

## Pharmacognostic Studies on *Foeniculum Vulgare*

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### Abstract

A common spice *Foeniculum vulgare* also known as Fennel have so many traditional medicinal uses. It shows wide range of therapeutic effect on body system mainly Digestive ,Respiratory, Reproductive and Endocrine.

Hippocrates and Dioscorides described it as a diuretic and also strengthen eyesight. The fennel plant is originated in southern Mediterranean region and through naturalization it is cultivated in almost every part of the world.

In this review regarding Fennel the information about Origin,local names ,various Pharmacognostic parameters like Phytochemicals,Macroscopy, Microscopy,Chemical constituents,extraction,evaluation ,traditional And pharmacological uses and other physiochemical parameters are evaluated.

**Key words:** Fennel, *Foeniculum Vulgare*, physiochemical parameters, common spice .

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### I. INTRODUCTION

*Foeniculum Vulgare* is a perennial, aromatic plant which belongs to Apiaceae (Umbelliferae) family. In accordance with the international rules as adopted at Cambridge, the name *Foeniculum vulgare* must be accredited to Philip Miller, who first validly published it in the eighth edition of his “Gardeners Dictionary” in 1768. From then on, the name of this plant is written as *Foeniculum vulgare* Mill. It have many subspecies and varieties. two sub-species of fennel, which have wide range of medicinal use.

*F. vulgare* subsp. *vulgare* var. *Dulce* is called sweet fennel, while *F. vulgare* mill. Subsp. *vulgare* var. *vulgare* is bitter fennel which have wide range of medicinal use. It is used as flavouring

agents in baked goods, meat and fish dishes, ice creams, alcoholic beverages, etc due to their characteristic anise odour. Many cultures in the Indian subcontinent and the middle east use fennel seeds in their cooking.

**Synonyms :** *Anethum foeniculum* L. (1753), *Foeniculum capillaceum* Gilib. (1782), *F. officinale* Allioni (1785).

**Scientific name :** *Foeniculum vulgare* Miller

**Common Name :** - Fennel, Sweet fennel, Florence fennel

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

- INDIA : - Fennel, Sweet fennel
- Hindi : - Sounf
- Manipuri : - Hop
- Tamil : - Sompu
- Malayalam : - Preumjirakam
- Telugu : - Peddajilakarra
- Kannada : - Doddasompu
- Bengali : - Mauri

### In other countries

- Dutch : Venkel
- English: Bitter fennel, common fennel, sweet fennel, wild fennel
- France: Fenouille
- French: Fenouil
- Germany: Fenchel, fenchle, bitterfenchel, wilder fenchel, dunkler fenchel,
- Japanese :Fenneru, uikyoyu, uikyoya, shouikyaya

**Taxonomy :**

Domain	Eukaryota
Kingdom	Plantae
Phylum	Spermatophyta
Subphylum	Angiospermae
Class	Dicotyledonae
Order	Apiales
Family	Apiaceae
Genus	Foeniculum
Species:	Foeniculum vulgare

**General Botanical Description**

**Stem :** Erect, shining green and grows to 2.5 tall with hollow stem.

**Leaf :** The leaves grow up to 40 cm long; they are finely dissected, with the ultimate segments filament-like, about 0.5 mm wide. The leaves are similar to those of dill, yet slightly thinner in comparison.

**Flowers :** The flowers are produced in terminal compound umbels (umbrella like clusters arising from the same point on the stem) 5–15 cm wide, each umbel section with 20–50 tiny yellow flowers on short stalks.

**Fruits :** The fruit is a dry seed from 4–10 mm long, half as wide or less, and grooved. This fruit is what the plant is better known for, and is usually mistakenly called seed. Fennel is used in Indian cooking.



**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.

Extraction of the essential oil:

The hydro-distillation of fennel seeds was accomplished using a Clevenger-type apparatus (Clevenger 1928). Triple repeated weighing of 300 g of the dried fennel seeds were added to 2-L distilled water into a 5-L flask. The whole was heated until boiling for 5 h. The essential oil, after their extraction, was collected and dried with anhydrous sodium sulphate, then recovered and stored in a small bottle opaque at 4 °C in the dark, (Na<sub>2</sub>SO<sub>4</sub>), until being analysed.

The essential oil of the fennel plant was extracted in three stages.

The first stage contains the essential oil extracted from the green herb in green seed formation stage, the second from the mature fennel seed and the third from the plant waste after harvest, Fennel (*Foeniculum*

vulgare) - umbelliferae family is perennial herb with yellow flowers. It is considered a very powerful aromatic herb with its many uses in food and medicine. It is widely cultivated, for its edible, strongly flavored leaves and fruits to study the most important compounds responsible for flavoring in fennel, it requires not only analysis of the components of oil seeds but also requires the analysis of essential oil extracted from other parts of the plant. So, some investigators have reported comparison between seeds oil and herb oil from sweet fennel.

Analysis :

- **Gas chromatography**

GC analysis was performed using a Shimadzu GC- 9A gas chromatograph equipped with a DB-5 fused silica column (30 m x 0.25 mm i.d., film thickness 0.25  $\mu$  m). Oven temperature was held at 40°C for 5 min and then programmed until 250°C at a rate of 4°C/min. Injector and detector (FID) temperature were 260°C; helium was used as a carrier gas with a linear velocity of 32 cm/s.

- **Gas chromatography- mass spectrometry**

GC-MS analyses were carried out on a Varian 3400 system equipped with a DB-5 fused silica column (30 m x 0.25 mm i.d.); Oven temperature was 40 to 240°C at a rate of 4°C/min, transfer line temperature 260°C, injector temperature 250°C, carrier gas helium with a linear velocity of 31.5 cm/s, split ratio 1/60, flow rate 1.1 ml/ min, Ionization energy 70 eV; scan time 1 s ; mass range 40-350 amu.

- **Qualitative and quantitative analysis of essential oil**

Identifications were made by library searches (Adams, 1995)[18] combining MS and retention data of authentic compounds by comparison of their GC retention indices (RI) with those of the literature or with those of standards available in our laboratories. The retention indices were determined in relation to a homologous series of n-alkanes (C8–C22) under the same operating conditions. Further identification was made by comparison of their mass spectra with those stored in NIST 98 and Wiley5 Libraries or with mass spectra from literature. Component relative concentrations were calculated based on GC peak areas without using correction factors.

#### Physicochemical parameters of the essential oil of fennel fruit:

- ❖ Moisture %: 3.35- 4.75;
- ❖ Solubility: alcohol, chloroform, carbon tetrachloride, hexane;
- ❖ acid value (mg/KOH/g): 1.5-2.45;
- ❖ Saponification value (mg/KOH/g): 121.50-145.75;
- ❖ Ester value: 116.00-141.30;
- ❖ Peroxide value (mEq/kg): 5.65-6.45;
- ❖ Iodine value (g/g): 94.25-98.5;
- ❖ Refractive index at 25°C: 1.5465 $\pm$ 0.30-1.5575 $\pm$ 0.25;
- ❖ Congealing point (16.4°C): 16.4 $\pm$ 0.5- 16.7 $\pm$ 0.5;
- ❖ Optical rotation (-2.25  $\pm$  0.70 to + 10.25  $\pm$  0.43) - (-2.10  $\pm$  0.36 to + 10.35  $\pm$  0.45)
- ❖ Specific gravity at 25°C: 0.978 $\pm$ 0.035 -0.985 $\pm$ 0.032 (40).

#### Chemical constituents:

The preliminary phytochemical study revealed the presence of saponins, flavonoids, cardiac glycosides, sterols, triterpenes, coumarins and volatile oils.

#### Compounds in essential oils of fennel :

Row	Compounds name	RI	Percentage
1	3,5-dimethyl-1,6-heptadien-4-ol	920	1.2
2	$\alpha$ -thujene	925	0.9
3	$\alpha$ -pinene	936	11.4
4	D-limonene	1024	5.6
5	Sylvestrene	1027	1.7
6	$\delta$ -3-carene	1030	2.2
7	$\alpha$ -fenchone	1076	4.4
8	Epi camphor	1114	1.8
9	endo fenchol	1115	1.9
10	exo fenchol	1118	2.4
11	Bornan-3-one	1138	1.9
12	Estragol	1186	4.5
13	Fenchyl acetate	1233	4.7
14	Cis-Anethol	1253	7.5
15	Trans-Anethol	1258	15.1
16	$\beta$ -cubebene	1317	0.8
17	$\beta$ -caryophellene	1386	3.3
18	10s-11s-Himachala-3(12),4-diene	1399	1.1

19	$\beta$ -farnesene	1460	1.6
20	Germacrene D	1480	1.8
21	Bisabolene	1506	0.7
22	Bronyl isovalerate	1514	0.9
23	Eugenol acetate	1526	2.4
24	$\delta$ -cadinene	1541	3.3
25	Spathulenol	1570	1.5
26	Caryophellene oxide	1580	1.3
27	Unknown	1601	0.8
28	$\tau$ -cadinol	1618	0.7
29	$\alpha$ -cadinol	1627	1.5
30	$\tau$ -muurolol	1641	0.4
31	Phytol	2002	0.6
32	Dipenthyl phthalate	2130	0.5

**Nutrients found in dried fennel**

**Composition                      Quantity (Per 100 g)**

Moisture	90.21 g
Energy	31 kcal
Protein	1.24 g
Total lipid (fat)	0.2 g
Carbohydrate	7.3 g
Total dietary fiber	3.1 g
Sugars	3.93 g

**Minerals**

✓ Calcium, Ca	49 mg
✓ Iron, Fe	0.73 mg
✓ Magnesium, Mg	17 mg
✓ Phosphorus, P	50 mg
✓ Potassium, K	414 mg
✓ Sodium, Na	52 mg
✓ Zinc, Zn	0.2 mg

**Vitamins**

✓ Vitamin C	12 mg
✓ Thiamin B-1	0.01 mg
✓ Riboflavin B-2	0.032 mg
✓ Niacin B-3	0.64 mg
✓ Vitamin B-6	0.047 mg
✓ Folate	27 $\mu$ g
✓ Vitamin A	48 $\mu$ g
✓ Vitamin E	0.58 mg
✓ Vitamin K	62.8 $\mu$ g

**Lipids**

✓ Fatty acids, total saturated	0.09 g
✓ Fatty acids, total monounsaturated	0.068 g
✓ Fatty acids, total polyunsaturated	0.169 g

**Essential amino acids**

✓ Leucine	0.63 g
✓ Isoleucine	0.73 g
✓ Phenylalanine	0.45 g
✓ Tryptophane	0.53 g

**Nonessential amino acid**

✓ Glycine	0.55 g
✓ Proline	0.53 g

**PHYTOCHEMISTRY:-**

*Foeniculum vulgare* seeds contain alkaloids, carbohydrates, Phytosterols, phenols, tannins, coumarins and flavonoids as nonvolatile substances;

The acetone extract have phenols while methanol extract contains higher amounts of flavonoids .

Kaur et al. reported the presence of alkaloids, flavonoids, tannins, saponins and trace amounts of cardiac glycosides in hot water fruit extract and methanol extract of fruit sample from Egypt was reported to contain flavonoids, terpenoids, alkaloids, phenols and sterols

**Phenolic compound :** Estragole (methyl chavicol) (71.1%) as the predominant alcohol, gallic acid (18.9%) as the major phenolic compound and l-limonene (11.9%) as the most prevalent monoterpene hydrocarbon .

**Other phenolic compounds identified in fennel include**

3-o-caffeoylquinic acid	Chlorogenic acid	4-o-caffeoylquinic acid	Eriocitrin	Rutin
1,3-o-dicaffeoylquinic acid	1,5-o-dicaffeoylquinic acid	1,4-o-dicaffeoylquinic acid	Rosmarinic acid	

**Flavone (OL)-o-glycosides :** are quercetin 3-glucuronide, isoquercitrin, rutin, and quercetin 3-arabinoside; other phenols reported are kaempferol 3-glucuronide and kaempferol 3-arabinoside .

Bergapten, columbianetin, ostheno, psoralen, scoparone, seselin, vanillin, beta-sitosterol and stigmasterol have also been identified in fruits .

**Digluconide :** stilbene trimers and a benzoisofuranone derivative have also been isolated from the fruits .

**Elements :** present in fennel fruits from Ethiopia were reported as calcium, magnesium, iron, manganese, copper, chromium, cobalt, zinc, nickel and cadmium . Fennel is reported as one of the plant sources with highest amounts of calcium, potassium, sodium and phosphorus .

**Essential oil :**

The method of distillation significantly affects the yield and qualitative composition of the essential oil .Essential oil composition also varies depending on the maturation stages of the plant.

The yield of Turkish essential oil (5.0ml/kg) and content of trans-anethole are very low (34.8%),

The yield of essential oil is maximum in fennel from Norway and Austria (50.7 ml/kg and 50.5ml/kg), respectively; these samples are richer in Fenchone (21.2% and 22.8%, respectively), but contain less trans-anethole (64.6% to 63.7%) than samples from Estonia and Moldova (82.0% and 80.9%) .

In fennel samples collected from the wild population in the center and south of Portugal, the yields of essential oils varied greatly from 1.1% to 2.9%, and the main constituents, trans-anethole (7.9% to 77.7%), Fenchone (16.9% to 34.7%) and estragole (2.5% to 66.0%) also showed great variations. In general, fennel oil extracted by either distillation-extraction or supercritical fluid extraction shows similar compositions, with trans-anethole, estragole and Fenchone as the main components. Trans-anethole (85.63%) is generally the predominant constituent of the oil , while estragole is found in small amounts (2.87%), and the quantity of Fenchone is <1% . Trans-anethole (69.8%) and limonene (22.5%), though, were identified as the major constituents of essential oil in fennel samples cultivated in southeastern Brazil and Miguel et al. reported estragole as the dominant constituent in the fruit essential oil of samples from Portugal, and trans-anethole, alpha-pinene and limonene being the main components of dried aerial parts essential oil.

In samples of essential oil of fennel grown under different climatic conditions in Romania, major compounds identified in all samples were trans-anethole, estragole, fenchone, limonene, alpha-pinene and gamma-terpinene and fennel oil samples from Egypt also showed trans-anethole, estragole, fenchone and limonene as the major constituents.

Essential oils obtained from various wild Italian varieties contained five chemical groups characterized by

- (i) alpha-phell andrene, methyl chavicol (estragole) and trans-anethole;
- (ii) alpha-pinene, limonene and trans-anethole;
- (iii) methyl chavicol and alpha-phell andrene;
- (iv) methyl chavicol and alpha-pinene; and
- (v) alpha-phell andrene .

In Chinese medicine various frying methods are used before the fruits are incorporated in poly herbal preparations. After different frying methods, contents of all twenty-four ingredients of the volatile oil from these fruits were changed, and eighteen new compounds, including Linalyl acetate, farnesene, p-allylphenyl aromatic oxide, and Menthone and hexyl octanoate were created; however, transanethole remained the largest of the effective ingredients in the fried samples .

**Traditional Medicinal Use**

**Leaves**

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

**Bark**

- a) The bark is used to do fever and tonic from.
- b) Bark of tree is used for blood related diseases .

### Root

- a) Root is used for urinary tract infection and renal calculi and glycosuria.
- b) Root is used in fevers, colic, muscular pains .

### Flowers

- a) 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 .
- b) Flowers are used in perfumes.

### Aerial Parts

- a) The aerial parts are also used in treat improving the milk flow Brest feeding mother .

### Pharmacological Uses

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. Phenolic compounds separated by *Foeniculum vulgare* are considered responsible for antioxidant activity.

### Fennel also shows following activities

- ✓ Anti-inflammatory,
- ✓ Antispasmodic,
- ✓ Diuretic,
- ✓ Antihypertensive,
- ✓ Antimicrobial,
- ✓ Gastro protective,
- ✓ Estrogenic,
- ✓ Hepatoprotective
- ✓ Antithrombotic activities.
- ✓ Hypoglycaemic
- ✓ Antihirsutism,
- ✓ Cytoprotective,
- ✓ Antitumor,
- ✓ Antioxidant
- ✓ Oestrogenic
- ✓ Memory-enhancing
- ✓ Anticarcinogenic
- ✓ Antiaging
- ✓ Antiulcerogenic
- ✓ Cytotoxic
- ✓ Antimycobacterial
- ✓ Apoptotic

### REFERENCE

- [1]. Badgujar SB, Patel VV, Bandivdekar AH. *Foeniculum vulgare* Mill: a review of its botany, phytochemistry, pharmacology, contemporary application, and toxicology. *Biomed Res Int.* 2014;2014:842674.
- [2]. Endalamaw FD, Chandravanshi BS. Levels of major and trace elements in fennel (*Foeniculum vulgari* Mill.) fruits cultivated in Ethiopia. *Springerplus.* 2015;4:5.
- [3]. Gori L, Gallo E, Mascherini V, Mugelli A, Vannacci A, Firenzuoli F. Can estragole in fennel seed decoctions really be considered a danger for human health? A fennel safety update. *Evid Based Complement Alternat Med.* 2012;860542:2012.
- [4]. Jarić S, Mitrović M, Djurdjević L, Kostić O, Gajić G, Pavlović D, et al. Phytotherapy in medieval Serbian medicine according to the pharmacological manuscripts of the Chilandar Medical Codex (15th,16thcenturies). *J Ethnopharmacol.* 2011;137(1):601-19.
- [5]. Dymock W, Warden CJH, Hooper D. *Pharmacographia Indica.* 1890. Karachi, Pakistan: Reprinted by The Institute of Health and Tibbi Research. Hamdard National Foundation.1972;2:124-6.
- [6]. Albert-Puleo M. Fennel and anise as estrogenic agents. *J Ethnopharmacol.* 1980;2(4):337-44.
- [7]. Kabeeruddin M. *Kitabul-Advia, Vol. II Makhzan-al-Mufradat,* Delhi:Aligarh Barqi Press. 1937:57-8.
- [8]. Kumar,N."A textbook of Pharmacognosy",Medical Publishers,third edition 2018,page no.127-128.
- [9]. 243Anonymous, 2007. Research Achievement. In annual report (2006-07), National Research Centre on Seed Spices, Tabiji, Ajmer (Raj) pp18-19.
- [10]. <https://www.agrifarming.in/fennel-farming>.
- [11]. "Classification for Kingdom Plantae Down to Genus *Foeniculum* Mill.". US Department of Agriculture, Natural Resources Conservation Service. 2015. Retrieved 24 March 2015.
- [12]. 30. Goswami N, Chatterjee S. Assessment of free radical scavenging potential and oxidative DNA damage preventive activity of *Trachyspermum ammi* L. (carom) and *Foeniculum vulgare* Mill. (fennel) seed extracts. *Biomed Res Int.* 2014;2014:582767.
- [13]. 32. Mohamad RH, El-Bastawesy AM, Abdel-Monem MG, Noor AM, AlMehdar HA, Sharawy SM, et al. Antioxidant and anti-carcinogenic effects of methanolic extract and volatile oil of fennel seeds (*Foeniculum vulgare*). *J Med Food.* 2011;14(9):986-1001.

- [14]. 34. Kunzemann J, Herrmann K. [Isolation and identification of flavon(ol)-O-glycosides in caraway (*Carum carvi* L.), fennel (*Foeniculum vulgare* Mill.), anise (*Pimpinella anisum* L.), and coriander (*Coriandrum sativum* L.), and of flavon-C-glycosides in anise. I. Phenolics of spices (author's transl)]. *Z Lebensm Unters Forsch.* 1977;164(3):194-200.
- [15]. 36. De Marino S, Gala F, Borbone N, Zollo F, Vitalini S, Visioli F, et al. Phenolic glycosides from *Foeniculum vulgare* fruit and evaluation of antioxidative activity. *Phytochemistry.* 2007;68(13):1805-12.
- [16]. 37. Mimica-Dukic N, Kujundzic S, Sokovic M, Couladis M. Essential oil composition and antifungal activity of *Foeniculum vulgare* Mill obtained by different distillation conditions. *Phytother Res.* 2003;17(4):368-71.
- [17]. 39. Raal A, Orav A, Arak E. Essential oil composition of *Foeniculum vulgare* Mill. Fruits from pharmacies in different countries. *Nat Prod Res.* 2012;26(13):1173-8.
- [18]. 40. Mota AS, Martins MR, Arantes S, Lopes VR, Bettencourt E, Pombal S, et al. Antimicrobial activity and chemical composition of the essential oils of Portuguese *Foeniculum vulgare* fruits. *Nat Prod Commun.* 2015;10(4):673-6.
- [19]. 42. Bajan M, Aprotosoiaie AC, Spac A, Stanescu U. [Chemical composition of essential oil obtained from Romanian fennel fruits]. *Rev Med Chir Soc Med Nat Iasi.* 2011;115(2):590-4.
- [20]. 45. Coşge B, Kiralan M, Gürbüz B. Characteristics of fatty acids and essential oil from sweet fennel (*Foeniculum vulgare* Mill. var. dulce) and bitter fennel fruits (*F. vulgare* Mill. var. vulgare) growing in Turkey. *Nat Prod Res.* 2008;22(12):1011-6.
- [21]. 49 Miguel MG, Cruz C, Faleiro L, Simões MT, Figueiredo AC, Barroso JG, et al. *Foeniculum vulgare* essential oils: chemical composition, antioxidant and antimicrobial activities. *Nat Prod Commun.* 2010;5(2):319-28.
- [22]. 50. Aprotosoiaie AC, Hâncianu M, Poiată A, Tuchiluş C, Spac A, Cioană O, et al. In vitro antimicrobial activity and chemical composition of the essential oil of *Foeniculum vulgare* Mill. *Rev Med Chir Soc Med Nat Iasi.* 2008;112(3):832-6.
- [23]. 51. Shahat AA, Ibrahim AY, Hendawy SF, Omer EA, Hammouda FM, AbdelRahman FH, et al. Chemical composition, antimicrobial and antioxidant activities of essential oils from organically cultivated fennel cultivars. *Molecules.* 2011;16(2):1366-77.
- [24]. 52. Piccaglia R, Marotti M. Characterization of some Italian types of wild fennel (*Foeniculum vulgare* Mill.). *J Agric Food Chem.* 2001;49(1):239-44.
- [25]. 53. Zhang F, Li Z, Tian S, Ma L. [Analysis on changes of chemical compounds in different samples of fried *Foeniculum vulgare*]. *Zhongguo Zhong Yao Za Zhi.* 2009;34(7):829-32.
- [26]. Faudale, M., Viladomat, F., Bastida, J., Poli, F., Codina, C., 2008. Antioxidant activity and phenolic composition of wild, edible, and medicinal fennel from different mediterranean countries. *J. Agric.Food Chem.* 56, 1912–1920.
- [27]. Ruberto, G., Baratta, M.T., Deans, S.G., Dorman, H.J.D., 2000. Antioxidant and antimicrobial activity of *Foeniculum vulgare* and *Crithmum maritimum* essential oils. *Planta Med.* 66, 687–693.
- [28]. Marino, S.D., Gala, F., Borbone, N., Zollo, F., Vitalini, S., Visioli, F., Iorizzi, M., 2007. Phenolic glycosides from *Foeniculum vulgare* fruit and evaluation of antioxidative activity. *Phytochemistry* 68, 1805–1812.
- [29]. Birdane FM, Cemek M, Birdane YO, Gülçin I, Büyükkokuroğlu ME. Beneficial effects of *Foeniculum vulgare* on ethanol-induced acute gastric mucosal injury in rats. *World J Gastroenterol.* 2007;13(4):607-11.
- [30]. Vasudevan K, Vembar S, Veerarahavan K, Haranath PS. Influence of intragastric perfusion of aqueous spice extracts on acid secretion in anesthetized albino rats. *Indian J Gastroenterol.* 2000;19(2):53-6.
- [31]. Tognolini M, Ballabeni V, Bertoni S, Bruni R, Impicciatore M, Barocelli E. Protective effect of *Foeniculum vulgare* essential oil and anethole in an experimental model of thrombosis. *Pharmacol Res.* 2007;56(3):254-60.
- [32]. Choi EM, Hwang JK. Antiinflammatory, analgesic and antioxidant activities of the fruit of *Foeniculum vulgare*. *Fitoterapia.* 2004;75(6):557-65
- [33]. Nickavar B, Abolhasani FA. Screening of antioxidant properties of seven Umbelliferae fruits from Iran. *Pak J Pharm Sci.* 2009;22(1):30-5.
- [34]. Mohsenzadeh, M., 2007. Evaluation of antibacterial activity of selected Iranian essential oils against *Staphylococcus aureus* and *Escherichia coli* in nutrient broth medium. *Pak. J. Biol. Sci.* 10,3693–3697.
- [35]. Kaur, G.J., Arora, D.S., 2008. In-vitro antibacteri al activity of threeplants belonging to the family Umbelliferae. *Int. J. Antimicrob.Agents* 31, 393–395.
- [36]. Mahady, G.B., Pendland, S.L., Stoia, A., Hamill, F.A., Fabricant, D., Dietz, B.M., Chadwick, L.R., 2005. In-vitro susceptibility of *Helicobacter pylori* to botanical extracts used traditionally for the treatment of gastro-intestinal disorders. *Phytother. Res.* 19, 988–999.
- [37]. Kwon, Y.S., Choi, W.G., Kim, W.J., Kim, W.K., Kim, M.J., Kang, W.H., Kim, C.M., 2002. Antimicrobial constituents of *Foeniculum vulgare*. *Arch. Pharmacal. Res.* 25, 154–157.
- [38]. El-Soud, N.A., El-Laithy, N., El-Saeed, G., Wahby, M.S., Khalil, M., Morsy, F., Shaffie, N., 2011. Antidiabetic activities of *Foeniculum vulgare* Mill. Essential oil in Streptozotocin induced diabetic rats. *Macedonian J. Med. Sci.* 173, 1857–5773.
- [39]. Ozbek, H., Ugras, S., Dulger, H., Bayram, I., Tuncer, I., Ozturk, G., Ozturk, A., 2003. Hepatoprotective effect of *Foeniculum vulgare* essential oil. *Fitoterapia* 74, 317
- [40]. A Comprehensive Review on Pharmacological Activity of *Foeniculum vulgare* Shubham Pratap Singh \*  
Research Scholar, School of Pharmacy, Monad University, India  
<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4137549/>

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