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# Pharmaco - Botanical Observation on *Foeniculum vulgare* Mill- A Review

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## Abstract

*Foeniculum vulgare* Mill. is one of the important raw drugs in Ayurveda, which is required in large quantities for the manufacture of various Ayurvedic formulations and an important medicinal plant employed to cure various diseases and possess a number of biological activities. Distribution, botanical description, microscopic characters of fruit, chemical analysis and pharmacognostic studies are detailed here.

**Key words:** *Foeniculum vulgare*, Apiaceae, pharmacognocny.

## Introduction

The plants *Foeniculum vulgare* (Mill.) belong to family Apiaceae (Umbelliferae). The other species attributed for the source of fennel are *Foeniculum officinale* (All.) and *Foeniculum capillaceum* (Gilib.). It is commonly known as Sweet fennel, bitter fennel, large fennel, carosella, Florence fennel, finocchia, garden fennel, large fennel, wild fennel.

According to Greek legend, men received knowledge from Mount Olympus as a fiery coal enclosed in a stalk of fennel. The ancient Chinese knew the herb; Indian, Egyptian and Greek civilization and Pliny recommended it for improving the eyesight. The name "foeniculum" is from the Latin word for "fragrant". Fennel was in great demand during the middle ages. Fennel shoots, fennel seeds and fennel water all are mentioned in ancient Spanish agricultural records. Spanish priests introduced plant to North America and English brought it to their early settlements in Virginia<sup>4</sup>. It was also used as ingredient in traditional formulations in the Arab and Ayurvedic system of medicine for a long time. Recently in 20th century, its use as a source of oil has been developed. Fennel is native of Southern Europe and the Mediterranean region.<sup>3</sup> It is extensively grown in all countries of Asia and Europe.

The plant is cosmopolitan in its natural distribution and the fruits are the main source of official drug in several pharmacopoeias of the world. Dried fruits and even fresh whole plant have been in use since long in India. The plant commonly known as sounf. The whole plant is used for external as well as internal administration. Externally, it is used in the form of dry powder for flavouring liquors, confectionary and meat products. It also used in perfumery and cosmetic. Internal use of fennel seed for treatment dyspepsia, spasmodic gastrointestinal, bloating and flatulence<sup>12</sup>. In the classical Indian Ayurvedic literature, it is recommended as shatapushpa means "one hundred flowers"<sup>8</sup>.

## Distribution

The plant is widely distributed in India. This plant grows fairly in mild climates but thrives in sunny situation. All North Indian states are

suitable for the cultivation of crop in India. It is also cultivated in the United States, Great Britain and temperate areas of Eurasia. It is native to Mediterranean region has spread to England, Germany, South Tyrol and the Argentina. Fennel is also found today in Iran and China<sup>2</sup>.

## Morphology

Fennel is an aromatic, perennial herb, attaining a height of 1-2 m. The leaves are decomposed very finely divided long and slender. The flowers are small, yellow in colour, born in compound terminal Umbel.

**Stem:** The stem is erect, abundantly branched, rounded, hollow, herbaceous, glabrous and green.

**Leaves:** Leaves alternate, 3 to 4 times pinnate, the ultimate leaflets are numerous, filiform, elongated, the superior leaves with sheath and longer blade, aromatic.

**Flowers:** Flowers small yellow, bisexual, sepals 5, gamosepalous, petals 5, emarginate, yellow. Stamens 5, longer than petals, yellow, ovary bicarpellary, inferior, bilocular, style stylopodium and stigma capitate.

**Fruit:** Ellipsoidal cremocarp, 6 mm long and 2 mm in diameter, greenish; glabrous mericarp compressed dorsally, semi cylindrical with 5 prominent regular ribs<sup>9,12</sup>.



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## Microscopical features of drug

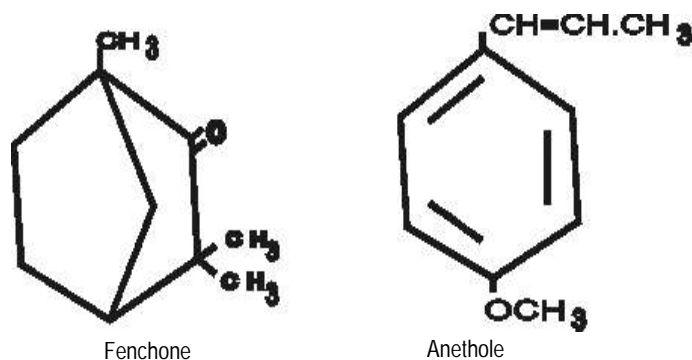
The epidermis is composed of polygonal tabular cells about 15 to 30  $\mu$  in length and width; it contains occasional stomata and the cuticle is not striated. The mesocarps contain much thickened and lignified parenchyma in the region of the vascular strands of the ribs. These thickened cells have large oval or rounded pits, the band of thickening between ribs giving a reticulate appearance of the wall. The remaining parenchyma of the mesocarp composed of ordinary polyhedral cellulosic cells. The vitta is about 250  $\mu$  in width and taper towards base and apex of fruit; the walls are brown and each duct is divided in two chambers by transverse partitions. The vitta is lined by an epithelium of small polygonal – tabular cells. The endocarp consist of narrow elongated cells having a parquetry arrangement and appearing in transverse section of the fruit as large narrow rectangular cells with here and there groups of very short cells<sup>14</sup>. Testa narrow, having tangentially elongated cell with brownish granular contents. Endosperm consists of wide polyhedral thick – walled cells. Embryo present in upper 1/3 area at the apex<sup>11</sup>.

Name	Subspecies and Variety	Taste and Odour of Seed	Composition of Essential (%)		
			Aricthoe	Fenchone	Estragole
Piper fennel	Sub Sp. Pipertum	Spicy	Trace	55	46
Bitter or Wild fennel	Sub Sp. Lapillaceum Var. volgare	Pleasant Sweetish	60-70	12-22	2-5
Sweet and Roman fennel	Sub sp. Lapillaceum Var. dulce	Pleasant Sweetish	85-90	Trace	4-8
Indian fennel	Sub Sp. Lapillaceum Var. Panmorium	Slightly strong taste	40-60	7-20	Trace
Florence Or Finocchio fennel	Sub Sp. Lapillaceum Var. Panmorium	Unpleasant taste	Trace	1-2	2-3

Table 1. Main characteristics of fennel (*Foeniculum vulgare*) subspecies and varieties-

### Key constituents

All the aerial organs of fennel are rich in essential oil. Oil (*Foeniculi aetheroleum*) comes from fennel fruit (*Foeniculi fructus*); it is the schizocarpic fruit of fennel (*Foeniculum vulgare* Miller). Fennel fruit contain 2-6% volatile oil, which can be separated by steam distillation. The composition of the oil depends on the variety of fennel. The oil contains 50-60% anethole and 20% fenchone, a bicyclic monoterpene.



Fenchone modifies the aroma of the oil. Fatty oil, protein, sugars, vitamins and minerals are also present in fennel fruits<sup>10</sup>.

The chemical compositions differs between two varieties these defined below-

### In bitter fennel the chief components are-

Essential oil	(> 4 %)
Trans – anethole	(55 –75 %)
Fenchone	(12-33%)
Estragole	(2-5 %)

Additional components – Alpha-pinenes (0.37%), Beta-pinene (0.5%), Camphor (0.35%), Para-cymene (0.3%), Myrcene (1%), Limonene (3.5%), Alpha phellandrene (1.1%), Gamma-terpenes (1.1%).

### In sweet fennel the chief components are-

Essential oil	(> 2 %)
Trans- anethole	(80-90%)
Fenchone	(1-10%)
Estragole	(3-10%)

Additional components – Alpha-pinenes (3.7%), Camphor (0.6%), Carphene (0.1%), Beta-phellandrene (11.1%), Limonene (15.7%), Gamma terpenes (0.4%).

**Hydroxycoumarins (traces)** : Umbelliferone, scopoletine, osthenol, scoparin, furocoumarins traces including bergapten, columbianetin, psoralen, xanthotoxin.<sup>2</sup>

### Pyranoumarins

### Flavonoids

The sweetness of fennel is due to the presence of trans-anethole and astragole, either alone or in combination. Sweet varieties of fennel taste sweeter than bitter varieties because they contain more trans-anethole and less fenchone. The bitter taste is caused by the monoterpene ketone fenchone<sup>7</sup>.

### Pharmacology

**General animal data** : The volatile oil of fennel increases the spasmolytic effect on smooth muscles of experimental animals. Aqueous extracts of fennel experimentally increase ciliary action and it also stimulates secretions of the upper respiratory tract and ciliary epithelium in frogs. An estrogenic component of fennel was originally thought to be anethole and estragole has been reported to cause tumors in animals<sup>6</sup>.

**General human data** : Interaction between fennel oil and other drugs in human are not expected. But very high doses of fennel oil should be avoided in hepatic disorder. Acute or chronic poisoning with fennel oil in human has not been reported<sup>13</sup>.

**Antimicrobial activity** : Fennel oil show bacteriostatic activity for *Aerobacter aerogenes*, *Bacillus subtilis*, *E-coli*, *Proteus vulgaris*, *Pseudomonas aeruginosa*. The antibacterial activity of oil is equal or even greater than commercial antibiotics. Mould growth is also inhibited by the application of 0.1% oil<sup>7</sup>.

**Dermatological reactions :** Allergic skin reactions are rare. Phototoxic effect is doubtful due to lack of furocoumarins or similar compounds. The dermal applications aggravate inflammation caused by mustard oil, UV irradiation.

**Respiratory reactions :** A percentage patients who are allergic to celery display allergy reaction to fennel. The reoccurrence of asthma after eating fennel and the relief from asthma by elimination of fennel from the diet make a correlation between fennel and allergic asthma probable<sup>13</sup>.

**Fertility, pregnancy and lactation :** An Acetone extract of the seeds of fennel has been shown to have estrogenic effect on the genital organs. Its specific effect can increase the flow of milk in lactating mothers. Fennel also useful in menstrual difficulty and lower abdomen pain. Side effect have not been represent any special risk in pregnancy and lactation<sup>8</sup>.

**Toxicology :** Indigestion of the volatile oil may induce nausea, vomiting and seizures. Fennel caused allergic reaction in skin and respiratory tract. The principal hazards with fennel itself are photodermatitis and contact dermatitis. Some individuals exhibit cross reactivity to several species of Apiaceae characteristic of the so called celery – carrot – mugwort – condiment syndrome. A serious hazard associated with fennel is that 'poison hemlock' can easily be mistaken for the herb. Hemlock contains highly narcotic coniine, and a small amount of hemlock juice can cause vomiting, paralysis and even death<sup>4</sup>.

#### Side Effect

In individual cases allergic reaction of skin and respiratory tract may occur. Nursing mother taking fennel tea to stimulate lactation exhibited temporary disturbances, emesis, lethargy, poor suckling, restlessness and torpor in the newborn, possibly due to Anethole in the milk (infants were healthy at 6-month follow-up). It should be avoided by women who are pregnant<sup>5</sup>.

#### Traditional uses

Fennel seeds are used in Ayurveda and Unani systems of medicine as a carminative. Seeds of both sweet and bitter fennel are used in eastern countries for cooking. Bitter fennel and sweet fennel oil also used as fragrance components in cosmetics, soaps, creams and perfumes. Leaves have diuretic properties so it is used in making fish sauce and for garnishing, while leaf stalk are used in salad. The roots are purgative with an aromatic taste. Fennel oil is widely used in most major food products including, alcoholic and non-alcoholic beverages, candy, baked goods, meat products, condiments and processed vegetables<sup>12</sup>.

Fennel tea is much used to treat dyspepsia and diarrhoea in infants. During an initial fasting period the child is given nothing but fennel tea. This not only provides for fluid intake, but due to its carminative action also relieves meteorism and intestinal spasm. The aromatic fennel water is used to treat inflammatory conditions of the external eye, e.g. blepharitis and conjunctivitis with swelling of the lids. Loose compresses are applied and changed frequently, or the eyes are bathed in the liquid<sup>1,15</sup>.

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