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# The Use, Phytochemical and Antimicrobial Activity Evaluation of *Foeniculum vulgare*, *Cuminum cyminum*, and *Trachyspermum ammi* Were Reviewed for the Treatment of Gastric Diseases As Future Compounds

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**Abstract:** Food spices are the major source for many health benefits in traditional medicine system, to consider recent pandemic and health issues herbs become the utmost focus of global scientific research. We opted these herbs because of its easy availability and economical values. This is a review article to understand what is polyherbal formulation, how we can have benefit of synergistic effects when combining different herbs together to get more pronounced pharmacological effect and lesser side effects. We have considered three herbs that are *Cuminum cyminum*, *Trachyspermum ammi*, and *Foeneculum vulgare*, how these herbs have beneficial effect upon gastric complains by inhibiting microbes effecting normal gastrointestinal (GI) flora. We have studied their phytochemisry, uses and antimicrobial effect by reviewing the previous work done by different researchers; we have a plan to make a formulation using these three herbs and evaluate their synergistic effect upon peptic ulcer caused by *Helicobacter pylori.*

**Key words:** Traditional medicine, *Foeneculum vulgare*, *Tachyspermum ammi*, *Cuminum cyminum*, GI complaints, phytochemistry, pharmacological effect, antimicrobial effect, synergistic effect, peptic ulcer.

## 1. Polyherbal Formulation

Polyherbal therapy has been used in Chinese, Unani and Ayurvedic medicines for thousands of years, but however the scientific evidence for their therapeutic benefits is still lacking and researches have to be made to make their use common to get better treatment with fewer side effects [1].

The Polyherbal formulations due to their synergistic effect and lesser side effects provide better chronic disease management. However, the concept of Polyherbal formulation has been well developed and gained much success in western medicine system, opening new doors of hope to the suffering patients [2].

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In the recent era, resistance to antibiotics is a worldwide evolving problem that has made the researchers think for the development of antimicrobial agents with more potent effects so that they can combat the microbial resistance.

Natural products have always been a source of new drugs that provide a vast array of compounds with structural diversification and provide pure and complex secondary metabolites that have antimicrobial activity.

These products of natural origin are safer nutritionally and degraded easily with lesser or no side effects due to their antioxidant properties.

## 2. Gastric Complaints

With the emergence of antibiotic resistance evolution of natural remedies have gained vast

importance, Gastrointestinal complaints are common among people of all ages. Some common GI ailments occurring commonly are Diarrhea, Vomiting, Gastric ulcers, Indigestion, Stomachaches, Gastric cramps. Most problems occur due to food borne pathogens and contamination due to microbes.

Several researches are being made to look for herbal formulations to treat these gastric issues and avoid using antibiotics due to their adverse effects on other body systems [3].

This review article aims to find out the research that has been carried out to understand the importance of antimicrobial screening of multi herbal formulas and their use in the treatment of gastrointestinal diseases.

## 3. *Foeniculum vulgare*

### *3.1 Introduction*

Fennel, (*Foeniculum vulgare*), is a perennial herb belonging to the family Apiaceae (Umbelliferae). Flowers are yellow and leaves are feathery, stems are hollow it reaches the height of up to 2.5 cm. A native of Asia Minor and southern Europe, Fennel is widely cultivated in tropical belt and temperate zones for its fruit (Figure 1).

**Fig. 1** ***Foeniculum vulgare*.**

The plant is aromatic in nature and is widely used as a flavoring agent in cooking. Some authors distinguish fennel in to two subspecies, one is piperitum and other is vulgare. The subspecies piperitum has known to have bitter seeds, whereas the subspecies vulgare has reported to have sweet seeds and is used as a flavoring agents in variety of foods that include baked goods, fish and meat dishes, alcoholic beverages, and ice creams due to their characteristic anise odor [4]. Morphological differences between the two subspecies are not cleared. The essential oil from the fennel seeds is reported to have considerable antibacterial and antifungal activities.

### *3.2 Taxonomical Features*

The categorical characteristics of *Foeniculum vulgare* are shown in Table 1 [5].

### *3.3 Culinary Uses*

Fennel is a flavorful and an aromatic herb having both culinary and the medicinal value. It is a commonly found ingredient in the kitchen. The aroma of fennel is anise like and preferably used as flavoring agent in many food items including baked goods, fish and meat dishes in some medicines etc. Its bulb, seeds and foliage are used widely in the world of culinary tradition, for cooking purpose green seeds of fennel are preferred [6].

### *3.4 Usage and Significance in Traditional Medicine System*

The seeds and oil of fennel are used as condiments in many foods, and are widely used to promote health and prevent diseases. The seeds are sweet in taste, and tend to have stomachic, and laxative properties, and used as an appetizer because of its stimulant property. They are

used to treat headache, flu, eyesight weakness, brain tonic, and some studies also suggest their use to cure deafness [4].

In the Unani medicinal system, fennel seeds are preferably used to treat bloating, diarrhea, problems related to menstruation, and in case of piles. For about decades, fennel seeds remained a traditional herbal medicine in Europe and China [6].

**Table 1 Taxonomical Features of *Foeniculum vulgare*.**

| Parameter | |
|---|---|
| Botanical name | *Foeniculum vulgare* |
| Kingdom | Plantae |
| Sub kingdom | Tracheobionta |
| Superdivision | Spermatophyta |
| Division | Magnoliophyta |
| Class | Magnoliopsida |
| Subclass | Rosidae |
| Order | Apiales |
| Genus | Foeniculum |
| Species | *Foeneculum vulgare* |
| Family | Apiaceae |
| Common names | Saunf, Fennel |
| Taste | Sweet, Pungent, Bitter |
| Physical appearance | Unctuous, Light |
| Potency | Hot |
| Parts used | Fruits, Fruit oil, Roots, Stems, Leaves |
| Habitat | Plant is native of Mediterranean region of North Africa, Western Asia and Europe |

### *3.5 Phytochemistry*

The moisture content is found to be 6.3%, the amount of protein is 9.5%, fat content is 10%, carbohydrate concentration is found to be 42.3%, fibers are 18.5%, minerals are 13.4% including potassium, calcium, iron, phosphorous, sodium and vitamins include thiamine, niacin, riboflavin, ascorbic acid.

6.3% of moisture, 9.5% protein, 10% fat, 13.4% minerals, 18.5% fiber and 42.3% carbohydrates. The minerals and vitamins present in *F. vulgare* are calcium, potassium, sodium, iron, phosphorus, thiamine, riboflavin, niacin and vitamin C.

*Foeneculum vulgare* is reported to contain about 1–3% of essential oil comprising approx. 50–60% of anethole and 20% of de-fenchone. Others include dipentene, foeniculum, anisic acid, d-α-phellandrene, d-α-pinene, methyl chavicol, and anisaldehyde [7].

### *3.6 Antimicrobial Activities of Fennel*

- Different studies conducted showed that Fennel possess good antimicrobial activity. A study conducted to test the activity of fennel seeds essential oil against *Streptococcus mutants* strain, the concentration of essential oil taken for test was 80 ppm, the results obtained shows that all the strains of *S. mutants* tested were inhibited and no growth were seen [8].
- In another study conducted by Diao et al [9] using kill time assay techniques to evaluate antibacterial effect of fennel seed essential oil against many food borne pathogens. The results revealed fennel seeds essential oil shows antibacterial effect against following pathogens: *Staphylococcus albus*, *Bacillus subtilis*, *Pseudomonas aeruginosa*, *Shigella dysenteriae*, *Salmonella typhimurium*, *Escherichia coli*.

Several foodborne pathogens were inhibited by fennel seed essential oil with the lowest minimum inhibitory concentration of 0.125 mg/mL.

- Agar diffusion method was used to interpret antimicrobial effect of crude extract of fennel in a study conducted against following bacterial strains: *Escherichia coli*, *Aspergillus versicolor*, *Aspergillus fumigatus*, *Proteus vulgaris*, *Penicillium camemberti*, *Proteus mirabilis*, *Staphylococcus saprophyticus*, *Staphylococcus epidermidis*.
- The results obtained indicate that crude extract of *foeniculum vulgare* has a very good potential against all the tested microbes particularly against fungal strains taken [10].
- Acetone, ethanol and methanol extracts of fennel were also tested by different researchers, a study was conducted using acetone extract of fennel to test the activity against fungal strains, 10 different fungal strains were taken including the following fungal strains: *Aspergillus niger*, *Aspergillus flavus*, *Aspergillus oryzae*, *Aspergillus ochraceus*, *Fusarium graminearum*, *Fusarium moniliforme*, *Penicillium citrinum*, *Penicillium madriti*, *Penicillium viridicatum*, *Curvularia lunata*.

The antifungal property of acetone extract of fennel was evaluated; the results showed complete inhibition of following strains including: *Aspergillus flavus*, *Fusarium graminearum*, *Aspergillus niger* and *Fusarium monoliforme* in the dose of 6 µL [11].

- Essential oil extracted from fennel seed have been shown to pronounce therapeutic effect against dermatophytes, a study conducted using following fungal strains: *Trichophyton rubrum*, *Trichophyton tonsurans*, *Microsporum gypseum*, *Trichophyton mentagrophytes*.
- To evaluate antifungal effect of fennel, different aspects were considered that include minimum inhibitory concentration, minimum fungicidal concentration, germination of spore, mycelial growth and biomass. The results were interpreted as fennel seed essential oil shown to have inhibitory effect on all the tested fungal strains. the natural compound however has shown more potent effect than synthetic antifungal agent such as Fluconazole and Amphotericin B, however it is also coined that fennel seed oil have less chances of producing drug resistance effect hence can be used as a potent antidermatophyte [12].

## 4. *Cuminum cyminum*

### *4.1 Introduction*

Cumin also known as zeera, with a scientific name *Cuminum cyminum*, an annual herb, a member of the Apiaceae family also known as parsley family. The plant is a native of the Mediterranean region, and is generally cultivated in China, Mexico and India.

The plant is herbaceous, small, and slender, leaves are dissected finely, and flowers are grown in characteristic flat-topped umbel cluster and are generally rose or whit colored. The fruit is seed like, having strong and distinctive aroma and warm taste. The cumin generally used as dried fruit known as schizocarp (Figure 2) [13].

**Fig. 2** ***Cuminum cyminum*.**

*4.2 Taxonomical Features*

The categorical characteristics of *Cuminum cyminum* are shown in Table 2 [14].

*4.3 Culinary Uses*

It is found as an essential ingredient of many mixed spices, generally added in chutneys, and curry powders. It is considered a more popular ingredient of Asian, Latin American and North African cuisines. The fruit can be used whole or crushed.

It is used widely since ancient time; its oil is used in perfumery, used as flavoring agent, and for medicinal purpose as well [13].

*4.4 Usage and Significance in Traditional Medicine System*

Cumin has number of pharmaceutical, nutraceutical and medicinal value. Its seeds have following pharmacological properties including being antispasmodic, abortifacient, diuretic, to increase menstrual flow, and carminative.

In traditional medicine system, cumin is used for treating gastric conditions such as diarrhea, dyspepsia and gastritis, neurologic and inflammatory conditions, also shown to have preventive actions against cancer. Also given in toothache, also used in diabetes.

According to Iranian system of medicine cumin is used to increase breast milk supply. In India, the seeds of cumin are used as disinfecting and antiseptic agent.

**Table 2 Taxonomical Features of *Cuminum cyminum*.**

| Parameter | |
|---|---|
| Botanical name | Cuminum cyminum |
| Kingdom | Plantae |
| Sub kingdom | Viridiplantae |
| Division | Tracheophyta |
| Class | Magnoliopsida |
| Order | Apiaceae |
| Genus | Cuminum |
| Species | Cyminum |
| Family | Umbelliferae |
| Common names | Zeera or Jeera |
| Taste | Pungent |
| Physical appearance | Dry, light weight |
| Potency | Hot |
| Parts used | Fruits, Seeds |
| Habitat | Cultivation requires hot climate of about 30 ℃ to grow, plant is a native mainly to India, Egypt, China, North Africa, and Mexico |

*4.5 Phytochemistry*

The fruits of cumin mainly contain cellulose, the fixed oil is present in the concentration of about 10%, there are also proteins, sugar, minerals particularly rich in iron, and the volatile oil content is about 1.5%, and phenolic compounds are also present in cumin [15].

The seeds of cumin are very rich nutritionally, also contain vitamin B and E. Cuminaldehyde, terpenoids, cymene is found to be the main volatile component of cumin, cuminaldehyde and cuminic alcohol is responsible for the warm aroma of cumin.

Other chemicals from essential oil of cumin includes: γ-Terpinine, α-Flandren, α-kadinin, α-Sabinin, α-Terpineol acetate, α-Thujene, α-Acoradiene, p-Cymene, β-Pinene, γ-Terpineol, Linalol, Linalyl acetate, Limonene, 1,8-Cineole, Sabinene, Terpinolene, Geraniol, Methyl eugenol, Myrcene, Daucene, d3-Carene, Cariophyllene,

Pinocarvone, Carotol, Germacrene D, Farnesene-(Z)-β are essential oil found in the seeds of Cumin, α-Pinene, α-Phellandrene, α-Terpineol, α-Terpinene and Safranal is obtained from the fruit of Cumin [16].

*4.6 Antimicrobial Activities of Cumin*

- A study conducted using Agar diffusion method and Dilution method to test the activity of cumin against the strains of *Escherichia coli, Staphylococcus. aureus, Enterococcus faecalis, Pseudomonas aeruginosa, Klebsiella pneumonia*.

The results evaluated showed that *S. aureus, S. faecalis* and *E. coli* were inhibited by cumin essential oil [17].

- In a study the researcher took microwave and oven roasted cumin seed to look for the effect of microwaves on the antimicrobial activity of cumin seed essential oil, the researcher took the samples of following:

1) *Pseudomonas aeruginosa*
2) *Aspergillus niger*
3) *Aapergillus parasiticus*
4) *Escherichia coli*
5) *Candida albicans*

The phenomenon of disk diffusion was used for the evaluation of antibacterial effect of Cumin oil, from the results it is concluded that microwave roasted and conventionally roasted cumin essential oil have identical antimicrobial activity, however both shown to have more portent activity in comparison to raw oil samples [18].

- The antifungal activity of Cumin seeds essential oil was carried out in a study using 1,230 strains of fungi that were isolated from different samples of food. The results obtained shown that the tested sample is fungicidal to many of the species of fungi and shown to exert a broad spectrum of fungal toxicity at minimum inhibitory concentration of 0.6 micro liter per ml [19].
- In this study, the disc diffusion method was used to screen the antibacterial effect of cumin. For this reason, the water extract and decoction of the tested herbal medicine were prepared to evaluate its antibacterial effect on some gram-negative and gram-positive bacteria isolated from the oral cavity of healthy people. Cumin has strong activity against 73% of the tested bacteria [20].
- In a study, cumin seeds were taken and oil was extracted from it by the procedure of distillation. Six types of bacterial sample were taken to test the effectiveness of extracted seed oil as an antibacterial. Following gram positive and gram negative bacteria were taken as mention in the table below (Table 3):

**Table 3 Bacteria reactive to cumin extract.**

| Gram Positive Bacteria | Gram Negative Bacteria |
|---|---|
| *Escherichia coli* | *Proteus Vulgaris* |
| | *Klebsiella Pneumonia* |
| *Salmonella typhi* | *Enterococcus Faecalis* |
| | *Staphylococcus Aureu* |

Four concentrations for the screening of tested sample were prepared that are 12.5%, 25%, 50% and 100% respectively. The researcher selected Gentamicin (10 µg) as positive control. The evaluation test was conducted using Cup plate agar diffusion method. The area of inhibition, diameter of minimum inhibition zone in mm, and relative percentage of inhibition were measured and compared to control. Results showed that cumin oil possesses potent antibacterial activity against gram positive and gram negative bacteria in all of the above four concentrations [21].

## 5. *Trachyspermum ammi*

*5.1 Introduction*

It is an annual herbaceous plant; member of Apiaceous family, the plant is grown widely in the arid and semi-arid region preferably in soil with rich concentration of salt. It is cultivated in different regions of which include Pakistan, Iran, Afghanistan, Egypt and in India, while being indigenous to Egypt.

It is favorably grown in the month of October and November and must be harvested by May and June. The color of the fruits is grey brown, stem is smooth, striated and grows upright [22].

**Fig. 3** ***Trachyspermum ammi.***

*5.2 Taxonomical Features*

The categorical characteristics of *Tachyspermum ammi* are shown in Table 4 [23].

*5.3 Culinary Uses*

Ajwainis used in the kitchen in small amount due to its strong and dominating aroma, it is added as spice to increase flavor of the food, it is used to tempering curries and fried snacks, also used in pickles and spice powders, also used as mouth freshener and appetizer.

**Table 4** **Taxonomical features of *Tachyspermum ammi.***

| Parameter | |
|---|---|
| Botanical name | *Trachyspermum ammi* |
| Kingdom | Plantae |
| Sub kingdom | Tracheobionta |
| Division | Magnoliophyta |
| Super Division | Spermatophyta |
| Class | Magnoliopsida (Dicotyledons) |
| Order | Apiales |
| Genus | Trachyspermum |
| Species | Ammi |
| Family | Apiaceae |
| Common names | Ajwain, carom seeds, caraway seeds |
| Taste | Astringent |
| Physical appearance | Light, piercing, and dry |
| Potency | Hot |
| Parts used | Fruits, seeds |
| Habitat | Annual plant widely grown in India and Middle East. Mediterranean region of Egypt has plenty of carom seeds |

*5.4 Phytochemistry*

The analysis shows ajwain contains fiber in the concentration of 11.9%, carbohydrates are 38.6%, moisture is 8.9%, protein content is 15.4%, fat portion is 18.1%, glycosides, tannins, saponins, flavone and other mineral matters are 7.1% including calcium, cobalt, phosphorus, copper, iron, iodine, manganese, riboflavin and nicotinic acid are among the phytochemical constituents reported.

Essential oil yield is found to be 2 to 4%, brownish in color, thymol is the major essential oil of ajwain

found in the concentration of 35 to 60%, whereas the non-thymol fraction Thymene includes alpha and beta pinene, alpha and gamma terpinene, dipentene, carvacrol, para cymene, delta-3-carene, styrene, beta phyllandrene [24].

In another investigation conducted, the following constituents were introduced as the principal oil constituents including dillapiole 8.9%, limonene 38.1% and carvone 46.2%. Other constituents including linoleic, oleic, palmitic, resin acids, petroselinic acid, are also isolated from ajwain fruits. Whereas, recently 6-hydroxycarvacrol 2-O-β-D-Glucopyranoside and 3, 5-Dihydroxytoluene 3-O-β-D-Galactopyranoside are reported as new glycoside constituent. Also, asubstance resembling steroid namely 6-O-β Glucopyranosyl oxy thymol compound is recently extracted from ajwain fruit [25].

*5.5 Uses in Traditional Medicine System*

In Indian medicinal system, *T. ammi* is given for treating gastric disorders, a fruit is squashed and paste is made to relieve colic pains, and application of its dry hot fomentation is preferred in case of asthma, ajwain has shown to have following pharmacological actions including: antimicrobial, bronchodilation, hypo-lipidemic, hepato-protactive, digestive stimulant, antispasmodic, anthelmintic. It also helps in the detoxification of aflatoxins, act as diuretic, anti-inflammatory, abortifacient, anti-platelet aggregating effect, gastro-protective. In addition, it is also used in relieving symptoms of amenorrhea, also have antipyretic effect and is use some times in treating typhoid fever [26].

*5.6 Antimicrobial Activity*

- ✓ In a study conducted to evaluate antibacterial activity of *T. ammi*, against strains of following bacterial species: *Escherichia coli*, *Enterococcus faecalis*, *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Salmonella typhi*, *Staphylococcus*, *Shigella flexneri*.

Aqueous and acetone extract of ajwain were taken, the method used was Agar diffusion assay. Acetone extract of ajwain have shown more potent antibacterial effects according to the findings [27].

- ✓ Another study conducted using ethanolic extract of *T. ammi* which shows it possesses good antibacterial property against 8 strains of *H. pylori* [28].
- ✓ Methanolic exract of *T. ammi* was tested against the following bacterial species: *Bacillus cereus*, *Bacillus pumilus*, *Bordetella bronchiseptica*, *Klebsiella pneumonia*, *Micrococcus luteus*, *Escherichia coli*, *Serratia marcescens*, *Pseudomonas aeruginosa*, *Pseudomonas fluorescens*, *Staphylococcus aureus*, and *Staphylococcus epidermidis*.

Agar diffusion method was used, the results were evaluated by measuring diameter of zone of inhibition DIZ, which gives following evaluation results: 10 to 14 mm DIZ was found for *P. aeruginosa* and *B. pumilus*; 7 to 9 mm DIZ was found for *E. coli*, *K. pneumonia* and *B. bronchiseptica*; and more than 15 mm DIZ was measured against *S. epidermidis* and *S. aureus*. The tested sample shown no activity against *P. fluorescens* and *M. luteus* [29].

- ✓ A study conducted using Phenolic compounds of ajwain that are Thymol and Carvacrol, both being major constituents among its total essential oil present show that these two may have bacteriostatic or bactericidal effects based on the concentration being employed for the evaluation [25].
- ✓ Antifungal activity of ajwain essential oil was assessed on *Aspergillus niger* and *Curvularia ovoidea*, the tested sample shown potent fungicidal effect with the MIC of 5,000 ppm [30].

## 6. Conclusions

We have reviewed many articles related to fennel, cumin and carom activity against different microbial

species and it was observed that utmost most of the bacterial growth was inhibited and also they show good potential against different fungal strains, the test for evaluation of their antimicrobial screening was conducted using agar diffusion method and disc diffusion method. Fennel, cumin and carom are aromatic plants with a varying pharmacological activity and have significant importance specifically to the food industry. The bioactive molecules found in these can be used as novel pharmacological lead molecules to aid human health benefits, it is suggested that these three can be combined in a formulation to have synergistic antimicrobial effect looking at their antimicrobial profile with lesser side effects. With the emergence of gastric issues caused by different pathogenic bacteria poly herbal formulation can evolve as a promising substitute due to their antibacterial effect. Keeping in view their importance, we have a plan to design polyherbal formulation of the herbs reviewed including fennel, cumin and carom and to use them to treat Peptic Ulcer caused by *Helicobacter pylori*.

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