

## Current update on Ethanobotanical, Phytochemical and Pharmacological Investigations on Fennel (*Foeniculum vulgare* Mill)

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### ABSTRACT:

*Foeniculum vulgare* Mill commonly called fennel has been used in traditional medicine for a wide range of ailments related to digestive, endocrine, reproductive, and respiratory systems. Additionally, it is also used as a galactagogue agent for lactating mothers. The review aims to gather the fragmented information available in the literature regarding morphology, ethnomedicinal applications, phytochemistry, pharmacology, and toxicology of *Foeniculum vulgare*. It also compiles available scientific evidence for the ethnobotanical claims and to identify gaps required to be filled by future research. Findings based on their traditional uses and scientific evaluation indicates that *Foeniculum vulgare* remains to be the most widely used herbal plant. It has been used for more than forty types of disorders. Phytochemical studies have shown the presence of numerous valuable compounds, such as volatile compounds, flavonoids, phenolic compounds, fatty acids, and amino acids. Compiled data indicate their efficacy in several in vitro and in vivo pharmacological properties such as antimicrobial, antiviral, anti-inflammatory, antimutagenic, antinociceptive, antipyretic, antispasmodic, antithrombotic, apoptotic, cardiovascular, chemomodulatory, antitumor, hepatoprotective, hypoglycemic, hypolipidemic, and memory enhancing property. *Foeniculum vulgare* has emerged as a good source of traditional medicine and it provides a noteworthy basis in pharmaceutical biology for the development/formulation of new drugs and future clinical uses.

**Key words:** *Foeniculum vulgare*, Ethanobotany, Traditional uses Phytochemistry, Pharmacology

### INTRODUCTION

The plant Fennel (*Foeniculum vulgare*, family **Umbelliferae**) is an aromatic, perennial herb attaining the height of about 1-2 m. Leaves are alternate, 3 or 4 times pinnate, the ultimate leaflets very numerous, filiform, very elongated the superior leaves with sheaths longer than the blade. Umbels compound, large, long-pedunculate, nearly, regular. Flowers are yellow, not involucre, July-October, calyx with 5 very slight teeth. Petals are 5, entire; tips involute. Stamens are 5, ovary 2-celled; stylopodium large, conical. Fruit aoid, 6 mm long by 2 mm in diameter, greenish; glabrous mericarp compressed dorsally, semi cylindrical, with 5 prominent, nearly regular ribs. Seeds are somewhat concave with longitudinal furrows. The fruit tastes sweet and pungent and smells like Anis seeds. The plant is known by various Vernacular Name like in Eng: Fennel; Hin: Saunf; Beng: Panmuhori; Kan: Badisepu; Tam: Shombu; Tel: Sopu. The plant is commonly cultivated in fields. It is mainly propagated by using seeds. (1)

### Morphological description of fruit:

The type of fruit is Cremocarp with two one-seeded mericarps. The Shape is straight or slightly curved, oblong, laterally compressed, tapering towards the base and apex. At the apex a short curved bifid structure called as stylopod is present. A thin pedicel is seen at the base. The Size of fruit is 5 to 10 mm, 2 to 4 mm. Surface of fennel mericarp has two surfaces-the dorsal and the commissural surface. Dorsal surface is glabrous with 5 straight, prominent primary ridges and stylopod at the apex. Commissural surface is flat and shows the carpophore which holds the two

mericarps together. Color of the fruit is greenish or yellowish brown and the odor and Taste is strongly aromatic.(2)

#### **Cultivation and collection:**

Fennel is an herb native to southern Europe and Asia Minor. It is cultivated there, and in the US, Great Britain, and temperate areas of Eurasia. All parts of the plant are aromatic. When cultivated, fennel stalks grow to a height of about 1 m. Plants have finely divided leaves composed of many linear or awl-shaped segments. Grayish compound umbels bear small, yellowish flowers. The fruits or seeds are oblong, oval shaped, about 6 mm long, and greenish or yellowish brown in color with 5 prominent ridges. The cultivated plant is about 1 meter (3 feet) tall and has stalks with finely divided leaves composed of many linear or awl-shaped segments. The grayish compound umbels bear small yellow flowers. The small dryfruits are greenish brown to yellowish brown oblong ovals about 6 mm (0.25 inch) long with five prominent longitudinal dorsal ridges. The seeds contain 3 to 4 percent essential oil. The principal components are anethole and fenchone. It is native to the Mediterranean, but is now found throughout the world. Dried fennel seeds are often used in cooking as an anise-flavored spice. But don't confuse fennel with anise; though they look and taste similar, they are not the same. Fennel's dried ripe seeds and oil are used to make medicine.(3)

#### **Traditional uses:**

Fennel is used for various digestive problems including heartburn, intestinal gas, bloating, loss of appetite, and colic in infants. It is also used for upper respiratory tract infections, coughs, bronchitis, cholera, backache, bedwetting, and visual problems. Some women use fennel for increasing the flow of breast milk, promoting menstruation, easing the birthing process, and increasing sex drive. Fennel powder is used as a poultice for snakebites. In foods and beverages, fennel oil is used as a flavoring agent.

#### **Ethanobotanical uses:**

Fennel is low in calories but rich in nutrients linked to many health benefits. The main fennel bulb is a plant based source trusted source of potassium, sodium, phosphorus, and calcium. It is also high in essential fatty acids and magnesium. People can also use fennel seeds, leaves, and flowers in different ways. Fennel seeds may have antioxidant, anti-inflammatory, anti-

fungal, and antiviral effects. Fennel seeds may also stimulate prolactin to help mothers naturally produce breast milk. A person can ingest fennel seeds in dishes or as an extract. People can also steep fennel seeds, leaves, and flowers to make tea. Fennel tea may aid digestion and other gastrointestinal issues such as heartburn, bloating, loss of appetite, and colic in infants.

#### **Effect on bone:**

The vitamin and mineral content in fennel contributes to building and maintaining bone structure and strength in the following ways: **Phosphate and calcium:** Both of these compounds are important in developing and maintaining strong bones. **Iron and zinc:** These are crucial for the production and maturation of collagen. **Manganese:** This mineral is necessary for bone matrix formation. **Vitamin K:** low intakes of vitamin K with a higher risk of bone fracture.

#### **Blood pressure**

Insufficient potassium intake can increase a person's risk of developing high blood pressure. In addition, there is evidence that potassium, calcium, and magnesium decrease blood pressure naturally. All of these are present in fennel. Dietary nitrates in fennel and other foods have vasodilatory and vasoprotective properties. Because of this, they can help lower blood pressure and protect the heart. Blood pressure levels were lower after taking nitrate supplements.

#### **Effect on heart health**

Fennel contains significant amounts of fiber. Fiber decreases the risk of heart disease as it helps reduce both the total serum cholesterol and low-density lipoprotein (LDL) cholesterol in the blood.

#### **Effectiveness in Cancer**

Selenium is a mineral found in fennel absent in many other fruits and vegetables. It contributes to liver enzyme function and helps detoxify some cancer-causing compounds in the body. Selenium can also prevent inflammation and decrease tumor growth rates. Fiber intake from fruits and vegetables like fennel is associated with a lower risk of colorectal cancer. Vitamin C, vitamin A, and beta-carotene are potent antioxidants that can help protect cells against damage from free radicals.

#### **As an Immunity enhancer**

The selenium found in fennel appears to stimulate the production of killer T-cells and

modulates the immune system in other ways. Studies have shown dietary intake of selenium can improve immune response, especially to viral agents

### **Weight management**

Dietary fiber is an important factor in weight management and works as a “bulking agent” in the digestive system. These compounds increase satiety and reduce appetite, making an individual feel fuller for longer and lowering overall calorie intake. Females who drank fennel tea before a meal reported feeling fuller than females who had received a placebo, further suggesting that fennel may help suppress appetite.

### **Increasing iron absorption**

Iron deficiency is one of the most common nutrient deficiencies globally and is the leading cause of anemia. Pairing high-vitamin-C foods, such as fennel, with iron-rich foods can improve the ability of the body to absorb iron.

### **Effect on estrogen**

Estrogen occurs naturally in fennel. It plays a central role in regulating the female reproductive cycle, and it can also determine fertility. A study on mice found that estrogen plays an important role in controlling factors that contribute to body weight, such as appetite, body fat distribution, and energy expenditure. Changes in a person’s estrogen levels can lead to weight changes.

### **Postmenstrual syndrome**

A 2020 study found that consumption of fennel seed powder reduced menopausal symptoms in postmenopausal women over 8 weeks.

### **Effect on Skin**

Raw fennel is an excellent source of vitamin C. Vitamin C is essential to collagen synthesis, the skin’s support system. It works as an antioxidant to help prevent damage caused by the sun, pollution, and smoke.

### **Nutrition value of Fennel:**

According to the United States Department of Agriculture (USDA) National Nutrient Database, one raw fennel bulb weighing 234 gram contains: 72.5 calories, 0.47 g of fat, 2.9 g of protein, 17 g of carbohydrate, 7.3 g of dietary fiber, and cholesterol. Fennel also found to contain - Phosphorous, zinc, copper, manganese, selenium, niacin, pantothenic acid, folate, choline,

beta-carotene, lutein, zeaxanthin, vitamin E, vitamin K

Fennel has a crunchy texture and mildly sweet flavor, making it a pleasant addition to any dish, whether eaten raw or cooked. A person can eat all parts of the fennel plant or use the seeds as a condiment. When buying fennel, avoid spotted or bruised bulbs and look for firmness and a white or pale green color. Stalks should be green, and leaves should be straight and bundled together. A fennel plant with flowering buds is overripe. To prepare fennel, cut the stalks off the bulb at the base where they sprout and slice it vertically. Prepare the fennel leaves, stalks, and bulb in a variety of ways, including: using the stalks as a soup base or stock, sautéing the leaves and stalks with onions for a quick and easy side, mixing sliced fennel with a variety of your favorite fresh vegetables for a light, crisp salad, serving roasted fennel bulbs as an entrée.

### **Promotes weight loss**

Fennel seeds are rich in fibre and may aid in weight loss and keep hunger pangs at bay. They work as diuretics and improve metabolism. Consuming fennel seed daily with a balanced diet and workout helps you to shed extra pounds quickly. You can have roasted fennel seed powder with warm water on an empty stomach to get better results. By helping you stay full for longer (due to high fibre), fennel seeds are also considered appetite suppressants. This may also improve your weight loss goals and make it easier to avoid overeating.

### **Reduces Gas**

Due to its excellent digestive properties, as well as the fact that it is antimicrobial, fennel seeds are thought to aid in reducing gas. By improving digestive movement, this seed allows easy passage of bowels without excessive gas build-up. And with its antimicrobial effect (mainly from the anethole, an organic compound in the seed) it prevents bacteria from growing and releasing gases in the first place. (4)

### **Pharmacological Activity of Fennel Fruits:**

#### **Antibacterial activity**

The essential oil extracted from the fruits of *F. vulgare* exhibited antibacterial effect against foodborne pathogens such as *Escherichia coli*, *Bacillus megaterium* and *Staphylococcus aureus*. Aqueous and organic extracts of *F. vulgare* have been reported to show antibacterial activity against some bacterial strains. The seed essential oil of *F. vulgare* has also been reported to

possess antibacterial activity against some human pathogenic bacteria. Ethanol and water extracts of *F. vulgare* have shown activity against *Campylobacter jejuni* and *Helicobacter pylori*. In another study, the *F. vulgare* essential oil has been shown to exhibit potential for the control of multidrug resistant *Acinetobacter baumannii* infections. Some chemical constituents from *F. 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 *F. vulgare* stem.

#### Antifungal activity

The fennel essential oil has been reported to exhibit antifungal effect. The fennel essential oil and its seed extracts have been reported to exhibit antimycobacterial and anticandidal activity. Various bark extracts of *F. vulgare* have also been reported to possess antifungal activity against *Candida albicans*.

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 dose.

#### Antithrombotic activity

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. Anethole, the main component of fennel oil tested in guinea pig plasma was as potent as the fennel oil in inhibiting arachidonic acid, collagen-ADP and induced aggregation. Anethole also prevented thrombin induced clot reaction at concentrations similar to fennel 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.

#### Anti-inflammatory activity

Oral administration (200 mg/kg) of *F. vulgare* fruit methanolic extract has been reported to show inhibitory effects against acute and subacute inflammatory diseases and type IV allergic reactions

#### Oestrogenic activity

*F. vulgare* has been used as an oestrogenic agent for centuries. It has been reported to increase

milk secretion, promote menstruation, facilitate birth, alleviate the symptoms of the male climacteric and increase libido. The main constituent of fennel essential oil, anethole has been considered to be the active oestrogenic agent.

#### Hepatoprotective activity

The fennel essential oil has been reported to possess hepatoprotective activity. In a study, the hepatotoxicity produced by acute  $\text{CCl}_4$  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.

#### Antidiabetic activity

The essential oil of *F. vulgare* has been reported to show hypoglycemic activity in Streptozotocin induced diabetic rats. Ingestion of essential oil of *F. vulgare* to diabetic rats corrected the hyperglycaemia from (162.5 + 3.19 mg/dl) to (81.97 + 1.97 mg/dl) and the activity of serum glutathione peroxidase from (59.72 + 2.78 u/g Hb) to (99.60 + 6.38 u/g Hb). This makes the possibility of its inclusion in antidiabetic drug industry.(5)

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