

A Comprehensive Review on Pharmacological Activity of *Foeniculum vulgare*



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Abstract

Foeniculum vulgare (Apiaceae / Umbelliferae) commonly known as fennel is a well-known and important medicinal and aromatic plant widely used as digestive, diuretic, Asthma, Breast feeding women, Diabetes help lower cholesterol level, cure edema, Anxiety, Depression, gastrointestinal disorders. Its seeds are used as Blood pressure, reduce asthma symptoms, reduce water Retention, Helps purify Blood, Improves eyesight. In vitro and in vivo models, many pharmacological experiments have demonstrated the ability to perform strongly *Foeniculum vulgare* to exhibit antifungal, antibacterial, antioxidant, anti-anxiety, and anti depression activities, supporting the argument behind its many therapeutic uses. Phenolic compounds separated by *Foeniculum vulgare* are considered responsible for antioxidant activity, while unstable aroma compounds make it an excellent flavour agent. The current review is an up-to-date and comprehensive analysis of the safety of chemistry, pharmacology, convention use and *Foeniculum vulgare*.

Keywords: *Foeniculum vulgare*; Pharmacological action; Traditional Uses Medicinal Parts

Introduction

Foeniculum vulgare is a biennial medicinal and aromatic plant belonging to the family Apiaceae (Umbelliferae). It is a hardy, perennial-umbelliferous herb with yellow flowers and feathery green leaves. Its growth to a height of up to 2.5 m with hollow stems. Leaves grow 40 cm; they are finely dissected with the last section filiform (like thread) of approximately 0.5 mm wide. Flower terminals are produced in compound umbels. The fruit is a dry seed of 4–10 mm long. It is generally considered indigenous to the shores of Mediterranean Sea, but on the dry search especially on the sea, it has become quite natural in many parts of the world. Some authors distinguish two sub-species of fennel, piperitum and vulgare: sub-species piperitum has bitter seeds, while sub-species vulgare has sweet seeds which are used as flavouring agents in baked goods, ice creams, alcoholic beverages, etc. [1].

Plant Details

Scientific Name: *Foeniculum vulgare*

Family: Umbelliferae (Apiaceae)

The plant is known by various names in different language as under

INDIA	: - Fennel, Sweet fennel
Hindi	: - Soumf

Manipuri	: - Hop
Tamil	: - Sompu
Malayalam	: - Preumjirakam
Telugu	: - Peddajilakarra
Kannada	: - Doddasompu
Bengali	: - Mauri
Sanskrit	: - Madhurika
Common Name	: - Fennel, Sweet fennel, Florence fennel.

General Botanical Description

Fennel (*Foeniculum vulgare*) belongs to Family Apiaceae, which is an annual, biennial or perennial aromatic herb, depending on the variety. It is a harsh, perennial, porous herb yellow flowers and feather leaves. This straight, light blue colour is green and increases with a hollow stem, up to a height of 2.5 meters. The leaves grow up to 40 cm, they are fine dissections, with the ultimate section of the filiform, about 0.5 mm wide. Its leaves are like dill but are thin. Flowers terminal compound umbels are produced in 5–15 cm wide; each egg segment contains 20–50 small yellow flowers on small pedicels. The fruit is 4–10 mm long, half wide or less and surrounded with dry seeds. The fruits are aromatic, stimulant and carminative [2].

Distribution and Habitat

Plant is a resident of southern Europe and Asia. Many varieties and races differing in size, odour and taste of the fruits exist among the wild and cultivated fennels. Variety *vulgare* is cultivated chiefly in Russia, Rumania, Hungary, Germany, France, Italy, India, Japan, Argentina, and USA. Fennel is cultivated mostly as garden herb or home yard crop throughout India at all altitudes up to 6,000 ft. Gujarat and Rajasthan are chief fennel growing states in India. It is grown on small scale in other states like Karnataka, Maharashtra, Uttar Pradesh, Punjab, Bihar and Jammu and Kashmir [3].

Traditional Medicine

Leaves

- The paste of the leaves is used in the treatment of mouth ulcer, liver pain, and kidney ailments.
- Foeniculum vulgare* tree leaves are used for curing diabetes [4].

Bark

- The bark is used to do fever and tonic from.
- Bark of tree is used for blood related diseases [1].

Root

- Root is used for urinary tract infection and renal calculi and glycosuria.
- Root is used in fevers, colic, muscular pains [5].

Flowers

- The paste of the flowers *Foeniculum vulgare* spasmodic gastric-intestinal complaints, bloating and flatulence. It is also used for the catarrh of the upper respiratory tract [5].
- Flowers are used in perfumes.

Aerial Parts

- The aerial parts are also used in treat improving the milk flow Brest feeding mother [2].

Pharmacological Activity

Anti-viral Activity

Naim et al. [6], reported the antiviral activity of the essential oil of fruit sample of *Foeniculum vulgare* against the DNA virus Herpes simplex type-1. Most of the oils and compounds displayed strong antiviral effects against Herpes Simplex Virus-1 (HSV-1), ranging between 0.8 and 0.025 µg/ml.

Anti-Fungal Activity

Naim et al. [6], showed in an in vitro study, fungal and aflatoxin contamination in stored tobacco leaves and the potential of *Foeniculum vulgare* (fennel) seed essential oil as a plant-based preservative in protection tobacco during storage

was examined and it showed that the fennel essential oil can thus be formulated as plant-based preservatives for food items.

Singh et al., (2010), reported that the fennel has exhibit antifungal effect. Fennel essential oils and its seed extracts have been reported to show antimicrobial and anticandidal activity. Various bark extracts from *F. vulgare* have also been reported to have antifungal activity against *Candida albicans*. The essential oil of *F. vulgare* has also been reported to reduce the mycelia growth and germination of *Sclerotinia sclerotiorum* and as such could be used as bio fungicide alternative to synthetic fungicides against phytopathogenic fungi. The essential oil of *F. vulgare* has been reported to show complete zone of inhibition against *Aspergillum Niger*, *Aspergillum flavus*, *Fusarium graminearum* and *Fusarium moniliforme* at 6 µl doses.

Kumar et al. [7], investigated that fennel extract has antifungal activity against various fungal species such as *Candida albicans*, species of *Aspergillus*, and dermatophytes (21). Apart from this, a study on herb antifungal effect showed significant antifungal activity against fungal in food waste such as *Aspergillum Niger* and *Fusium oxysporum*. For these molds, respectively, MIC was 750 and 250 micrograms per ml. Another study showed that Dillapional the derivative of fennel stalk phenyl propanoid has antimicrobial properties against *Aspergillus*.

Anthelmintic Activity

Kiani Sadegh, et al. [8], investigated that the essential oil of *Foeniculum vulgare* has antischistosomal activity and cytotoxic effects against V79 cell. The plant of displayed moderate in vitro schistosomicidal activity against adult *S. mansoni* worms, exerted remarkable inhibitory effects on the egg development, and was of low toxicity.

Antioxidant activity

Kiani Sadegh, et al. [8], evaluated that the effect of fennel and sage extracts and the influence of the egg yolk source (fresh or pasteurized) on the success of freezing boar epididymal spermatozoa. The results show that the interaction between fennel and sage antioxidants with fresh egg yolk has improved the quality of the protected plg epididymal spermatozoa due to the loss of post operation damage result of oxidative stress. Marino et al. [9] investigated that the antioxidant activity of wild, edible and medicinal fennels from different Mediterranean countries has been determined. Wild fennel has been found to display a radical scavenging activity compared to both a medicinal and edible fennel. The methanolic extract of *F. vulgare* fruit has also been reported to exhibit antioxidant activity by decreasing the malondialdehyde level in *F. vulgare* fruit methanol extract group compared to the control group. The essential oil and acetone extracts of *F. vulgare* have been reported to exhibit strong antioxidant activity in comparison with Butylated hydroxyanisole (BHA) and Butylated hydroxytoluene (BHT).

Musharaf Khan et al. [5] reported that the fennel has antioxidant property. Due to the high content of polyphenols

and flavonoids, this plant can stop free radicals. Phenolic compounds in this herb such as caffeoylquinic acid, rosmarinic acid, eriodictyol-7-O-rutinoside, quercetin-3-O-galactoside, and kaempferol-3-O-glucoside showed antioxidant activity. Fennel volatile oil also has strong antioxidant activity.

Anti-Anxiety Activity

Kumar et al. [7] reported the Anxiolytic activity of the crude extract of fennel. Fennel due to phytoestrogens extensively has therapeutic use in the treatment of estrogens deficiency abnormalities. There are estrogens hormones which are involved in the phenomenon of anxiety that started functioning through GABA-A receptors. The results of a study show that with the increase in the time spent in open hands, the plant has established important acollatic effects. Picrotoxin (GABA receptor antagonist) and Tamoxifen prevented Anxiolytic effect. Therefore, fennel probably is an herbal remedy that has Anxiolytic effects mediated by GABA-nergic system and estrogens receptors. Mesfin et al, Anxiolytic activity of fennel confirmed on adult mice. This plant can have a promising effect in the treatment of anxiety and stress.

Koppula et al, (2015) investigated the properties of fennel extract in stress reduction and memory enhancement in rats. This study showed that this herb with several functions such as anti-stress proceeding, increase in memory and antioxidant effects may reduce stress and stress-related disorders.

Anti-Inflammatory Activity

Mahmoud et al. [10] reported the pharmacological effects of fennel plant, anti-inflammatory activity can be noted. It also significantly increased plasma levels of High-Density Lipoprotein (HDL) cholesterol. In contrast, it significantly reduced the level of malondialdehyde (MDA) as a measure of lipid per oxidation. These results indicate that removing methanol of fennel fruit is effective in reducing inflammation. Choi and Hwang et al, (2004) investigated that oral administration of methanolic extract of *F. vulgare* fruit shows the inhibitory effects against acute and sub-acute inflammatory diseases and type IV allergic reactions. Research has shown that the methanol extract of fennel has anti-inflammatory effects of fennel. The results show that by removing the methanol of the fennel seeds, it is swollen through cyclooxygenase and lipoxygenase routes.

Antibacterial Activity

Sofi et al. [1], reported that the aqueous and organic extract of *F. Vulgare* shows the antibacterial activity against some bacterial strains. The essential oil of *Foeniculum vulgare* has also been reported to possess antibacterial activity against some human pathogenic bacteria. Ethanol and water extracts of *Foeniculum Vulgare* have shown Antibacterial activity. Mahady et al. (2005), reported the chemical constituents from *Foeniculum vulgare* have been identified as active antimicrobial principles such as a phenyl propanoid derivative – Dillapional was found to be the active antimicrobial principle of the *Foeniculum vulgare* stem.

Another molecule - scoplatin which is a quaterrain derivative, has been separated from *vulgare* and has been reported to have slight antimicrobial effects.

Samani et al. [11], investigated that the fennel is used to treat many bacterial, fungal, viral, and mycobacterial infectious diseases. Antibacterial activity occurs in the fennel compounds such as linoleic acid, unnecessary, 1, 3-bengenadieol, oleic acid, and 2, 4-unwanted. Fennel has 5-hydroxy-furanocoumarin which has important role in antibacterial activity. Aqueous extract of fennel shows bactericidal activity.

Antithrombotic Activity

Sofi et al. [1], found that the essential oil of *F. vulgare* and its main component, anethole has been shown to have a safe antithrombotic activity that originates due to their broad-spectrum anti-platelet activity, clot destabilizing effect and vasorelaxant action. The main component of fennel oil tested in Anithol, Guinea Pig Plasma was powerful as fennel oil in preventing aggregation of arachidonic acid, collagen-ADP and U46619. Anethole also prevent thrombin-driven clutter reaction at concentrations like phenyl oil. The fennel oil and anethole were tested in rat aorta with or without endothelium and displayed comparable NO-independent vasorelaxant activity at antiplatelet concentrations which have been proved to be free from cytotoxic effects in vitro. Furthermore, both *F. vulgare* essential oil and anethole (100 mg/kg oral administration) provided significant protection towards ethanol induced gastric lesions in rats.

Hepatoprotective Activity

Ozbek et al. [12], showed that the essential oil of fennel possesses hepatoprotective activity. In a study, the hepatotoxicity produced by acute CCl₄ administration was found to be inhibited by fennel essential oil with evidence of decreased levels of serum aspartate aminotransferase (AST), alanine aminotransferase (ALT), alkaline phosphatase (ALP) and bilirubin.

Qiang et al, (2015) studied that the effect of fennel extract in carbon tetrachloride -induced liver injury rats. Data from this study showed that this extract reduced the levels of AST (aspartate aminotransferase), ALT (alanine amino transferees), ALP (alkaline phosphatase) and serum bilirubin (69). Fennel effect was also investigated on lipid peroxidation in rats with hepatic fibrosis. After fennel consumption ALT, AST level and MDA material decreased significantly and TP, ALB and SOD, CAT, GSH-PX activities increased. According to the results, it can be concluded that maybe fennel may prevent Hepatic fibrosis on the regulation of lipid peroxide.

Wang et al, (2008), investigated the effect of fennel on cytokines in rats with hepatic fibrosis. The results show that the decline of lipid and swelling had reduced in the fennel cure group. Based on the data obtained from this study, it can be assumed that fennel can reduce liver swelling and save hepatocytes significantly against liver damage. In other studies,

the effect of fennel on the hepatic fibrosis and the quantity of potassium dose were examined.

Anti-diabetic activity

Soudetal. [13], investigated that the essential oil of *Foeniculum vulgare* show hypoglycaemic activity in Streptozotocin induced diabetic rats. *Foeniculum vulgare* essential oils for diabetic mice from hyperglycemias (162.5 ± 3.19 mg / dl) (81.97 ± 1.97 mg / dl) (Activity of serum glutathione peroxide (59.72 ± 2.78 U / g HB) (99.60 ± 6.38) U / G HB). This makes the possibility of its inclusion in ant diabetic drug industry.

Jamshidi et al [7], studied that the effect of aqueous extracts Apiaceae family plant such as fennel in lowering blood sugar and anti-diabetic activities. The findings showed that exhaust diabetics can be useful for blood glucose control and in addition, their daily use can be effective in reducing chronic complications associated with diabetes. To evaluate the effects of fennel on the reductions in blood glucose, a study was conducted on Streptocytosine-Diabetic Rats. The results showed that fennel extract improves hyperglycaemia in diabetic rats which part of this related to herb effect on oxidation/restored system.

Anti-hirustism activity

Manzoor A, Riather et al. [1], reported the effect of ethanolic extract of *F. vulgare* has anti-hirustism activity. In a double-blind study patient were treated with creams containing 1%, 2% of fennel extract and placebo. 2% fennel creams are better than 1% fennel cream.

Oestrogenic Activity

Arya et al, (2005), studied that the anethole present in fennel has efficient effect in increase milk secretion, promote menstruation, facilitate birth, alleviate the symptoms of the male climacteric and increase libido. Fennel essential oil, the main constituent of Athol is considered active oestrogenic agent. Some other studies have suggested that the actual pharmacological active.

Shamkant et al, (2006), reported that the fennel possesses estrogenic effect and it has been used for thousands of years as an estrogenic agent. Due to this property, fennel enhances milk secretion, reduces menstrual pain, facilitates birth and enhances sexual desire. Anethole is the main part of fennel plant that operates estrogenic properties. Research has shown that active pharmaceutical agents such as dianethole and photoanethole are polymers of anethole. Fennel substance showed lass side effects in the treatment of primary dysmenorrhoea. The administration of various doses of fennel extract has significantly reduced the contraction intensity induced by oxytocin and prostaglandin. Moderate doses increased mammary gland weight and higher doses increased the weight of oviduct, endometrium, myometrium and cervix investigated the effect of fennel seed ethanol extract on gonadotropin changes in adult male rats.

Acaricidal activity

Abbas, et al, (2009), reported that the fennel possess Acaricidal activity against *D. farina* and *D. pteronyssinus* using direct contact application and compared with that of the commercial repellent benzyl benzoate. The biologically active constituents of the *Foeniculum vulgare* fruit oil have been identified as P-anisaldehyde, (+)-fen chone, (-)-fen hone, thymol and estragol. The methanol extract of *F. vulgare* fruit has been reported to exhibit mosquito repellent activity against *Aedes aegypti* females using skin and patch tests. The biologically active constituents of the *Foeniculum vulgare* fruits were characterised as (+)-fen hone and (z)-9-octadecanoic acid.

Gastro-Protective activity

Delaram M et al. [14], investigated that fennel plant has significant protective effect on gastrointestinal disorders. It was shown that the use of fennel oil emulsion removed the collic in 65% of infants who were much better than the control group. The effect of fennel plant on gastric ulcer. The findings showed that the plant had a protective effect on gastric ulcer. In addition, the herb reduced the muscular lining of the stomach. These functions were attributed to its antioxidant capacity.

Anti-Cancer activity

Kooti W et al. [15,16], found that anethole in fennel seed has inhibitory effect on activating TNF- α by transcription factor NF-KB. The results show that Athol stopped cellular responses inspired by these cytokines that could explain its role in suppressing cancer. It has also been specified that fennel prostate tumour with its antangongi mechanism stops xenograft. Boguga-Coca et al, evaluated apoptotic activity of fennel's ethanol findings against leukaemia. The findings have shown that the removal of cancer cells had significant apoptotic effect. In other study, methanolic extract of fennel has effects on antitumor and cytotoxic activities in mice with cancer.

Memory-Protective Activity

Abe R, et al. [17], investigated that some plants including fennel herbs are used to enhance memory and intelligence. Therefore, the effect of removing fennel on memory in amnesiac mice was examined. The results showed that there was a memory increase property in removing this. The effect of removing fennel in the form of a neurotropic factor in mice and anti-acetylcholinastase was investigated. The findings of this study have shown that acetylchlorastatus has been severely stopped in fennel extract. According to this study it can be deduced that fennel might be used min treatment of cognitive disorders such as dementia and Alzheimer [18-20].

Conclusion

Research in medicinal plants has gained a renewed focus recently. The main reason is that the other system of medicine associated with number of side effects that often cause to serious problems. Though traditionally *Foeniculum vulgare*

has various medicinal activities like antioxidant, ant diabetic, hepatoprotective, ant diarrhoeal, diuretic etc, but it is time to explore its medicinal values at molecular level with the help of various biotechnological techniques. Pharmacognostical & physicochemical studies have been reported. The work could also be done in this direction to ensure free utility of the plant.

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