



***Trachyspermum ammi*: A review on traditional and modern pharmacological aspects**

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ABSTRACT

Ajwain (*Trachyspermum ammi* (L.) Sprague ex Turill) is a dried seed and a well-known spice globally. *Carum copticum* is the Latin name for this spice. In medieval Persian medical and pharmaceutical manuscripts, it is referred as Zenyan or Nankhah. Ajwain is widely recognized in both Ayurveda and Unani as a traditional Persian medication for thousands of years. This plant contains a variety of bioactive compounds of pharmacological importance, involving carbohydrates, fat, fiber, volatile oil, glycosides, protein, phenolic compounds, saponins, and mineral content. The ajwain extract is known as "Admoda Arka" in Ayurveda. Ethnopharmacological uses according to Vaidya gurus are coughs, colds, pain, headaches, heartburn, asthma, diarrhea, painful menstruation, cholera, stomach discomfort, and smooth respiratory and kidney function. It has been used in modern medicine as Bronchodilator, Cardiac Stimulant, Carminative, Digestive Stimulant, Diuretic, Galactagogue, Hypo-glycemic, Anti-inflammatory, Antiflatulent, Analgesic, Antimicrobial, Antihypertensive, and Antifilarial. We investigated that its bioactive compounds are effective as nutrition as well as medicine. Here, we summarized the phytochemistry along with pharmacognostic and nutritional values. Also, information regarding pharmacological roles along with safety measurements are mentioned. Clinical Pharmacology and its traditional uses showed significant activities that can be used for therapeutic approaches.

Introduction

A highly valued medicinal and nutritional important

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seed species *Trachyspermum ammi* (L.) Sprague, known as Ajwain is a grassy, aromatic annual herbaceous herb with erect and striate stem involving glabrous pubescent properties. It is member of medicinal important family Apiaceae (Umbelliferae or carrot or parsley family). This family comprises of about 250 genera and more than 3300 species. Many botanical names are assigned to this plant as shown in **Fig 1** [1] *Trachyspermum* has about to 14 species. It's a native of Egypt that is cultivated in Afghanistan, Pakistan, India, Iraq and other nations in South and West Asia as well as

Madhya Pradesh, Uttar Pradesh, Gujarat, Rajasthan, Maharashtra, Bihar, and West Bengal are among the states in India where it is grown commercially. This plant is also known by various vernacular names ajwain, ajowan, caraway, etc given in **Table 1** [2]. The seed is ovoid in shape, greyish brown in color, aromatic odor, and has a pungent taste. It is 2 m long and 1 mm wide in size. These plant's seeds are simple to grow and may be up to 90 cm tall and for their cultivation, well-drained loam soil with a pH of 6.5 to 8.2, temperatures of 15 to 25 degrees Celsius, and relative humidity levels of 65 to 70 percent are required for optimal growth and is suitable in both direct and indirect sunlight [2]. The herb is generally grown in October-November, Flowers and fruits bearing from January - April and should be harvested in May-June. This crop is generally cross-pollinated. The plant is reportedly cultivated extensively in dry and semi-arid places when the soil has a massive level of salts. The herb has several bioactive compounds that have a higher energy value that is 314.55% that have been identified in ajowan were carbohydrates (38.7%), Fiber (11.8%), fat (18.2%), tannins, glycosides, protein (17.2%), moisture (8.2%), saponins and flavones. Calcium, phosphorus, iron, cobalt, copper, iodine, manganese, thiamine, sodium, potassium, riboflavin, and nicotinic acid make up 7.1% of the mineral constituents in Ajwain [3]. Ajwain seeds are rich in brownish essential oil, in which thymol (50.1%) is the major constituent along with α -pinene, β -pinene γ -terpinene, α -terpinene, and p-cymene. Bioactive constituents of natural plants like Ajwain are used for medicinal and nutritional purposes from the dawn of creation [4]. The taxonomy of this herb is given in **Table 2** [1]. The most useful factor of ajwain is in household folks, which is especially admired in Indian appetizing recipes, beverages, snacks, and baked goods that provide flavor and aroma to food recipes. It is a potent abortifacient, but not safe in pregnant women and liver disease patients. Traditional Ayurvedic and Unani medicine have been long using this to cure several ailments and increase the body's resistance. Ajwain is helpful for pacifying Vata, and Kapha, and increases Pitta. Since ancient times, ajwain has been used to make herbal mixtures in the hopes of balancing the body's systems. Ajwain has exceptional therapeutic and curative characteristics, making it effective in the respiratory, heart, neurological, liver, spleen, and gastrointestinal disorders, and also acts against some toxicity, fever, pain, and inflammation. Chewing seeds is beneficial in stomach trouble such as nausea, vomiting, indigestion, Diarrhea, dysentery, spasmodic symptoms, abdominal cramps, and loss of appetite. It possesses stimulant and carminative properties [5]. In the case of respiratory, it is effective on cough, pleurisy, and dysphonia. It protects against heart disease by regulating both good and bad cholesterol in the body. The chemical components in ajwain extracts

block calcium channels, potentially decreasing blood pressure even more. Persian practitioners used Hydrosol and oil extracted from the seeds of Ajwain in neuropathic pain as well as chronic fevers and gripes. It was also incorporated in formulations prepared for pityriasis and all types of ecchymosis. Additionally, it was employed to lessen the negative consequences of opioid withdrawal. It is incorporated in some cosmetic values as it provides a yellowish complexion to the skin. The seed of ajwain acts as an analgesic, anthelmintic, aphrodisiac, anti-inflammatory, antioxidant, galactagogue, carminative, laxative, and stomachic while the essential oil produced by seeds exhibit Antimicrobial, anti-aggregatory, fungicidal properties [6] and applied topically to relieve rheumatic pain and decoction of seed used to alleviates the pain caused by scorpion's bite. The roots are diuretic in nature. Early Persian physicians noted several of the medicinal properties of ajwain seeds, including antiseptic, stimulant, carminative, diuretic, anesthetic, antimicrobial, antiviral, antihypertensive, antitussive, nematocidal, antiulcer, bronchodilatory, antiplatelet, and hepatoprotective effects and now has been used in modern medicines. Here, we collect all information on the herb *Trachyspermum ammi* from electronic database, google scholar, Pubmed, Scopus, and many medicinal and traditional-based manuscripts. This article provides comprehensive information regarding the Nutritional, Pharmacognostical, Phytochemical, and Ethnopharmacological profile of *T. ammi* and also provides safety measurements. The experimental and animal study is not much sufficient, so there is a need to conduct more clinical study to reconfirm the various traditional activities to implement in modern medicine.

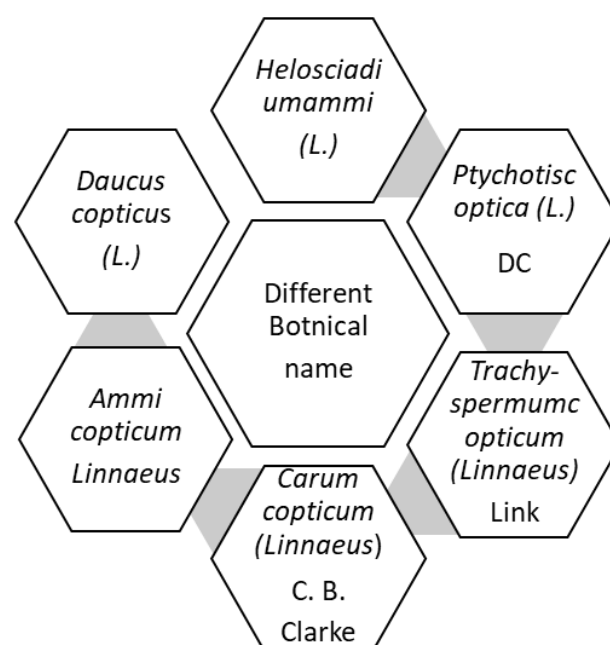


Fig. 1. Botanical names of ajwain.

Table 1. Vernacular names of *Trachyspermum ammi*.

Language	Common name
Sanskrit	Yamini, Yaminiki, Yaviniki
Assamese	Joni-gutti
Bengali	Yamani, Javan
English	Bishop's weed
Gujrati	Ajma, Ajmo, Yavan
Hindi	Ajwain, Jevain
Kannada	Oma, Yom
Kashmiri	Kath
Malayalam	Omam
Marathi	Onva
Oriya	Juani
Arabic	Taleb elkoub
Farsi	Nanava
Thai	Chilan
Turkish	Misiranason
Korean	Ayowan
Nepali	Javano
Portugese	Oregano-semente, ajowan
Punjabi	Ajavain, Lodhar
Singhalese	Assamodum
Tamil	Omam, Vamu, omu

Table 2. Taxonomical classification.

Kingdom	Plantae, Plant
Subkingdom	Tracheobionta, Vascular Plant
Phylum	Spermatophyta, Seed Plant
Subphylum	Angiospermae, Flowering Plant
Class	Magnoliopsida, Dicotyledons
Order	Apiales
Family	Apiaceae
Genus	Trachyspermum
Species	Ammi

Pharmacognostic profile

A pharmacognostic traits evaluation of a plant is an identification mark and aids in the standardization of drugs in terms of purity and quality. Its detailed illustration of the crude drug's organoleptic and physicochemical properties is shown in **Table 3** [6].

Phytochemical constituents

The constituents of this herb add high nutritional value as shown in **Table 4** [7]. Qualitative analysis of *Trachyspermum ammi* seeds revealed the presence of carbohydrates, glycosides, amino acids, saponins, phenol compound, volatile oil (thymol-

Table 3. Pharmacognostical traits of *Trachyspermum ammi*.

Appearance	Powder
Color	Light brown
Taste	Pleasant
Odor	Characteristic
Loss on drying (% w/w)	4.7
Foreign matter (% w/w)	2.4
pH of 10% w/v solution	3.35
pH of 1% w/v solution	3.23
Total ash (%)	8.6
Acid insoluble ash (%)	0.49
Water soluble extractive	42
Alcohol soluble extractive	17.9

Table 4. Nutritional values of ajwain.

Parameter	G%
Energy value	31.55
Carbohydrate	47.54
Protein	20.23
Fat	4.83
Moisture	11.6
Fiber	4.3

terpinene, para-cymene, and α and β -pinene), protein, fat, fiber, and mineral matter as well as mineral matter containing calcium, chromium, cobalt, copper, iodine, iron, manganese, phosphorus, zinc, thiamine, Riboflavin, thiamine, ascorbic acid, nicotinic acid, carotene [8,9]. The aroma of plants and various phytochemical constituents obtained from ajwain depends on a variety of factors, including soil type, and climatic conditions such as temperature, pressure, humidity, and extraction time for the percentage yield of ajwain oil. Steam-distilled volatile oil obtained from *T. ammi* by various analytical techniques is composed of nine monoterpenes which include seven hydrocarbons and two alcohols [10]. The predominant, monoterpenes were α -phellandrene, β -pinene, β -Myrcene, o-Carene, cis-Myrtenol, p-Mentha-1,3,8 triene, γ -Terpinene, Ot-Pinene, and p-Cumin-7-ol. The key compounds are acyclic monoterpene (β -Myrcene), monocyclic monoterpenes (m-Cymene, γ -Terpinene, 4-Terpinol, β -Selinene, Terpinolene, β -Phellandrene) and bicyclic terpenes (α -Pinene and β -Pinene, 4-Caren, β -Pinene, α -Thujene). Ajwain oil additionally contained a few non-terpenoid kinds of compounds that are 1-(3-isopropylidene-2,2-dimethylcyclopropyl)- isopropanol, 6-methyl-octene-1, 14.6.6-trimethyl-bicyclo [3.1.1]-hept-3-ene-2-one and 2,2-dimethyl-4,5-bis-1-propene-1,3-Dioxalane. Thymol is found to be the major phenolic constituent of the essential oil of ajwain, which may

be yielded from 50% to 60% [11]. Other than this, the main components are carvone (47%), limonene (39%), and dillapiole (9.5%); oleic acid, linoleic acid, and resin acids have been extracted from the fruit. Non-Thymol fraction is Thymene, which comprises terpinene-4-ol, betaphyllanderene, paracymene, gamma-terpinene, styrene, alpha-pinene, as well as beta-pinene. The water-soluble fraction of the methanol extract of the Ajwain fruit yielded 25 different chemicals, those were novel monoterpenoid glucosides, novel monoterpenoid, glycosyl constituents, novel glucides, novel aromatic compound glucosides and a compound named 6-O- β -glucopyranosyloxythymol. Monoterpenoid Glucosides namely 6-hydroxythymol 3-O- β -D-glucopyranoside, (2S, 6Z)-3, 7-Dimethyloct-3(10)-ene-1, 2, 6, 7-Tetrol 1-O- β -D-Glucopyranoside and 6-Hydroxythymol 3-O- β -D-Glucopyranoside, Whereas novel monoterpenoid glucoside were 7-hydroxythymol 3-O- β -D-glycopyranoside, 3 β -hydroxy-p-menth-1-en-4 β ,5 β -oxide 3-O- β -D-glucopyranoside, (4R,6S)-p-menth-1-ene-4,6-diol 4-O- β -D-glucopyranoside, (4S)-p-menth-1-ene-4,7-diol 4-O- β -D-glucopyranoside, 6-hydroxythymol 3,6-di-O- β -D-gluco-pyranoside, (4S)-p-menth-1-ene-4,7-diol 4-O- β -D-glucopyranoside, (4R,6S)-p-menth-1-ene-4,6-diol 4-O- β -D-glucopyranoside. A novel Monoterpenoid were identified namely 3, 7-Dimethyloct-3(10)-ene-1, 2, 6, 7-tetrol, p-menth-3-ene-1 β , 2 β , 5 β -triol. Novel glycosyl constituents such as 6-hydroxycarvacrol 2-O- β -D-Glucopyranoside and 3, 5-Dihydroxytoluene 3-O- β -DGalactopyranoside are recently reported from fruits of Ajwain. Glucide namely (3R)-2-Hydroxymethyl butane-1,2,3,4-tetrol, but novel glucides were 1-DeoxyL-Erythritol and 1-Deoxypentitol. Alkyl and aromatic compound glucoside isolated were 2-methyl-3-buten-2-ol- β -D-glucopyranoside, 19-(3-hydroxy-4,5-dimethoxyphenyl)-propane-29, 39-diol and benzyl- β -D-glucopyranoside 19-(3-hydroxy-4,5-dimethoxyphenyl)-propane-29, 39-diol and novel aromatic compound glucosides as 3,4-dihydroxyphenylpropanol-3-O- β -D-glucopyranoside, 2-Methyl-3-Buten-2ol- β -DGlucopyranoside. Uridine and Nucleosides were identified as (2S, 3R)-2-methylbutane-1,2,3,4-tetrol and adenosine respectively were isolated from Ajwain fruits [12]. The active phytocompound extracted from the leaves, seeds, and fruits of the herb *T. ammi* is demonstrated in **Table 5** [13]. Table 6 describes the phytoconstituents with their chemical structure.

Adulteration

The whole or ground form of *T. ammi* seed can be contaminated by adding wasted seed (from which oil or oleoresin has been removed), additional stems, chaff, and soil or dust. The oil is also tainted

with ajwain chaff where essential oil content should be in the range of 2%-4%, and the thymol content should be in the range of 35%-60%, the thymol content will drop to less than 35% in addition to the chaff oil. The seeds are mostly adulterated by randhuni (*Apium graveolens* (Linn.) Sprague) and ban ajwain (*Seselidiffusum*). Gas chromatography or thin-layer chromatography coupled with high-performance liquid chromatography can be done for the detection of these adulterants [14].

Ethnopharmacological values of *Trachyspermum ammi* in medieval and traditional medicine

The Ajowan is referred to as Bhootika in the Indian Vedic text Sushritasamhita and Yavanika in the Charaka Samhita comments. Indian Vaidya gurus used the ajwain extract as "Admoda Arka" in their preparation. The Vaidya gurus, hakims, Ayurvedic, and Unani doctors recommend ajwain to treat various uneasiness such as acidity, indigestion, headache, menstrual cramps, cold, etc. Traditionally, it is used in the Unani system of medicines for centuries. Tribals of India use it for the treatment of various health problems given below [15-17].

Acidity

A mixture of 1tsp of cumin seeds and 1tsp of carom seeds should be combined. Taken daily with a little ginger powder to get rid of acidity.

Alcoholic

Carom seeds can be chewed regularly to help combat alcohol cravings.

Amenorrhoea

In this case, seeds soaked in lemon juice and almonds are administered.

Arthritis

The usage of carom seed oil as an arthritic pain reliever is highly beneficial. To relieve rheumatic discomfort, consistently massage carom seed oil into the troubled joints.

Asthma

Consuming carom seeds with warm water provides immediate cold relief and helps the body get rid of mucous and coughing. It may be eaten twice a day with jaggery. Asthma and bronchitis are two more conditions it can help with.

Table 5. Phytoconstituents in different plant parts.

S.No.	Source	Phytoconstituents	Activity
1.	Seed	α -phellandrene, β -pinene, Cis-myrtanol, γ -terpinene, o-carene, Ot-pinene, p-cumin-7-ol, p-mentha-1,3,8 triene, Thymol, Carbohydrate, Glycosides, Saponins, Calcium, Flavones, Fiber, Moisture, Fat, Protein, Mineral.	Insecticidal, Estrogenic, Antiulcer, Antioxidant, Abortifacient, Antibacterial, Antihypotensive, Hepatoprotective.
2.	Fruits	3, 5-Dihydroxytoluene 3-O- β -D Galactopyranoside (glycosal compound), 1-(3-isopropyliden-2,2-dimethyl cyclopropyl) - isopropanon (Non terpenoids), Alpha-pinene, Alpha-terpinene, Beta pinene, Beta phellandrene, Carvacrol, Delta-3-carene, Gamma-terpinene, Paracymene, Styrene, Terpinene-4-ol (Non thymol), 2-Methyl-3-Buten-2ol- β -D-Glucopyranoside, 7-Dimethyloct3(10)-ene-1, 2, 6, 7-Tetrol 1-O- β -D-Glucopyranoside and 6-Hydroxythymol 3-O- β -D-Glucopyranoside.	Antifilarial, Analgesic, Antipyretic, Antiinflammatory, Antifertility.

Bed Wetting

Carom seeds, black sesame, and jaggery blended well, and consumed one teaspoon of this combination twice a day.

Belching

A combination of black salt, carom seeds, and dried ginger in powdered form as well as with cardamom hot water helps treat indigestion, belching, and gas.

Body cleanser

Using carom seed tea can aid in the removal of body toxins. This can therefore lessen the number of skin or health-related issues, cleanse the body, and enhances blood circulation throughout the body.

Breastfeeding

The fennel seeds and carom seeds are boiled in water for 5 minutes followed by cooling and consume this water daily which helps to stimulate milk production and cleanse the uterus.

Calculus

To prevent this, carom seeds are consumed daily, one can get rid of this stone disease.

Cold

For the finest outcomes in a short amount of time, take steam from ajwain seeds soaked in hot water.

Colic

The fennel seeds and carom seeds are boiled in water for 5 minutes followed by cooling and drinking this liquid after the meal.

Deafness- To cure deafness, put a few drops of thymol oil into your ears.

Diabetes

At night, combine 1 teaspoon of the neem powder with 1/2 teaspoon each of cumin and carom seeds and consume it daily.

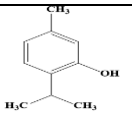
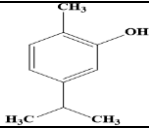
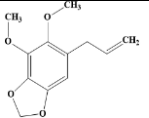
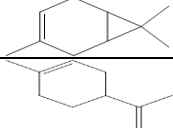
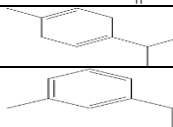
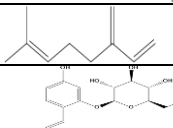
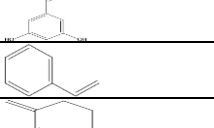
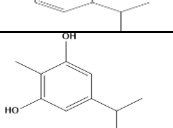
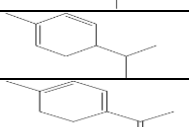
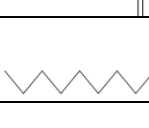
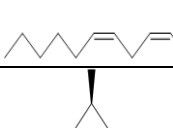
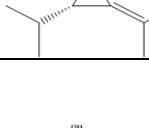
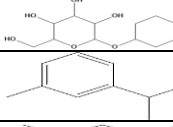
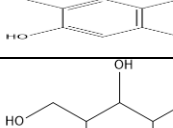
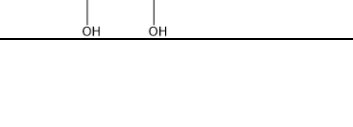

Diarrhea

Boil one tablespoon of carom seeds in a glass of water, let it cool, then filter it and drink it twice a day.

Digestion

Three teaspoons of carom seeds should be soaked in lime juice and dried in the shade. Pulverize this and combine it with black salt. Take this with lukewarm water twice a day.

Table 6. Phytoconstituents with their chemical structure.

S.No.	Phytoconstituents	Structure
1	Thymol	
2	Carvacol	
3	Dillapiole	
4	Delta-3-carene	
5	Limonene	
6	Gamma terpinene	
7	m-cymene	
8	Beta myrcene	
9	2-o-betaglucopyranoside	
10	Styrene	
11	Beta phellandrene	
12	6-hydroxycarvacrol	
13	α-phellandrene	
14	p-mentha-1,3,8 triene	
15	Petroselinic acid	
16	Linoleic acid	
17	1-(3-isopropylidene-2,2-dimethylcyclopropyl)	
18	3-o-beta-D-glucopyranosid-isopropanon	
19	m-cymene	
20	6-hydroxythymol	
21	1-Deoxypentitol	

Eye cleanser

Boil one tablespoon of carom seeds in a glass of water, let it cool, then filter. It can be used to wash the eye.

Ear pain

Two teaspoons of carom seeds and one teaspoon of garlic are heated in sesame oil until they become red. Drop some of this liquid into each ear once it has cooled and been strained. Boils in the ears can also be treated with this.

Flatulence

Put three teaspoons of carom seeds in lime juice to soak. Dry in a shaded area. Take one teaspoonful twice a day with warm water after mixing the powder with black salt.

Flu

Boil carom seeds in water with cinnamon and drink it four times a day to cure the flu.

Heart problems

To receive immediate relief from cardiac issues, one might combine one teaspoon of jaggery with a few carom seeds.

Irregular menses and excessive bleeding

To solve this issue, carom seeds should be soaked in an earthenware container with water overnight. Grind them and drink the mixture in the morning.

Itching, boils & eczema

Grind the seeds with lukewarm water, and apply this ajwain paste to any area of the body or face that is afflicted. For optimal results, you should also try cleaning the injured area with ajwain water. Make a carom seed and lemon juice paste to treat swelling brought on by boils or pimples.

Joint pains

Shatavari, black cumin, fenugreek, and carom seeds should all be combined. To relieve joint discomfort, grind this combination and take a half teaspoonful of the powdered mixture.

Kidney disorder

Nine days of oral administration of ajwain seeds in milk to participants with urinary stones was conducted. The results were successful in the case of pure calcium oxalate stones.

Lost appetite

Carom seeds, fennel seeds, dried ginger powder, salt, and black cumin seeds should all be combined and ground. Combine this mixture with heated ghee. Add the cooked rice to the mixture. Eventually, this will increase any lost appetite.

Liver disorders

Ajwain water is very beneficial in this.

Menorrhagia

Put carom seeds in a clay pot with water and let them soak all night. To drink in the morning, grind these carom seeds.

Menstrual cramps

Ajwain oil is very beneficial in cramps on applying topically.

Migraine

Smell this concoction after wrapping carom seeds in tissue paper. It can help to lessen migraine headaches. Additionally, they can be burned and breathed to treat various head-related issues.

Mosquito repellent

Carom seeds mashed with mustard oil. In this mixture, soak cardboard pieces, and then knot them in the room's corners. This will assist in clearing the room of insects.

Mouth problems

It has been shown that carom seeds can relieve dental pain. To alleviate tooth pain, bad breath, and decay, floss your mouth using a mixture of water, clove oil, and caraway oil.

Paralysis

Daily use of carom seeds treated in water can help alleviate paralysis, trembling, and shaking.

Pharyngitis in influenza

For this ailment, ajwain seeds and clove with a pinch of table salt are taken.

Phlegm removal

Internal administration of buttermilk and ajwain seed powder is beneficial.

Piles

Combine dried neem leaves, poppy seeds, and pomegranate petals. When you have bleeding piles, drink this combination with milk twice a day. After lunch or supper, drinking buttermilk flavored with carom seed powder and rock salt will help to lessen piles' tendency to bleed.

Pimple

Add carom seed powder with yogurt and apply it on the face for 30 minutes, then rinse with tepid water. This treatment will greatly aid in lightening acne scars.

Reduce weight

Consume a teaspoon of carom seeds or carom seeds water every morning on an empty belly.

Rheumatism

Applying the oil isolated from carom seeds to the afflicted areas relieves rheumatic and neuralgic pain.

Sexual disability

Grind tamarind kernels, clarified butter, and roasted carom seeds then take 1 teaspoon of the mixture with honey at night. This approach has been shown to lessen sexual impairment.

Stomach pain

Make a powder of sabootisabgol, fenugreek, onion, and carom seeds. Take 1 teaspoon of this powder every morning after grinding them all together into a slurry. For the finest outcomes in the shortest amount of time, consume this on an empty stomach.

Urticaria- Jaggery with carom seeds should be consumed. This is an effective treatment for the urticarial condition.

Experimental pharmacological findings of *Trachyspermum ammi* in aspects of modern trends

Insecticidal

Ajwain essential oil had insecticidal action against *Callosobruchus chinensis* in the oviposition stage, as well as egg-hatching and developmental inhibitory activities [18-19]. T. ammi's alcoholic seed extract was proven to be efficient against *Aedes aegypti* larvae and pupae and is regarded as an environmentally beneficial therapy. The larva stage has a three-fold higher mortality rate than the pupa stage [20].

Antibacterial

The maximum activity against *P. aeruginosa* was found in an ethanol extract of ajwain seeds, while the best activity against *E. coli* was found in an acetone extract [21]. *P. aeruginosa*, *Bacillus pumilus*, *Staphylococcus aureus*, *S. epidermidis*, *E. coli*, *Klebsiella pneumoniae*, and *Bordetella bronchiseptica* showed substantial antibacterial action in a methanol extract of ajwain seeds [22]. Using an agar diffusion assay, acetone and aqueous extract of ajwain seeds were found to have antibacterial activity against *E. coli*, *P. aeruginosa*, *Shigella flexneri*, *K. pneumoniae*, *Salmonella typhi*, *S. aureus*, *S. typhimurium*, and *Enterococcus faecalis*. The presence of substantial levels of phenolic chemicals such as thymol and Carvacrol in ajwain's total essential oil may explain its antibacterial capabilities. Depending on the concentration, these are either bactericidal or bacteriostatic agents [23].

Analgesics and Antinociceptive activity

Tail-flick Analgesiometer device was utilized in vivo experiment to assess the analgesic and antinociceptive properties of Ajwain. The ethanolic extract dramatically increased Tail-Flick Latency in 2 hrs. of medication treatment. The anti-nociceptive effect of the hydroalcoholic extract of ajwain was assessed using a formalin test with morphine sulfate in animal trial research. The results demonstrated that Ajwain extract had an antinociceptive effect in both the early and late phases of the study [24].

Antifungal

The presence of organic phenolic compounds in *T. ammi* confers antifungal action. The ethanolic and hexane fractions of *T. ammi* seeds have antifungal properties against *Candida albicans*, with the hexane fraction having a minimum inhibitory concentration of 225 g/ml. It's essential oil inhibited *Candida* and *Aspergillus* species virulent strains

from growing mycelia. *T. ammi* seeds were examined for antifungal activity against 10 fungi named *Curvularia lunata*, *Alternaria grisea*, *F. poae*, *A. tenuissima*, *Fusarium chlamydosporum*, *Acrophialophorafusispora*, *Drechsleratetramera*, *Myrothecium roridum*, *Papulasporasp*, *Rhizoctonia solani* and testing revealed that 72-90% of the test fungi's growth was inhibited when the substance was put to the test. Depending on the concentration, phenolic substances like thymol and carvacrol are known to be either bactericidal or bacteriostatic agents [25].

Antimicrobial activity

Carvacol and thymol were the active chemicals responsible for ajwain's antibacterial action [26]. Essential oil and other solvent extracts from ajwain seeds, including chloroform, methanol, petroleum ether, and benzene were tested for antibacterial activity against four bacterial species using agar disc diffusion (*S. typhi*, *E. coli*, *Lactobacillus*, and *B. licheniformis*). The results revealed that of the various solvent extracts, chloroform extract had the most antibacterial activity when compared to the other extracts [27]. Antioxidation property: Two distinct in vitro experiments, the hydrogen peroxide, and the nitric oxide radical scavenging assay, were used to evaluate the antioxidant capacity of the ajwain seed's extract. The antioxidant activity of the ethanol extract of ajwain oil was discovered to be quite high. On nitric oxide, superoxide, and hydroxyl radicals, it had a substantial anti-scavenging effect. Ajwain's pharmacological activity as a natural antioxidant source was supported by all of these properties. It has the potential for scavenging free radicals and oxidative DNA damage. The ferric reducing antioxidant power assay, the protection against oxidative DNA damage as well as DPPH radical scavenging assay, were used to investigate the preventative activity of aqueous, methanol, and acetone extracts of ajwain seeds. The results showed that the acetone extract of ajwain seeds had the largest quantity of total phenols, whereas the methanol seed extract had the highest amount of total flavonoids.[28] In an in vivo study, ameliorative the anti-oxidant properties of Ajwain extract were tested on the oxidative stress caused by hexachlorocyclohexane and damage. As a result, the dietary Ajwain extract was found to attenuate the toxicity caused by hepatic free radical stress [29].

Anti-inflammatory

Ajwain was also tested for its anti-inflammatory properties. As a result, both the total aqueous extract and the total alcoholic extract have a remarkable anti-inflammatory effect in vivo. Weights of the adrenal glands in total alcoholic extract (TAE) and total aqueous extract (TAQ) treated mice were

found to be considerably higher. The anti-inflammatory properties of TAE and TAQ extract from ajwain seeds are noteworthy [30]. TAE and TAQ extracts may have functioned via influencing kinin, prostaglandin, bradykinin, and lysozyme production, based on their activities. Its ability to reduce inflammation could be attributed to an increase in the number of fibroblasts and collagen and mucopolysaccharide synthesis during the creation of granuloma tissue [31].

Anti-filarial

A methanol extract of ajwain fruit was tested in vitro for its ability to kill *Setaria digitata* worms. In both MTT reduction and filarial worm mortality experiments, the active fraction and crude extract demonstrated substantial efficacy against mature *S. digitata*. Ajwain crude extract had macrofilaricidal efficacy as well. In a *Mastomyscoucha* model, thymol's in vivo impact was tested against the *B. malayi*. It also showed anti-*B. malayi* macrofilaricidal action and female worm sterility in vivo [32].

Antihelminthic activity

Haemonchus contortus in sheep and *Ascaris lumbricoides* in humans were used to assess Ajwain's anthelmintic activity. Interfering with parasite energy metabolism by potentiating ATPase activity produced a loss of energy stores, according to the findings. During peristaltic motions, ajwain has also been related to cholinergic activity in the intestines. As a result, this fact could aid in the ejection of intestinal parasites and contribute to their anthelmintic activity [33].

Nematocidal

With an LC₅₀ of 0.431 mg/ml, ajwain seed essential oil showed nematocidal action against *Bursaphelenchus xylophilus* [34]. The constituents of ajwain oil (carvacrol, limonene, thymol, pinene, terpinen-4-ol, myrcene) demonstrated nematode nematocidal activity.

Hypotensive

The dose-dependent hypotensive effect of ajwain seed extract in 70% methanol ranged from a 6% drop in mean arterial blood pressure at a dose of 3mg/kg to a 40% reduction in blood pressure at a dose of 100 mg/kg. At 1 g/kg, acetylcholine had a hypotensive impact that was equivalent to that of ajwain extract at 30.0 mg/kg [35].

Anti-hyperlipidemic activity

T. ammi seed has been shown to have an antihyperlipidemic effect in albino rabbits. At a dosing rate of 2 g/kg body weight, *T. ammi* powder and its equivalent methanol extract were found to be exceptionally effective at lowering LDL-cholesterol, triglycerides, total cholesterol, and total lipids.[36] The high fiber content of *T. ammi* may explain its beneficial benefits on fat metabolism, according to the researchers. According to an in vivo study, ajwain seeds powder can lower total cholesterol, LDL-cholesterol, triglycerides, and total lipids while also lowering total cholesterol, LDL-cholesterol, triglycerides, and total lipids. Furthermore, in albino rabbits, an organic extract of seeds lowered the atherogenic index and elevated HDL-cholesterol levels [37].

Antitussive and bronchodilatory activity

Traditional medical literature claims that ajwain has antitussive properties. By counting the number of coughs produced, the therapeutic effect of aerosols containing different concentrations of macerated extracts and aqueous of ajwain seeds, as well as saline, codeine, and carvacrol was examined. According to the findings, both concentrations of ajwain seeds significantly reduced the number of coughs, possibly due to their effective antitussive activity [38]. Both ajwain extract and essential oil have been shown to block histamine (H1) receptors in isolated guinea-pig tracheal chains in studies. Different fractions of ajwain seed essential oil were studied for their respiratory and bronchodilatory effects. The level of Carvacrol in essential oil fractions was found to have a relaxing and bronchodilatory effect.

Diuretic activity

T. ammi was examined in vivo for its antilithiasis and diuretic effects in rats with oxalate urolithiasis. *T. ammi* was shown to have no influence on urine production over 24 hours. The results indicate that there is no experimental evidence to support the traditional usage of *T. ammi* for kidney stone treatment [39]. Based on experimental evidence, it was determined that the traditional use of ajwain in the treatment of nephrolithiasis was no longer justified [40].

Antiplatelet activity

In vitro studies using blood from healthy volunteers revealed that a dried etheric extract of ajwain seeds prevented platelet aggregation generated by arachidonic acid, adrenaline, and collagen [41]. The goal of this study was to back up the traditional use of *T. ammi* in postpartum women [42].

Antiviral properties

An in vitro study was performed on the methanolic extract of Ajwain to determine its antiviral activity, which revealed strong inhibitory effects on Hepatitis C Virus (HCV) protease [43].

Digestive stimulant activity

The herb was once used as a digestive stimulant by traditional healers. Ajwain has now been shown to boost stomach acid secretion, bile acid secretion, and digestive enzyme activity and also shorten the time between meals [44]. Ajwain's enzyme modulatory activity increased the efficacy of pancreatic lipase and amylase, possibly supporting the digestive stimulating activity [45].

Gastroprotective activity

Using various ulcer models, *Trachyspermum ammi* fruit demonstrated antiulcer efficacy. In all scenarios, the ulcer index and % ulcer protection in mice pretreated with ethanolic extract were significantly reduced. When compared to a control group of animals, the data suggest that the extract provided significant protection by lowering ulcerative lesions [46].

Spermicidal activity

Ajwain essential oil's spermicidal properties were assessed using an in vitro investigation, which demonstrated that the volatile oil had significant spermicidal activity [47]. As a result, the oil could be used as a natural contraceptive.

Estrogenic activity

A total phytoestrogen content of 473 parts per million was detected in dry Ajwain seed (ppm). In this way, the herb ranks second in terms of total phytoestrogen concentration among plants studied [48]. The estrogenic concentration of ajwain, that have historically been used to promote milk yield in dairy calves was examined by India's National Dairy Research Institute.

Hepatoprotective

CCI4-induced extension of pentobarbital sleeping time was similarly prevented by the methanolic extract, as was equilibrating the levels of hepatic enzymes, Aminotransferases (AST and ALT), and Alkaline Phosphatase (ALP) after hepatic injury. In vivo studies revealed that in mice, ajwain was found to be 80% protective against paracetamol (1 g/kg) at a fatal dose and it also operated to normalize

elevated blood levels of hepatic enzymes generated by CCl₄-induced hepatic damage in rats. In mice, an aqueous-methanol extract of ajwain seeds for 2 days at 12 h intervals orally at a dose of 500 mg/kg reduced the CCl₄-induced prolongation of the pentobarbital-induced sleeping time, demonstrating its hepatoprotective properties. These findings revealed the existence of calcium antagonists (s) in ajwain seeds, providing a solid molecular basis for some of their health benefits [49].

Abortifacient activity

In a survey done in 1987, *Trachyspermum ammi* was mentioned among 14 naturally occurring medicinal herbs that were allegedly utilized for abortion in various regions of Uttar Pradesh (India). 50 of the 75 pregnant women investigated in the village of Kallipuschium district Lucknow, were reported to have used *T. ammi* seed for abortion (out of a total of 155 women in the fertile time). The risk of congenital malformations was a concern because the herb was not fully effective. Based on teratogenicity demonstrated in rat fetuses, seven plants, including *T. ammi*, posed a high risk of potential human fetotoxicity [50]. Fetuses with diverse skeletal deformities and other visceral anomalies were found in cases when pregnancy was sustained despite the use of herbal drugs. They voiced concern about the putative abortifacient herbal medications' exceptional capacity to harm a fetus, as well as the enormous number of individuals in rural India who continue to be exposed to these plants without fully understanding the potential harmful effects.

Ameliorative effect

Ajwain extract was studied for its effects on hexachlorocyclohexane-induced toxicity and oxidative stress in rats. Catalase, G-6-PDH, Glutathione-S-Transferase, Glutathione reductase, Glutathione peroxidase, and SOP performance were raised but lipid peroxides at the hepatic level were lowered after pre-feeding with ajwain extract. HCH administration was found to cause hepatic free radical stress, which caused toxicity, which could be mitigated by dietary ajwain extract [51-52].

Anti-cancer effects

The chemopreventive potential of *Trachyspermum ammi* seeds against carcinogenesis for doses of 2%, 4%, and 6% has been reported [53].

Detoxification of aflatoxins by Trachyspermum ammi

T. ammi seed extract showed the highest aflatoxin G1 (AFG1) degradation which was assessed using ELISA and TLC. The aflatoxin detoxifying activity of the seed extract was significantly reduced upon boiling. Other aflatoxins, including AFB1, AFB2, and AFG2, were also significantly degraded by *T. ammi* extract. Time course study of AFG1 detoxification by dialyzed *T. ammi* extract showed that more than 91% degradation occurred at 24 h and 78% degradation occurred within 6 h after incubation. Detoxification of aflatoxins by seed extract of Ajwain can support the related traditional reports [54].

Safety information

Bishop's weed, borage, chaparral, uva-ursi, and other herbs and supplements that can cause hepatotoxicity, as well as angelica, red clove, danshen, garlic, turmeric, ginger, white willow, and ginkgo biloba, which may prevent platelet aggregation, increase the risk of hepatotoxicity and bleeding, respectively, when combined with *T. ammi* seeds. *Trachyspermum ammi* is an abortifacient, therefore should not be used in pregnancy. In higher doses, it is toxic and may lead to fatal conditions due to its high thymol content. The acute oral LD₅₀ of thymol is reported as 0.98 g/kg in the rat and 0.88 g/kg in the guinea pig. Ajwain is recognized as safe only when used in the prescribed quantities, however, it can give some individuals headaches and nausea. There is no information on safety for nursing mothers, pregnant mothers, younger kids, or those with severe liver or renal illness. *T. ammi* seeds, when taken with drugs such as abciximab, (ReoPro) antithrombin III, (thrombate III) argatroban, (argatroban) aspirin, (bufferin, ecotrin) aspirin and dipyridamole, (aggrenox) bivalirudin, (angiomax), clopidogrel, (plavix) dalteparin, (fragmin) danaparoid, (organan) dipyridamole, (novo-dipiradol, persantine) enoxaparin, (lovenox) eptifibatide, (integrillin) fondaparinux, (arixtra) heparin, (hepalean, hep-lock) indobufen (ibustrin), may increase the risk of bleeding and bruising [55-56].

Conclusion

Ajwain is beneficial in both ways dietary as well as medicinal in traditional and western cultures. These Medicinal plants play an important role in the management of various diseases by providing new molecules for drug discovery. These days ethnobotanical information about plants gains interest for their effectiveness and minimal side effects and is useful in the conservation of traditional cultures, biodiversity, health care, and drug discovery. Here we collected all the updated clinical information regarding its therapeutic and ethnopharmaceutical uses. Nutritional, Phytochemical constituent, and Pharmacognostical

Traits study revealed the presence of diverse organic and natural compounds along with this major constituent thymol (volatile oil) in ajwain's seeds that deals with body problems and proven therapeutically active. Ajwain's oil exhibits potential antimicrobial, insecticidal, analgesic, gastroprotective activities, and galactagogue activities. *T. ammi* has been supported by various ethnic groups and traditional practitioners for their better ailments (earache, rheumatism, dental caries, etc) and become a part of Indian medicine. Furthermore, overconsumption of seeds can worsen the conditions of existing peptic ulcers, liver diseases also show some teratogenicity. *T. ammi* can cause interaction with some drugs and supplements. With all the above information we conclude that ajwain seeds could be a promising candidate for use in clinical practice. It has more therapeutic potential that is still unknown. despite numerous animal and experimental studies, there is a need for more clinical trials and extraction to reconfirm the existing information and encourage to find its silent therapeutic potential.

Contribution of authors

Conceptualization and writing of original draft by Saloni Goyal and Varunesh Chaturvedi. Garima Dhingra, Sonia Tanwar, and Kapil Sharma contributed to reviewing and editing. The manuscript is supervised by Sandeep Singh.

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Conflict of interest

No conflict of interest exists for the author.

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