needed to determine the efficacy of *F. arabica* extract for treating specific health conditions in humans. Overall, more research is needed to fully understand the potential side effects of *F. arabica*. It is important to note that more research is needed to determine the efficacy and safety of *F. arabica* extract for treating specific health conditions in humans. If researchers are considering using *F. arabica* extract for a particular health condition, it is important to establish its safety and efficacy through preclinical trials followed by clinical trials.

RECOMMENDED DOSAGE FOR F. ARABICA EXTRACT

There is no established recommended dosage for *F. arabica* extract, as most of the studies conducted so far have used different doses and formulations. In addition, the optimal dosage may vary depending on the specific health condition being treated, as well as individual factors such as age, weight, and overall health. It is important to note that herbal supplements, including *F. arabica* extract, are not regulated by the FDA in the same way as prescription drugs. As a result, the quality and potency of herbal supplements can vary widely, and there may be significant differences between products from different manufacturers.^[73] Before considering the use of *F. arabica* extract as a dietary supplement, it is imperative to initiate a dialogue with a qualified healthcare practitioner and conduct clinical trials. It is also important to follow the manufacturer's instructions carefully when taking herbal supplements and to monitor yourself for any potential side effects. If you experience any adverse effects, you should stop taking the supplement and seek medical attention if necessary.



Figure 1: Title plant: *Fagonia arabica*; Family: *Zygophyllaceae*; Genus: *Fagonia*

CLINICAL TRIALS FOR *F. ARABICA*

At present, there were no ongoing clinical trials investigating the efficacy of *F. arabica* extract listed on clinicaltrials.gov, which is a registry of clinical trials conducted around the world. However, it is important to note that clinical trials can be initiated at any time, and it is possible that new studies investigating the potential therapeutic benefits of *F. arabica* extract may be initiated in the future. While there is some preclinical evidence suggesting that *F. arabica* extract may have therapeutic potential for various health conditions, more research is needed to determine its safety and efficacy in humans. Clinical trials are the gold standard for evaluating the safety and efficacy of new treatments and can help to establish the optimal dosage, route of administration, and treatment duration for a particular condition.

CONCLUSION

Several studies have reported the neuroprotective activity of *F. arabica* plant extract. The neuroprotective effect of *F. arabica* extract could be attributed to its antioxidant and anti-inflammatory properties, as well as the presence of flavonoids such as quercetin, kaempferol, and luteolin. These findings suggest that *F. arabica* plant could be a potential candidate for the development of new neuroprotective agents. However, further studies are needed to elucidate the underlying mechanisms of its neuroprotective activity and to evaluate its safety and efficacy in humans.

FUTURE RESEARCH DIRECTIONS/ APPLICATIONS

F. arabica, with its traditional medicinal uses and unique chemical composition, holds promise for future healthcare and pharmaceutical applications. Research could focus on isolating and characterizing its active compounds, particularly for their anti-inflammatory, analgesic, and

antidiabetic properties. Exploring its antimicrobial activity against drug-resistant pathogens, investigating its antioxidant and cytoprotective effects, and conducting a comprehensive analysis of its phytochemical composition is crucial for unlocking its full therapeutic potential. Thorough safety studies are essential to ensure its safe and effective use in medicinal products and therapies.

CREDIT AUTHORSHIP CONTRIBUTION STATEMENT

Ibrahim Ahmed Shaikh: Conceptualization, Methodology, Software; Writing – Original draft preparation; Hanish Singh Jayasingh Chellammal: Methodology, Data curation, Writing – Reviewing and Editing; Noordin Othman: Methodology, Supervision, Writing – Reviewing and Editing; Basheerahmed Abdulaziz Mannasaheb: Data curation, Writing – Reviewing and Editing; Gurmeet Kaur Surindar Singh: Conceptualization, Software, Supervision, Writing – Reviewing and Editing.

ACKNOWLEDGMENT

The authors are thankful to College of Pharmacy, UiTM, Malaysia. The authors would like to express sincere gratitude to AlMaarefa University, Riyadh, Saudi Arabia, for supporting this research.

REFERENCES

1. Ageely H, Suneet K, Gupta BR. Review of ethnomedicinal plant *Fagonia*. *Int J Pharm Appl* 2014;5:22-8.
2. Walbi IA, Alshabi AM, Alkahtani SA, Shaikh IA, Abdel-Wahab BA, Khateeb MM, *et al.* A preliminary cytotoxicity study of *Fagonia arabica* against breast (MCF-7), oral (KB-3-1), and lung cancer (A-549) cell lines: A study supported by molecular marker analysis using dual staining dyes. *Separations* 2023;10:110.
3. Rasool BT, Tahira B, Mir AK, Mushtaq A, Muhammad Z. Indigenous knowledge of folk medicine by the women of Kalat and Khuzdar regions of balochistan, Pakistan. *Pak J Bot* 2010;42:1465-85.
4. Tawaha K, Alali F, Gharaibeh M, Mohammad M, Elelimat T. Antioxidant activity and total phenolic content of selected Jordanian plant species. *Food Chem* 2007;104:1372-8.
5. Prasad S, Kashyap RS, Deopujari JY, Purohit HJ, Taori GM, Dagainawala HF. Effect of *Fagonia arabica* (Dhamasa) on *in vitro* thrombolysis. *BMC Complement Altern Med* 2007;7:36.
6. Chourasia SR, Kashyap RS, Purohit HJ, Deopujari JY, Taori GM, Dagainawala HF. *In-vitro* clot lytic potential of *Fagonia arabica*: A comparative study of two methods.

- Blood Coagul Fibrinolysis 2011;22:288-94.
7. Aloni P, Nayak AR, Chaurasia SR, Deopujari JY, Chourasia C, Purohit HJ, *et al.* Effect of *Fagonia arabica* on thrombin induced release of t-PA and complex of PAI-1 tPA in cultured HUVE cells. *J Tradit Complement Med* 2016;6:219-23.
 8. Hussain AI, Rathore HA, Iftikhar N, Chatha SA, Ahmad T, Ali Q. *Fagonia arabica* L.: A review of its phytochemistry, pharmacology and traditional uses. *Comb Chem High Throughput Screen* 2022;25:1187-99.
 9. Shad AA, Shah H, Khattak FK, Dar NG, Bakht J. Proximate and mineral constituents of medicinal herb *Fagonia arabica*. *Asian J Plant Sci* 2002;1:710-1.
 10. Rizvi MA, Ahmad L, Sarwar GR. Wild medicinal plants of Madinat Al-Hikmah and its adjacent areas. *Hamdard Medicus* 1996;39:8-10.
 11. Kakrani HN, Saluja AK. Plants used for Diuretic Activity in traditional medicine in Kutch district, Gujrat. *J Nat Remed* 2001;1:121-4.
 12. Patel R, Upwar N, Mahobia NK, Waseem N, Jha AK, Singh S. Pharmacognostical evaluation of *Fagonia arabica* L. *Stem J Pharm Res* 2012;5:1015-7.
 13. Satpute RM, Kashyap RS, Deopujari JY, Purohit HJ, Taori GM, Daginawala HF. Protection of PC12 cells from chemical ischemia induced oxidative stress by *Fagonia arabica*. *Food Chem Toxicol* 2009;47:2689-95.
 14. Kumar VP, Chauhan NS, Padh H, Rajani M. Search for antibacterial and antifungal agents from selected Indian medicinal plants. *J Ethnopharmacol* 2006;107:182-8.
 15. Azam F, Sheikh N, Ali G, Tayyeb A. *Fagonia indica* repairs hepatic damage through expression regulation of toll-like receptors in a liver injury model. *J Immunol Res* 2018;7967135.
 16. Tareen RB, Bibi T, Khan MA, Ahmad M, Zafar M, Hina S. Indigenous knowledge of folk medicine by the women of Kalat and Khuzdar regions of Balochistan, Pakistan. *Pak J Bot* 2010;42:1465-85.
 17. Khattak KF. Free radical scavenging activity, phytochemical composition and nutrient analysis of *Elaeagnus umbellata* berry. *J Med Plants Res* 2012; 6:5196-203.
 18. Satpute R, Bhattacharya R, Kashyap SR, Purohit HJ, Deopujari JY, Taori GM, *et al.* Antioxidant potential of *Fagonia arabica* against the chemical ischemia-induced in PC12 cells. *Iran J Pharm Res* 2012;11:303-13.
 19. Said HM. Medicinal Herbal: A Textbook for Medical Students and Doctors. Pakistan: Hamdard Foundation Pakistan: Medical Students and Doctors; 1996.
 20. Al-Harbi N. A comparative study on the kinds of weeds of palm plantations in Tabuk and Al-Qassim Regions in Saudi Arabia. *Iraqi J Agric Sci* 2021;52:763-73.
 21. Syed F, Jahan R, Ahmed A, Khan S. *In vitro* antimicrobial activities of *Glycyrrhiza glabra* and *Fagonia arabica*. *J Med Plants Res* 2013;7:2265-70.
 22. Dasegowda KR, Maruthiprasad E, Rahmathullah SB, Kodidala LD. Protective effect of *Fagonia arabica* against isoproterenol induced myocardial infarction in albino rat model. *Int J Appl Biol Pharm Technol* 2016;7:160-7.
 23. Basit A, Sultana R, Aziz A. Extraction of phytochemicals from *Fagonia arabica* and their antimicrobial activity. *Int J Chem Biochem Sci* 2019;15:25-7.
 24. Abobaker DM. Preliminary phytochemical analysis and antibacterial activity of the aqueous and ethanolic extracts of *Fagonia arabica* L., used as traditional medicinal plant in Libyan. *Int J Sci Res* 2017;6:1056-9.
 25. Sulieman AM, Alanaizy E, Alanaizy NA, Abdallah EM, Idriss H, Salih ZA, *et al.* Unveiling chemical, antioxidant and antibacterial properties of *Fagonia indica* grown in the Hail mountains, Saudi Arabia. *Plants (Basel)* 2023;12:1354.
 26. Anwar AK, Ashfaq M, Nasveen MA. Pharmacognostic Studies of Selected Indigenous Plants of Pakistan. Pakistan: Pakistan Forest Institute, Peshawar NWFP; 1979.
 27. Qureshi H, Asif S, Ahmed H, Al-Kahtani HA, Hayat K. Chemical composition and medicinal significance of *Fagonia cretica*: A review. *Nat Prod Res* 2016;30:625-39.
 28. Shinwari MI, Shah M. Medicinal Plants of Margalla Hills. Islamabad: Pakistan Museum of Natural History; 2003.
 29. Puri D, Bhandari A. *Fagonia*: A potential medicinal desert plant. *J Nepal Pharm Assoc* 2015;27:28-33.
 30. Sarwar T, Anwar S, Amjad I, Munir Z, Jameel M, Binish A, *et al.* Wild medicinal plants of Madinat Al-Hikmah and its adjacent areas. *World J Pharm Life Sci* 1996;7:8-10.
 31. Kasture VS, Gosavi SA, Kolpe JB, Deshapande SG. Phytochemical and biological evaluation of *Fagonia* species: A review. *World J Pharm Pharm Sci* 2014; 3:1206-17.
 32. Saleh NA, El-Hadidi MN. An approach to the chemosystematics of the *Zygophyllaceae*. *Biochem Syst Ecol* 1977;5:121-8.
 33. Pareek A, Batra N, Goyal M, Nagori BP. Phytochemicals and biological activities of *Fagonia indica*. *Int Res J Pharm* 2016;3:56-9.
 34. Alghanem SM. Antimicrobial and antioxidant evaluation of different solvent extracts of medicinal plant: *Fagonia mollis* Delile. *J Med Herbs Ethnomed* 2018;4:7-11.
 35. Sam AW, Shahnaz AM. Significance of flavonoid chemistry in the Egyptian *Fagonia glutinosa* and *F. isothricha* complex. *Biochem Syst Ecol* 1992;20:259-64.
 36. Al-Waeel S, El-Garf IA, Salen N. Distribution of flavonoids in *Fagonia thebica* complex. *Biochem Syst Ecol* 1988;16:57-8.
 37. El-Hadidi MN, Al-Wakeel SA, El-Garf IA. Systematic significance of the flavonoid constituents in *Fagonia indica* complex. *Biochem Syst Ecol* 1988;16:293-7.
 38. Atta-ur-Rahman, Ansari AA, Kenne L. Hederagenin, ursolic acid and pinitol from *Fagonia indica*. *J Nat Prod* 1984;13:186-7.
 39. El-Negoumy SI, Al-Wakeel SA, El-Hadidi MN, Saleh NA. The flavonoids of the *Fagonia arabica*-complex (*Zygophyllaceae*). *Phytochemistry* 1986;25:2423-4.

40. El-Wakil EA. Phytochemical and molluscicidal investigations of *Fagonia arabica*. *Z Naturforsch* 2007; 62:661-7.
41. Perrone A, Masullo M, Bassarello C, Hamed AI, Belisario MA, Pizza C, *et al.* Sulfated triterpene derivatives from *Fagonia arabica*. *J Nat Prod* 2007; 70:584-8.
42. Miyase T, Melek FR, El-Gindi OD, Abdel-Khalik SM, El-Gindi MR, Haggag MY, *et al.* Saponins from *Fagonia arabica*. *Phytochemistry* 1996;41:1175-9.
43. Alqasomi SI, Yusufoglu HS, Alam A. Anti-inflammatory and wound healing activity of *Fagonia schweinfurthii* alcoholic extract herbal gel on albino rats. *Afr J Pharm Pharmacol* 2011;5:1996-2001.
44. Puri D, Bhandari A, Gaur P. Screening of anti-histaminic activity of *Fagonia schweinfurthii* hadidi in guinea pig ileum and formulate anti-histaminic syrup. *Nat Prod J* 2015;5:176-9.
45. Rawal AK, Muddeshwar MG, Biswas SK. *Rubia cordifolia*, *Fagonia cretica* linn and *Tinospora cordifolia* exert neuroprotection by modulating the antioxidant system in rat hippocampal slices subjected to oxygen glucose deprivation. *BMC Complement Altern Med* 2004;4:11.
46. Farheen R, Mahmood I, Parveen R, Anwar KF. Review on medicinal and bioactive role of genus *Fagonia*. Review on medicinal and bioactive role of genus *Fagonia*. *FUUAST J Biol* 2017;7:33-6.
47. Chopra RN, Nayar SL, Chopra IC. Glossary of Indian Medicinal Plants. New Delhi: CSIR; 1956.
48. Saeed MA, Khan Z, Sabir AW. Effects of *Fagonia cretica* L constituents on various endocrinological parameters in rabbits. *Truk J Biol* 1999;23:187-97.
49. Saeed MA, Wahid SA. Effects of *Fagonia cretica* L constituents on various haematological parameters in rabbits. *J Ethopharmacol* 2003;85:195-200.
50. Kapoor L, Chopra I. The ancient history and evolution of the present indigenous drugs in india1. *Planta Med* 1961;9:47-52.
51. Watt G. Dictionary of the economic products of India pages 1 to 178. In: A Dictionary of the Economic Products of India. Cambridge: Cambridge University Press; 2014. p. 1-178.
52. Kanwal I, Fatima N, Wazir A, Khan M, Zaheer M, Masroor D, Syed S. *Fagonia Arabica* Linn, a miraculous medicinal plant with diminutive scientific data but hefty potential. *RADS J Pharm Pharm Sci* 2021;9:185-189.
53. Hamid A, Majid A. Isolation of docosyl docosanoate from *Fagonia cretica* Linn. *Arab Gulf J Sci Res* 1989;7:29-34.
54. Rugaie OA, Mohammed HA, Alsamani S, Messaoudi S, Aroua LM, Khan RA, *et al.* Antimicrobial, antibiofilm, and antioxidant potentials of four halophytic plants, *Euphorbia chamaesyce*, *Bassia arabica*, *Fagonia mollis*, and *Haloxylon salicornicum*, growing in Qassim region of Saudi Arabia: Phytochemical profile and *in vitro* and *in silico* bioactivity investigations. *Antibiotics (Basel)* 2023;12:501.
55. Mansoor S, Shahid S, Javed M, Saad M, Iqbal S, Alsaab HO, *et al.* Green synthesis of a MnO-GO-Ag nanocomposite using leaf extract of *Fagonia arabica* and its antioxidant and anti-inflammatory performance. *Nanostruct Nanoobjects* 2022;29:100835.
56. Heikal YM, Gebreil AS, Elshamy MM, Rizwan M, Ali S. Antifungal activity of ethanol extracts of fourteen wild indigenous plants against four phytopathogenic fungi. *Plant Biol Crop Res* 2022;5:1067.
57. Dilshad R, Batool R. Antibacterial and antioxidant potential of *Ziziphus jujube*, *Fagonia arabica*, *Mallotus philippensis* and *Hemidesmus indicus*. *Jordan J Pharm Sci* 2022;15:413-27.
58. Ahmad ES, Girgis SM, Kassem S, Shoman TM, Hassanane MS. *Fagonia arabica* extract ameliorate the mutagenic and biochemical effects of antitumor drug mitomycin C in male mice. *Res J Pharm Biol Chem Sci* 2016;7:878.
59. Yamamoto J, Yamada K, Naemura A, Yamashita T, Arai R. Testing various herbs for antithrombotic effect. *Nutrition* 2005;21:580-7.
60. Das R, Koushik A. Synergistic activity of *Fagonia arabica* and *Heteropneustes fossilis* extracts against myocardial, cerebral infarction and embolism disorder in mice. *J Pharm Bioallied Sci* 2010;2:100-4.
61. Rajapakse N, Jung WK, Mendis E, Moon SH, Kim SK. A novel anticoagulant purified from fish protein hydrolysate inhibits factor XIIa and platelet aggregation. *Life Sci* 2005;76:2607-19.
62. Nagase H, Enjyoji K, Minamiguchi K. Depolymerized holothurian glycosaminoglycan with novel anticoagulant actions: Antithrombin and heparin cofactor independent inhibition of factor X activity by factor IXa-factor VIIIa complex and heparin cofactor dependent inhibition of thrombin. *Blood* 1995;85:1527-34.
63. Chaudhary S, Godatwar PK, Sharma R. *In vitro* thrombolytic activity of Dhamasa (*Fagonia arabica* Linn.), Kushta (*Saussurea lappa* Decne.), and Guduchi (*Tinospora cordifolia* Thunb.). *Ayu* 2015;36:421-4.
64. Godatwar P, Chaudhary S, Sharma R. *In vitro* thrombolytic activity of Dhamasa (*Fagonia arabica* Linn.), Kushta (*Saussurea lappa* Decne.), and Guduchi (*Tinospora cordifolia* Thunb.). *Ayu* 2015;36:421-4.
65. Iqbal P, Ahmed D, Asghar MN. A comparative *in vitro* antioxidant potential profile of extracts from different parts of *Fagonia cretica*. *Asian Pac J Trop Med* 2014;7S1:S473-80.
66. Anjum I. Flavonoids and alkaloids from *Fagonia arabica* with their anti-inflammatory and antioxidant activities. *Phytochemistry* 2014;100:199-204.
67. Wazir A, Fatima N, Kanwal I, Masroor D, Khan M, Zaheer M, *et al.* Phytochemical analysis and fertility enhancement effects of aerial parts of *Fagonia arabica* in male and female rats. *Pak J Pharm Sci* 2022;35:501-6.
68. Aziz MA, Khan AH, Ullah H, Adnan M, Hashem A, Abd Allah EF. Traditional phytomedicines for gynecological problems used by tribal communities of Mohmand

- Agency near the Pak-Afghan border area. *Rev Bras Farmacogn* 2018;28:503-11.
69. Li MC, Nassan FL, Chiu YH, Mínguez-Alarcón L, Williams PL, Souter I, *et al.* Intake of antioxidants in relation to infertility treatment outcomes with assisted reproductive technologies. *Epidemiology* 2019; 30:427-34.
70. Fouda AE, Ahmed AE, El-Darier SM, Badr SE. *Fagonia arabica* extract as a safe-environment green corrosion inhibitor for Cu in HNO₃ solution. *J Chin Chem Soc Taipei* 2021;68:1445-55.
71. Ahmed GT, Venkata RD. Protective Effect of *Fagonia arabica* (L.) against Alloxan Monohydrate-Induced Diabetes in Albino Wistar Rat. In: *Proceedings Researches of the Fourth Medical Scientific Conference*; 2016.
72. Fugh-Berman A. Herb-drug interactions. *Lancet* 2000;355:134-8.
73. Andrew R, Izzo AA. Principles of pharmacological research of nutraceuticals. *Br J Pharmacol* 2017; 174:1177-94.

Source of Support: Nil. **Conflicts of Interest:** None declared.