



EFFECTS OF FOENICULUM VULGARE ON HUMAN HEALTH

BY:

Hussain Zuhair Ghanim

Mayar Adnan Dawood

Supervisor: **Dr. Yousif Naeem**

Department of Pharmacognosy



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Abstract:

Foeniculum vulgare (Apiaceae) commonly known as fennel is a well known and important medicinal and aromatic plant widely used as carminative, digestive, lactagogue and diuretic and in treating respiratory and gastrointestinal disorders. Its seeds are used as flavourings in baked goods, meat and fish dishes, ice cream and herb mixtures. Phenols, phenolic glycosides and volatile aroma compounds such as trans-anethole, estragole and fenchone have been reported as the major phytoconstituents of this species. Different pharmacological experiments in a number of in vitro and in vivo models have convincingly demonstrated the ability of *F. vulgare* to exhibit antifungal, antibacterial, antioxidant, antithrombotic and hepatoprotective activities, lending support to the rationale behind several of its therapeutic uses. Phenolic compounds isolated from *F. vulgare* are considered to be responsible for its antioxidant activity while the volatile aroma compounds make it an excellent flavouring agent. The present review is an up-to-date and comprehensive analysis of the chemistry, pharmacology, traditional uses and safety of *F. vulgare*.

Introduction:

It is a medicinal plant belonging to the Umbelliferae (Apiaceae) family, known and used by humans since antiquity, due to its flavor. It was cultivated in almost every country. It is universally known as Fennel and is known by more than 100 names. It is a traditional and popular herb with a long history of use as a medicine. A series of studies showed that *F. vulgare* effectively controls numerous infectious disorders of bacterial, fungal, viral, mycobacterium, and protozoal origin. It has antioxidant, antitumor, chemopreventive, cytoprotective, hepatoprotective, hypoglycemic, and oestrogenic activities. Some of the publications stated that *F. vulgare* has a special kind of memory-enhancing effect and can reduce stress. Animal experiments and limited clinical trials suggest that chronic use of *F. vulgare* is not harmful. Fennel may be consumed daily, in the raw form as salads and snacks, stewed, boiled, grilled, or baked in several dishes and even used in the preparation of herbal teas or spirits. A diet with desired quantity of fennel could bring potential health benefits due to its valuable nutritional composition with respect to the importance of fennel as a medicinal herb, the aim of the present study was to evaluate the phytochemical characteristics, and therapeutic properties of this medicinal plant. Presence of essential fatty acids. In recent years, increased interests in improvement of agricultural yield of fennel due to its medicinal properties and essential oil content has encouraged cultivation of the plant on large scale. Fennel has been used in traditional medicine to treat various diseases for thousands of years in the East Asian countries, India and China. Nowadays, the different parts of the plant are used in treatment of many diseases, particularly pain in the digestive system. Also it is very useful in the treatment of diabetes, bronchitis, chronic cough and kidney stones. Fennel seeds are used as a flavoring in cooking meat and fish, prepare ice cream and cream. Due to its diuretic effect the plant is used to treat kidney and bladder diseases. It is also used to relieve nausea and remove vomiting. The herb is helpful for chronic fever and removing the obstruction in the internal organs, especially the liver, gut, respiratory



and urinary tract and also it is used to improve eye diseases such as cataract as well as diseases of the stomach, chronic diarrhea.. so as a summary to this introduction Fennel (*Foeniculum vulgare* Mill) is one of the oldest spice plants which, due to its economic importance and significant pharmaceutical industry applications, is considered as one of the world's most important medicinal plants. The purpose of this study is to investigate and collect scientific reports such as morphological characteristics, phytochemical compounds and evaluation of the therapeutic properties of this valuable medicinal plant that have been published

Toxiconomy:

Kingdom: Plantae,

Division: Tracheophyta,

Subdivision: Spermatophytina,

Class: Magnoliopsida,

Order: Apiales,

Family: Apiaceae,

Genus: *Foeniculum*,

Species: *vulgare*, and *botanical name: Foeniculum vulgare* Mill

Common Names: Fennel, saunf, Adas landi, Adas londa, Anis Vert, Anis, Comino

Botanical Description:

Fennel is an ancient seasonal herb. The fennel plant originated in the southern Mediterranean region and through naturalization and cultivation it grows wild throughout the Northern, Eastern, and Western hemispheres, specifically in Asia, North America, and Europe. It is cultivated in fields and also grows wild. The herb was well-known to the ancient Egyptians, Romans, Indians, and Chinese. The Romans grew it for its aromatic seeds and the edible fleshy shoots are still a very common vegetable in southern Italy. Emperor Charlemagne was known to have encouraged its cultivation in Central Europe. It is an indispensable ingredient in modern French and Italian cooking. All parts of the plant are aromatic and can be used in many ways.

F. vulgare is an upright, branching perennial herb ([Figure 2\(a\)](#)) with soft, feathery, almost hair-like foliage growing upto 6.6 ft. (2 m) tall.

This plant looks similar to dill. It is typically grown in vegetable and herb gardens ([Figure 2\(f\)](#)) for its anise-flavored foliage and seeds, both of which are commonly harvested for use in cooking. It is erect and cylindrical, bright green, and smooth as to seem polished, with multiple branched leaves ([Figure 2\(c\)](#)) cut into the finest of segments. The leaves grow up to 40 cm long; they are finely dissected, with the ultimate segments filiform (threadlike), about 0.5 mm wide. The bright golden flowers, produced in large, flat terminal umbels, with thirteen to twenty rays, bloom in July and August ([Figure 2\(d\)](#)).

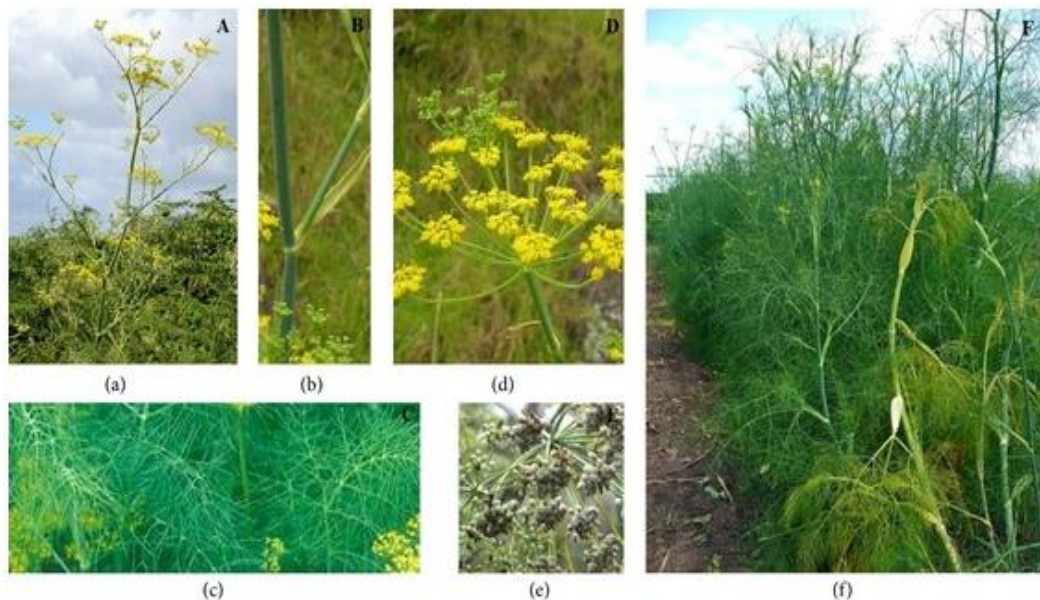


Figure: Foeniculum vulgare Mill (a) in its natural habitat; (b) stem; (c) leaves; (d) inflorescences and flowers; (e) fruits; and (f) population of *F. vulgare* Mill.

Foliage. Stem striate, leaves 3-4 pinnate, segments filiform, upto 1.6 in. (4 cm) long; leaf bases sheathing. It has a green, sleek, and slippery stem with upright stiff branches and much divided leaves in linear segments ([Figure 2\(b\)](#)). Rays are 5–30 numbers with 0.39–2.4 inches (1–6 cm) long. Flowers are small, yellow, and found in large flat-topped umbels ([Figure 2\(d\)](#)). Fruits are oblong to ovoid with 0.12–0.2 inches (3–5 mm) long and 1.5–2.0 mm broad ([Figure 2\(e\)](#)). The stylopodium persists on

the fruit. The fruits are elongated and have strong ribs. The most esteemed fennel seeds vary from three to five lines in length and are elliptical, slightly curved, and somewhat obtuse at the ends ([Figure 3\(a\)](#)). They are greenish-yellow, the colour of hay, from which the term fennel is derived. Wild fruits are short, dark coloured and blunt at their ends, and have a less agreeable flavour and odour than those of sweet fennel. Seeds ripen from September to October. This plant can reproduce from crown or root fragments but freely reproduces from seed.



Figure: Normal fennel seeds (a) and sugar coated and uncoated fennel seeds (b) used in *mukhwas*.

Phytochemical Composition of Fennel:

All parts of fennel such as roots, leaves, fruit and especially the seeds are used .Fennel seed contains

6.3% water,

9.5% protein,

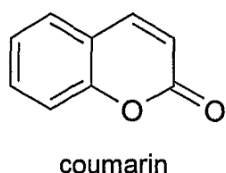
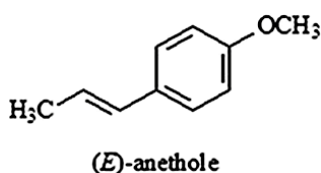
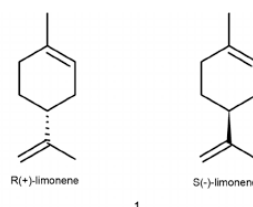
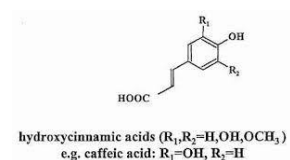
10% fat,

13.4% minerals,

18.5% fibers

and 42.3% carbohydrates

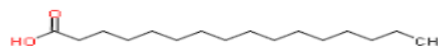
Its leaves contain vitamins and minerals such as calcium, potassium, sodium, iron, phosphorus, thiamine, riboflavin, niacin and vitamin C. Fruits consist 10 to 12 % of oil that is stored in the cotyledons of seeds. Oil obtained from the fennel fruit has 4% palmitic acid, 22% oleic acid, 14% linoleic acid and 6% petrocyclic acid. The fruit has value of 4 to 6% essence which its essence and combine ingredients vary according to the location of plant growth The aromatic property of fennel is because of the essence. There are more than 30 types of terpene compounds in the essential oil of fennel, the most important of them are 50 to 80% trans-anethole, 8% fenshon and limonene 5% .This herb also contains phenolic compounds such as flavonoids, phenolic acids, hydroxycinnamic acids, coumarin and tannin .Phenolic acids include 3-O-Caffeoylquinic



oleic acid

linoleic acid





Pharmacological Activity:

Anti-bacterial activity:

Fennel is used to treat many bacterial, fungal, viral, and mycobacterial infectious diseases. Fennel has antibacterial activity due to compounds such as, linoleic acid, undecanal, 1, 3-benzenediol, oleic acid and 2,4-undecadienal. Fennel has 5-hydroxy-furanocoumarin which has an important role in the antibacterial activity of this plant. Aqueous extract of fennel shows bactericidal activity against *Enterococcus faecalis*, *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Salmonella typhimurium*, and *Shigella flexneri*. During a study it was found that this plant extract has a significant antibacterial effect against a lot of bacteria except *Klebsiella pneumoniae* and one strain of *Pseudomonas aeruginosa*.

Anti-fungal activity:

Fennel extract has antifungal activity against various fungal species such as *Candida albicans*, species of *Aspergillus*, and dermatophytes. Also a study on the herb's antifungal effect showed significant antifungal activity against fungi in food waste such as *Aspergillus niger* and *Fusarium oxysporum*. The MIC of fennel extract for these molds respectively was 750 and 250 micrograms per ml. Another study showed that dillapional, the derivative of fennel stalk phenyl propanoid, has antimicrobial properties against *Aspergillus niger*, *Bacillus subtilis*, and *Cladosporium*.

cladosporioides. Also derivatives of coumarin named scopoletin had antimicrobial properties against above micro-organisms but was less important than dillapional. Antifungal activity of fennel essence on *Sclerotinia sclerotiorum* was investigated. The antifungal effect of this plant against *Sclerotinia sclerotiorum* observed based on survival of the microorganisms. A study demonstrated that nitric oxide production in peritoneal macrophages which were treated with fennel extract at a concentration of 10 mg/ml significantly increased. Also the production of reactive oxygen species compared to the control group increased. Lethality study also showed that treated macrophages with concentrations of 10 and 20 mg/ml had anti-candida effects more than control group. Among chemical compositions of the plant extract anethole had the strongest antifungal activity.

Antioxidant activity:

Fennel is known as an excellent source of natural antioxidants. This plant can inhibit free radicals due to the high content of polyphenols and flavonoids. Phenolic compounds in this herb such as caffeoylquinic acid, rosmarinic acid, eriodictyol-7-O-rutinoside, quercetin-3-O-galactoside, kaempferol-3-O-glucoside showed antioxidant activity. Fennel volatile oil has strong antioxidant activity, too. Plant ethanolic and aqueous extracts in comparison to its essence has less antioxidant activity.

Anti-inflammatory activity

Of the pharmacological effects of fennel plant, anti-inflammatory activity can be noted. Research has shown that the methanol extract of fennel has anti-inflammatory effects. Oral administration of 200 mg per kg of methanol extract of fennel fruit shows inhibitory effects on acute and subacute inflammatory diseases and type 4 allergic reactions. In addition, it decreased the activities of superoxide dismutase (SOD) and

catalase (CAT). It also significantly increased plasma levels of HDL cholesterol. In contrast, it significantly reduced the level of malondialdehyde (MDA) as a measure of lipid peroxidation. These results indicate that the methanol extract of fennel fruit is effective in reducing inflammation. Kataoka et al. studied anti-inflammatory effects of fennel. The results showed that the methanol extract of fennel seeds inhibits inflammation through cyclooxygenase and through lipoxygenase. evaluated fennel methanol extract anti-inflammatory effects. The results showed that the fennel methanol extract had anti-inflammatory activity dependent on the central and peripheral mechanisms.

Anti-anxiety activity

Anxiolytic activity of the crude extract of fennel has been reported. Fennel due to phytoestrogens extensively has therapeutic use in the treatment of estrogen deficiency abnormalities. Estrogens are hormones that are involved in the phenomenon of anxiety which appear to act via the GABA A receptors. The results of a study showed that the plant with increase in time spent in the open arm established significant anxiolytic effect. Picrotoxin (GABA receptor antagonist) and Tamoxifen prevented anxiolytic effect. Therefore, fennel probably is an herbal remedy that has anxiolytic effects mediated by GABA-ergic system

Cardiovascular and lipid activity

The study of the anti-cholesterol and anti-atherogenic effect of fennel methanol extract showed that treatment with the extract significantly reduced plasma lipid levels. Also the plant had important anti-atherogenic effects. It reduced triglycerides in fatty liver and facilitated blood flow in the coronary arteries by preventing the buildup of fatty deposit in arteries through reduction of plasma and liver fats. As a result


because of hypolipidemic and anti-atherogenic activities, this herb could be used for controlling cardiovascular disorders. Also intravenous injection of the extract significantly reduced blood pressure, without affecting the heart rate and respiration. It seems that fennel extract effect on blood pressure was not mediated by adrenergic, muscarinic, ganglion, serotonergic receptors. In other study, oral administration of the extract reduced systolic blood pressure. The fennel extract acts as a diuretic and natriuretic.

Anti-diabetic activity

A study investigated the effect of aqueous extract Apiaceae family plant such as fennel in lowering blood sugar and anti-diabetic activities. The findings exhibited that the extract could be useful for the control of blood glucose in diabetic patients and in addition, their daily use could be effective in reducing chronic complications associated with diabetes to evaluate the effect of fennel on blood sugar reduction. Therefore, this plant can be used in the pharmaceutical industry for the manufacture of anti-diabetic drugs. Also methanol extract of fennel fruit reduced blood glucose and triglycerides and led to higher levels of liver and muscle glycogen.

Anti-cancer activity

It was shown that TNF- α -dependent responses are involved in inflammation and cancer. It was found that anethole in fennel seed has inhibitory effect on activating TNF- α by transcription factor NF-KB. The results showed that anethole inhibited cellular responses induced by these cytokines which might explain its role in suppressing cancer. It also specified that the fennel with its antiangiogenic mechanisms inhibits prostate tumor. *and the* evaluated apoptotic activity of ethanol



extracts of fennel against leukemia. The findings showed that the extract had considerable apoptotic effects on cancer cells.

Gastro-protective activity

It has been shown that fennel plant has significant protective effect on gastrointestinal disorders.

It was shown that the use of fennel oil emulsions eliminated colic in 65% of treated infants investigated 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 mucosal lining of the stomach.

Hepato-protective activity

The studies demonstrated that the fennel plant has protective effect on liver. studies showed that extract reduced the levels of AST (aspartate aminotransferase), ALT (alanine amino transferase), ALP (alkaline phosphatase) and serum bilirubin. After fennel consumption ALT, AST level and MDA content significantly decreased and the TP, ALB and SOD, CAT, GSH-PX activities increased. According to results it might be concluded that fennel probably through effecton regulation of lipid peroxidation might inhibit hepatic fibrosis and capacity.

Dosages:

Adult PO fluid extract: 3-6ml/day

Adult PO essential oil: 5-20 drops/day



Adult PO fennel compound tincture:5-7.5g daily.

Adult PO herb 5-7g/day

Interactions:

1-Ciprofloxacin interacts with fennel. ciprofloxacin is an anti-biotic.taking 1-along with fennel decrease its effectiveness.so take fennel atleast after one hour of taking ciprofloxacin.

2-Estrogen interacts with fennel. large amount of fennel might have same -effect as of estrogen so taking fennel along with estrogen pills decreases the effect of estrogen pills.

3-Tamoxafen interacts with fennel. Some types of cancers are effected by hormones in body such as: estrogen-sensitive cancer that are effected by estrogen level in body.temoxifen is used to treat cancer.fennel seems to effect estrogen level in body. So taking temoxifen with fennel decrease the effectiveness of temoxifen.

Contraindications:

During pregnancy and breast feeding it is best to avoid use . because infants experienced damage to their nervous system.

Fennel cause allergic reaction in people who are skin sensitive so do not use fennel. Fennel might slow blood clotting so taking fennel might increase the risk of bleeding in people with bleeding disorders.

Side Effects:

1-Nausea, Vomiting, Allergic reactions, Cause convulsions


2-It is reported that the use of fennel extract for control and treatment of primary dysmenorrhea causes concern about the teratogenicity potential of it, due to its estrogen like activity. Investigating the herb extract effect showed teratogenic property that may have toxic effects on the cells of the embryo but no evidence of teratogenicity to concentration of 9.3 mg/ml

Safety:

The safety of medicinal and spice plants and of their preparations deserves increased scientific attention. One of the main conditions for use of herbal preparations in medicinal conditions is the absence of such risks as mutagenicity, carcinogenicity, and teratogenicity. In general, such products need to have minimal toxicity and side effects. Generally, the vast majority of herbal remedies are recognised as safe, and individual hypersensitivity is usually considered as the most common but controllable risk. However, for those individual compounds exhibiting toxic effects in laboratory animals, the question of possible negative effects in humans remains open. In the case of *F. vulgare* some compounds have come under scrutiny, most importantly, estragole.

Conclusions:


The available scientific research on *Foeniculum vulgare* has shown that it is an important medicinal plant used in a wide range of ethnomedical treatments, especially for abdominal pains, antiemetic, aperitif, arthritis, cancer, colic in children, conjunctivitis, constipation, depurative, diarrhea, dieresis, emmenagogue, fever, flatulence, gastralgia, gastritis,



insomnia, irritable colon, kidney ailments, as a laxative, leucorrhoea, liver pain, mouth ulcer, and stomachache. This plant has been in use for a long period of time without any documented serious adverse effects. Studies carried out in the past and present indicate that fennel possesses diverse health benefits and are an important constituent of food. Studies have shown that various extracts of fennel possess a range of pharmacological actions, such as antiaging, antiallergic, anticolitic, antihirsutism, anti-inflammatory, antimicrobial and antiviral, antimutagenic, antinociceptive, antipyretic, antispasmodic, antistress, antithrombotic, anxiolytic, apoptotic, cardiovascular, chemomodulatory action, cytoprotection and antitumor, cytotoxicity, diuretic, estrogenic properties, expectorant, galactogenic, gastrointestinal effect, hepatoprotective, human liver cytochrome P450 3A4 inhibitory, hypoglycemic, hypolipidemic, memory-enhancing property, nootropic, and oculohypotensive activity supporting its traditional use. However, the most prominent and the well studied effects are the antimicrobial and antioxidant effects of essential oil of fennel in different experimental models. The observed health benefits may be credited to the presence of the various phytochemicals like volatile compounds, flavonoids, phenolic compounds, fatty acids, and amino acids.

Fennel also contains mineral and trace elements like aluminum, barium, calcium, cadmium, cobalt, chromium, copper, iron, magnesium, manganese, nickel, lead, strontium, and zinc fat soluble vitamins such as vitamins A, E, and K; water soluble vitamins like ascorbic acid, thiamine, riboflavin, niacin, and pyridoxine; essential amino acids like leucine, isoleucine, phenylalanine, and tryptophane may contribute to the myriad health beneficial effects at least in part.

Most of the pharmacological studies were conducted using uncharacterized crude extracts of fennel. It is difficult to reproduce the results of these studies and pinpoint the bioactive compounds. Hence, there is a need for chemical standardization and bioactivity-guided identification of bioactive compounds. Among several classes of chemical constituents identified in fennel, volatile components of fennel



essential oil and phenolic compounds are assumed to be the main bioactive compounds responsible for the majority of its pharmacological effects. However, the vast traditional use and proven pharmacological activities of fennel indicate that an immense scope still exists for its chemical exploration. Future studies should be focused on validating the mechanism of action responsible for the various beneficial effects and also on understanding which plant based compounds are responsible for the reported effects. The required information when available will enhance our knowledge and appreciation for the use of fennel in our daily diet. Also, the outcome of such chemical studies may further expand its existing therapeutic potential.


Thus, there are many areas of research related to this plant that need to be further explored to fully recognize its beneficial effects for society. Factors such as geographical and seasonal variation play an important role in the authentication of the chemical constituents responsible for the activity which also can be an area of interest. Thus, it is incumbent on researchers to fill the huge gap of insufficient knowledge and create awareness among pharmacologists as well as investigators towards providing better medicinal value derived from this plant. This can be fulfilled only by generating interest among the research community through writing of critical appraisals (paper) and extending the interdisciplinary research area to focused studies on *Foeniculum vulgare*.

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