

Umbelliferous Fruits - A Brief Review on Chemical Constituents and Pharmacological Action

Seba M C¹, Anatt Treesa Mathew², Sheeja Rekha³, Dr. Prasobh G R⁴

^{1,2,3,4}Department of Pharmaceutical Chemistry and Analysis, Sree Krishna College of Pharmacy and Research Centre, Parassala, Kerala, India

Corresponding Author: Seba MC

DOI: <https://doi.org/10.52403/ijrr.20220704>

ABSTRACT

Umbelliferous fruits are usually cremocarps either entire or separated into mericarps. These types of fruits are produced by the plants which belongs to Apiaceae family of the flowering plants. Some of the examples of plants producing umbelliferous fruits are Fennel (*Foeniculum vulgare*), Caraway (*Carum carvi*), Anise (*Pimpinella anisum*), Dill (*Anethum graveolens*), Coriander (*Coriandrum sativum*), Cumin (*Cuminum cyminum*), and Celery (*Apium graveolens*). This review is written to shed light on detailed study of chemical constituents and pharmacological actions of Umbelliferous fruits. This review will be beneficial to the scientist, manufacturer and consumers in order to explore the potential health benefits of Umbelliferous fruits.

KEYWORDS: Umbelliferous fruits, Cremocarps, Apiaceae family

INTRODUCTION

Apiaceae or Umbelliferae is a family of generally aromatic flowering plants named after the type genus *Apium* and usually known as the celery, carrot or parsley family, or merely as umbellifers. It is the 16th-largest family of flowering plants, with more than 3,700 species in 434 genera including such well-known and economically important plants such as ajwain, angelica, anise, asafoetida, caraway, carrot, celery, chervil, coriander, cumin, dill, fennel, lovage, cow parsley, parsley, parsnip and sea holly. ⁽¹⁾

The General Characteristics of umbelliferous fruit are Fragments of epidermal cells of the pericarp, usually polygonal with smooth cuticle and very few anomocytic stomata. Umbelliferous fruits usually contain volatile oil. Schizocarpic. form bilocular bicarpellary inferior ovaries. Each cremocarp is equal to two mericarps. The carpophore connects the mericarps. Carpophore is attached to the stalk. The mericarp has two surfaces: dorsal and commissural. The remains of the sepals and style (stylopod) are located at the apex proving that the fruit originates from an inferior ovary. The mericarp is ridged with 5 primary and 4 secondary ridges. A bicollateral v.b. is present under each primary ridge. A schizogenous duct (vitta) is located under each secondary ridge. Two more vittae are located towards the commissural surface. The endocarp cells may divide to form a parquetry-like structure. The seed is anatropous and the raphe is located towards the commissural surface. The seed is albuminous and the embryo is straight and apical. ⁽²⁾

This review provide detailed study of chemical constituents and pharmacological actions of Umbelliferous fruits, which is beneficial to the scientist, manufacturer and consumers in order to explore the potential health benefits of Umbelliferous fruits.

1. Fennel

Fennel (*Foeniculum vulgare*) is a species in the genus *Foeniculum* (treated as the sole

species by many botanists), and is native to southern Europe (especially the Mediterranean) and southwestern Asia. It is a member of the family Apiaceae, formerly the Umbelliferae.⁽³⁾



Chemical constituents

The phytochemical study by Prof Dr Ali Esmail Al-Snafi showed the presence of flavonoids, saponins, cardiac glycosides, triterpenes, volatile oils, coumarins and sterols. In addition contained protein, fibre, carbohydrates, fat, and minerals. The minerals present in *Foeniculum vulgare* were included calcium, potassium, sodium, iron, phosphorus, and the vitamins include thiamine, riboflavin and niacin. Triterpenes, flavonoid glycosides, smaller terpenes (monoterpenoids, sesquiterpenoids and diterpenoids) and reducing sugars were isolated from the seeds of *Foeniculum vulgare*. Total phenolic content in organic fennel oil was 262.59 ± 15.5 mg Gallic Acid Equivalents. The phenolics present in the fruit of this plant were neochlorogenic acid (1.40%), chlorogenic acid (2.98%), gallic acid (0.169%), chlorogenic acid (6.873%), caffeic acid (2.960%), p-coumaric acid (4.325%), ferulic acid-7-o-glucoside (5.223%), quercetin-7-ogluconide (3.219%), ferulic acid (3.555%), 1,5 dicaffeoylquinic acid (4.095%), hesperidin (0.203%), cinnamic acid (0.131%), rosmarinic acid (14.998%), quercetin (17.097%), and apigenin (12.558%) (45). However, Parejo and co-workers isolated 3-caffeoylquinic acid, 4-caffeoylquinic acid, 1,5-O-dicaffeoylquinic acid, rosmarinic acid, eriodictyol-7-O-rutinoside, quercetin-3-O-galactoside, kaempferol-3-O-rutinoside, kaempferol-3-O-glucoside, hydroxycinnamic acid derivatives, flavonoid glycosides and flavonoid

aglycones from the aqueous extract of fennel fruits. The furocoumarins imperatorin, psoralen, bergapten, xanthotoxin and isopimpinellin were isolated from the methylene chloride extract. The flavonoids isorhamnetin 3-O- α -rhamnoside, quercetin and kaempferol were isolated from the ethyl acetate extract, whereas quercetin 3-O-rutinoside, kaempferol 3-O-rutinoside and quercetin 3-O- β -glucoside were isolated from the methanol extract.⁽⁴⁾

Pharmacological effects

Effects on urinary system

The aqueous and 80% methanol extract of *Foeniculum vulgare* showed an increased urine volume

CNS effects

The extract (400 mg/kg) exhibited maximum anti-anxiety effect. The memory deficits induced by scopolamine (1mg/kg, ip) in rats was reversed by *Foeniculum vulgare* dose-dependently. The extract also exhibited potent antioxidant effect by inhibition of lipid peroxidation in both rat liver and brain homogenates to a greater extent than the standard antioxidant, ascorbic acid (58). The antidepressant effect of *Vetiveria zizanioides* and *Foeniculum vulgare* in comparison with antidepressant drug fluoxetine was investigated. Monoamine oxidase inhibiting effect and anti-oxidant effect of *Foeniculum vulgare* may be contributing favorably to the antidepressant-like activity. *Foeniculum vulgare* can be employed in treatment of cognitive disorders such as dementia and Alzheimer's disease.

Gastrointestinal effects

Foeniculum vulgare essential oil and anethole provided significant protection toward ethanol induced gastric lesions in rats.⁽⁴⁾

Antimicrobial effect

Crude extracts of *Foeniculum vulgare* seeds were investigated for antimicrobial activity against *Staphylococcus aureus*, *Micrococcus*

spp and *Entecococcus* spp. The results showed that the ethanolic extract had superior activity against *Micrococcus* spp. (MIC=250µg/ml) (43).

Antiparasitic effects

The essential oil of the leaves, flowers, and roots of *Foeniculum vulgare* has larvicidal activity against fourth-instar larvae of the mosquito *Culex pipiens molestus*. Terpeneol and 1,8-cineole content of *Foeniculum vulgare* were the most effective contents against *Culex pipiensmolestus* bites offering complete protection for 1.6 and 2 h, respectively .

Foeniculum vulgare also has Antidiabetic effect, Effect on reproductive system(The anti-fertility effect) Antiinflammatory, analgesic effects:, Effect on osteogenesis, Bronchodilatory effects, Effect on glaucoma, Hepatoprotective , nephroprotective effects, Antimutagenic, anticancer effects, Dermatological effects, Antiallergic effect, Cardiovascular effects, Hypolipidemic effect and effect on body weight.⁽⁴⁾

2. Caraway (*Carumcarvi*)

Caraway, also known as meridian fennel and Persian cumin (*Carum carvi*), is a biennial plant in the family Apiaceae, native to western Asia, Europe, and North Africa.⁽⁵⁾



Chemical constituents

Carum carvi seeds contain 1–9% essential oils contain more than 30 compounds. Carvone and limonene are main portions. The chemical groups isolated from the oils of the seeds of *Carum carvi* were included monoterpene hydrocarbons, oxygenated

monoterpenes, oxygenated sesquiterpenes, saturated and unsaturated fatty acids, aldehydes, ketones and esters . The essential oil compounds were included (%) α -Pinene 0.3, Camphene 0.2, β -Pinene 0.1, β -Myrcene 0.1, Limonene 5.1, γ Terpinene 12.6, β -Ocimene 0.1, p-Cymene 0.1, Terpinolene 0.1, limonene oxide 0.1, Camphor 0.2, Linalool 0.7, Linalyl acetate 0.3, Terpinene-4-ol 0.1, β Caryophyllene, Dihydrocarvone 0.2, α -Terpineol 0.1, Germacrene-D 0.1, Carvone 70.1, β -Selinene 0.2, α Farnesene 0.4, Citronellol 0.1, δ -Cadinene 0.3, γ -Cadinene 0.5, Cuminaldehyde 0.1, Nerol 0.2, Trans-carveol 0.1, Nonadecane 0.1, Spathulenol 0.3, Eugenol 0.2, Thymol 0.5 and Carvacrol 0.2 . An aromatic compound, glucoside and a glucide were isolated from the water-soluble portion of the methanolic extract of caraway fruit. The flavonoid constituents of caraway were included quercetin-3-glucuronides, isoquercitrin, quercetin 3-0 caffeylglucoside, and kaempferol 3-glucoside. The nutritional analysis of *Carum carvi* seeds (100g) showed that they contained water 9.87 g, energy 333 kcal, protein 19.77g, total lipids (fat) 14.59 g, carbohydrates, by difference 49.90g, fiber, total dietary 38.0g, sugars, total 0.64g, Calcium 689 mg, Iron 16.23mg, magnesium 258mg, phosphorus 568mg, potassium 1351mg, sodium 17mg, zinc 5.50mg, total ascorbic acid 21.0 mg, thiamine 0.3606mg, riboflavin 0.379mg, niacin 3.606mg, vitamin B6 0.360mg, folate 10µg, vitamin A (RAE) 18µg, vitamin A (IU) 363IU, vitamin E 2.50mg, vitamin, fatty acids, total saturated 0.620g, fatty acids , monounsaturated 7.125g and fatty acids polyunsaturated 3.272g.⁽⁶⁾

PHARMACOLOGICAL EFFECTS

Anticancer effects

Four different derivatives of carvone were prepared in order to evaluate the anticancer potential. Only (1E)-1-[2-methyl-5-(prop-1-en-2-yl) cyclohex-2-en-1-ylidene]-2-phenyl hydrazine showed anticancer activity on MCF7 (breast), HeLa (cervix) and SK-OV3

(ovary) cell lines. Other derivatives were shown to have poor anticancer activity

Effect on gastrointestinal system:

Pretreatment with oral doses of 250 and 500 mg/kg was found to provide a dose dependent protection against ulcerogenic effect of different necrotizing agents in rats, ethanol induced histopathological lesions, depletion of stomach wall mucus and nonprotein sulfhydryl groups (NP-SH) and pylorous ligated accumulation of gastric acid secretion. The mechanism of action might be due to flavonoids related suppression of cytochrome P450 IAI (CYPIAI) which known to convert xenobiotics and endogenous compounds to toxic metabolites.

Antidiabetic effect

The hypoglycemic effect of caraway ethanolic extract was investigated in normal and streptozotocin-induced diabetic rats. The results showed that the caraway ethanolic extract seeds at doses 0.2, 0.4 and 0.6 g/kg body weight significantly decreased serum glucose in diabetic rats in 3 and 5 h, but not in healthy rats

Carum carvi also posses Endocrine effect, Anti-stress effect, Bronchodilatory effects, Diuretic effect, Analgesic effect, Renoprotective and hepatoprotective effects Antimicrobial effect, Antiprotozoal effects, Insecticidal effects, molluscicidal effects, Antioxidant and hypolipidemic effects.⁽⁶⁾

3. Anise

anise, (*Pimpinella anisum*), annual herb of the parsley family (Apiaceae), cultivated chiefly for its fruits, called aniseed, the flavour of which resembles that of licorice.⁽⁷⁾



Chemical Constituents

Aniseed contains 1.5–6.0 mass % of a volatile oil consisting primarily of trans-anethole and also as much as 8–11 mass % of lipids rich in fatty acids, such as palmitic and oleic acids, as well as approximately 4 mass % of carbohydrates, and 18 mass % of protein. Other studies have demonstrated the presence of eugenol trans-anethole, methylchavicol, anisaldehyde, estragole, coumarins, scopoletin, umbelliferone, estrols, terpene hydrocarbons, polyenes, and polyacetylenes as the major compounds of the essential oil of anise seed. Study of the essential oil of *Pimpinella anisum* L. fruits by GC and GC-MS showed the presence of trans-anethole (93.9%) and estragole (2.4%). Other compounds that were found with concentration higher than 0.06% were (E)-methyleugenol, α -cuparene, α himachalene, β -bisabolene, p-anisaldehyde, and cis-anethole. In another study for determination of the composition of essential oil of *Pimpinella anisum* L. fruits obtained from different geographical areas of Europe, in addition to the major components (trans-anethole (76.9–93.7%) and γ himachalene (0.4–8.2%), some other compounds such as trans-pseudoisoeugenyl 2-methylbutyrate, p-anisaldehyde, and methylchavicol were also identified in essential oil [9]. Study of components of the whole plants and the seeds of *Pimpinella anisum* from Alberta showed that the major oil constituent (trans-anethole) was 57.4% of whole plant and 75.2% of seed oil. The other constituents of plant oil, present in amounts of 1–5% were cis-anethole, carvone, β caryophyllene, dihydrocarvyl acetate, estragole and limonene [10]. The chemical constituents of aniseed extract obtained by Supercritical extraction using CO₂ were determined by GCMS. The major compounds were anethole (~90%), γ -himachalene (2–4%), and p-anisaldehyde.⁽⁸⁾

Pharmacological Properties

The aqueous and methanolic extract shows antibacterial, antifungal, insecticidal and antiviral properties. It also possess analgesic

effect, anticonvulsant effect, laxative action, and antioxidant property⁽⁸⁾

4. Dill (*Anethum graveolens*)

Anethum graveolens L. (dill) has been used in ayurvedic medicines since ancient times and it is a popular herb widely used as a spice and also yields essential oil. It is an aromatic and annual herb of Apiaceae family.⁽⁹⁾



CHEMICAL CONSTITUENTS

The chemical constituents present in Dill seed involves alpha-Terpenes, alpha-Phellanderene, Beta-Phellandrene, limonene, cymene, carvone, dihydrocarvone, Z-dihydrocarvone, E-dihydrocarvone, coumarin, thymol, dill apiole

PHARMACOLOGICAL EFFECTS

Dill is a medicinal herb and the seeds are carminative, stomachic, digestive, and tranquilizing, and have been used for treating stomach ailments, colic, hiccups, bad breath, flatulence, and hemorrhoids. Dill seeds' volatile oil is an important part of gripe water, which is a mixture used to treat infants' hiccups and colic. It also has galactogogue properties and promotes milk flow in nursing mothers. It has been reported that chewing dill seeds clears up bad breath or halitosis. Dill seed oil is active against harmful intestinal bacteria including *Escherichia coli*. Dill seed preparations applied externally in poultices and compresses can also be used to treat bruises, blocked milk ducts and overloaded breasts in women who are breast feeding, and gum infections. The leaves can also be used for the same purposes. Dill essential oil rubbed onto the skin can stop feelings of nausea.

Being rich in vitamin C can explain why dill was once used to treat scurvy, a disease caused by a lack of vitamin C. It is an herb that has been used in Indian herbal and Ayurvedic medicine for its digestive properties. Specific uses are for fever, jaundice, and intestinal and genitourinary tract infections.⁽¹⁰⁾

5. Coriander (*Coriandrum sativum*)

coriander, (*Coriandrum sativum*), also called cilantro or Chinese parsley, feathery annual plant of the parsley family (Apiaceae), parts of which are used as both an herb and a spice. ... Bowl of coriander fruits next to cilantro leaves, both of which are from the plant *Coriandrum sativum*.⁽¹¹⁾

CHEMICAL CONSTITUENTS

The fresh coriander herb, containing essential oil, fatty acids, flavonoids, carotenoids as well as coumarin compounds. The aroma of the coriander fruit and herb is completely different, the aliphatic aldehydes (mainly C10–C16 aldehydes), having unpleasant odour, are the main components of the volatile oil from the fresh herb, linalool and other oxidized monoterpenes as well as monoterpene hydrocarbons predominate in the oil distilled from the fruit. The compounds present in seeds and leaves were found to vary significantly. The chemical composition of coriander revealed that the linalool was 72.3 and 77.7 %, while α -pinene was 5.9 and 4.4 %, γ -terpinene 4.7 and 5.6 %, camphor 4.6 and 2.4 %, limonene 2.0 and 0.9 %⁽¹²⁾

PHARMACOLOGICAL PROPERTIES

Coriander promotes bowel movements and acts as a mild laxative. It is effective in treating digestive disorders such as indigestion, nausea, dysentery, diarrhoea, hepatitis and ulcerative colitis. Juice of fresh coriander leaves applied to the forehead cures headache, also it is a good remedy in the treatment of conjunctivitis, diseases of the respiratory and urinary systems, relief anxiety and insomnia, in allergies, amoebic dysentery, burns, cough, cystitis, dizziness,

edema, hay fever, headache, hemorrhoids, rash, urethritis, urinary tract infection, urticaria, and vomiting⁸¹⁻⁸³, diabetes, dyslipidemia⁸⁴, indigestion, flatulence, insomnia, renal disorders, loss of appetite and as a diuretic.⁽¹²⁾

6. Cuminum (Cuminum cyminum)

Cumin (*Cuminum cyminum*) is a flowering plant in the family Apiaceae, native to the Irano-Turanian Region. The term comes via Middle English and Old French from the Latin term *cuminum*.⁽¹³⁾



CHEMICAL CONSTITUENTS

Cumin seeds are nutritionally rich; they provide high amounts of fat (especially monounsaturated fat), protein, and dietary fibre. Vitamins B and E and several dietary minerals, especially iron, are also considerable in cumin seeds. Cuminaldehyde, cymene, and terpenoids are the major volatile components of cumin. Its main constituent of aroma compounds are cuminaldehyde and cuminic alcohol. Other important aroma compounds of roasted cumin are the substituted pyrazines, 2-ethoxy-3-isopropylpyrazine, 2-methoxy-3-sec-butylpyrazine, and 2-methoxy-3-methylpyrazine. Other components include γ -terpinene, safranal, p-cymene, and β -pinene⁽¹⁴⁾

PHARMACOLOGICAL PROPERTIES

Cumin seed possess different pharmacological actions such as dyspepsia, antidiabetic, neuroprotective, cardioprotective, chemoprotective, anti-inflammatory, anti-oxidant properties.⁽¹⁴⁾

7. Celery (Apium graveolens)

Celery, (*Apium graveolens*), herbaceous plant of the parsley family (Apiaceae). The tiny seedlike fruits, known as celery seed, resemble the plant itself in taste and aroma and are used as a seasoning, particularly in soups and pickles.⁽¹⁵⁾



CHEMICAL CONSTITUENTS

The methanol extract of celery seeds contained flavonoids, glycosides, steroids, alkaloids, and carbohydrates. Celery contains phenolic compounds and furocoumarins. Furocoumarins include apigravrin, celereoside, bergapten, osthonol, apiumoside, isoimperatorin, celerin, isopimpinellin, apiumetin, 5-hydroxy methoxypsoralen, and 8-hydroxy methoxypsoralen. Phenols include isoquercitrin, apiin, tannin, apigenin, Graurobioside A, Graurobioside B, and phytic acid. The leaves, stems, and oil of celery seeds contain fatty acids, alcohol sesquiterpenes, and essential oils, compounds isolated include camphene, limonene, terpinolene, cymene, selenin, sabinene, α -pinene, α -thuyene, β -phellendrene, β pinene, γ -terpinene, p-cymene, stearic acid, palmitic, linoleic, petrocellinic, myristic, oleic, myristic, myristoleic, palmitoleic, α -eudesmol, sant eudesmol, sedanenolide, phthalide, and 3-n-butyl phthalide. Celery tubers contain 5-methoxypsoralen, methoxsalen (8-methoxypsoralen), and prophylactic allergens.⁽¹⁶⁾

PHARMACOLOGICAL PROPERTIES

Celery can be used to treat kidney problems, because celery contains active compounds that can reduce uric acid levels. Celery stems and seeds can be used as anti-inflammatory, hypotensive, carminative, urinary antiseptic, sedative, antirheumatic, and spasmolytic antiseptic. Celery can also be used as a laxative, stimulant, diuretic, aphrodisiac, emmenagogue, carminative, antispasmodic, and anthelmintic. In addition, celery can be used to relieve flatulence and abdominal pain. Celery can be employed for the medication of insomnia and post-nasal edema. Celery can be combined with carrot juice as a treatment for chronic diseases. Celery seeds can be used to treat stomach disorders and chemical imbalances in the body.⁽¹⁶⁾

CONCLUSION

Umbelliferous fruits are produced by the plants which belongs to Apiaceae family of the flowering plants and the fruits are usually cremocarps either entire or separated into mericarps. The umbelliferous fruits possess various types of chemical constituents and they possess large number of pharmacological actions.

This review has fulfilled significant information about chemical constituents and pharmacological actions of umbelliferous fruits such as Fennel (*Foeniculum vulgare*), Caraway (*Carum carvi*), Anise (*Pimpinella anisum*), Dill (*Anethum graveolens*), Coriander (*Coriandrum sativum*), Cumin (*Cuminum cyminum*), and Celery (*Apium graveolens*). It may be concluded that this review is beneficial to the scientist, manufacturer and consumers in order to explore the potential health benefits of Umbelliferous fruits.

Acknowledgement: None

Conflict of Interest: None

Source of Funding: None

REFERENCE

1. Ahmed Darwish El-Gamal, Hassan Bassiouni, Mohamed Hafez, Khalid Hassan, UHPLC-MS metabolome based classification of umbelliferous fruit taxa: a prospect for phyto-equivalency of its different accessions and in response to roasting, RSC Advances, 2019; 10(1):76-85
2. <https://dokumen.tips/documents/umbelliferous-fruit.html>
3. <https://www.cs.mcgill.ca/~rwest/wikispeedia/wpcd/wp/f/Fennel.htm>
4. Dr Ali Esmail Al-Snafi, The chemical constituents and pharmacological effects of *Foeniculum vulgare* - A review, IOSR Journal Of Pharmacy, 2018; 8(5):81-96
5. <https://en.wikipedia.org/wiki/Caraway>
6. Ali Esmail Al-Snafi, The Chemical Constituents And Pharmacological Effects Of *Carum Carvi*- A Review, Indian Journal of Pharmaceutical Science & Research, 2015; 5(2); 72-82
7. <https://www.britannica.com/plant/anise>
8. Asie Shojaii and Mehri Abdollahi Fard, Review Article Review of Pharmacological Properties and Chemical Constituents of *Pimpinella anisum*, International Scholarly Research Network, 2012; 8
9. S. Jana and G. S. Shekhawat, *Anethum graveolens*: An Indian traditional medicinal herb and spice, Pharmacogn Rev., 2010; 4(8): 179-184.
10. Zahra Tayarani Najaran, Mohammad K. Hassanzadeh, Maryam Nasery, Seyed Ahmad Emami, Named Essential Oils Dill (*Anethum graveolens* L.) Oils, Chapter 45 pg no 405- 412 PART II
11. <https://www.britannica.com/plant/coriander>
12. Mandal, Manisha Mandal, Coriander (*Coriandrum sativum* L.) essential oil: Chemistry and biological activity Shyamapada, Indian Journal of Natural Products and Resources, 2017, 8(3), 193-203
13. <https://en.wikipedia.org/wiki/Cumin>
14. Krishnapura Srinivasan, Review Cumin (*Cuminum cyminum*) and black cumin (*Nigella sativa*) seeds: traditional uses, chemical constituents, and nutraceutical

effects Food Quality and Safety, 2018, 2, 1–16

15. <https://www.britannica.com/plant/celery>
16. Aswin Rafif Khairullah, Tridiganita Intan Solikhah², Arif Nur Muhammad Ansori, Akvyan Rafi Hidayatullah, Erwan Budi Hartadi, Sancaka Cashyer Ramandinianto, Amaq Fadholly, Review on the Pharmacological and Health Aspects of Apium Graveolens or Celery: An Update, Sys Rev Pharm 2021;12(1):606-612 A

How to cite this article: Seba M C, Anatt Treesa Mathew, Sheeja Rekha et.al. Umbelliferous fruits - a brief review on chemical constituents and pharmacological action. *International Journal of Research and Review*. 2022; 9(7): 18-25. DOI: <https://doi.org/10.52403/ijrr.20220704>
