AN OVERVIEW OF AJWAIN (TRACHYSPERMUM AMMI)

Abstract

Nowadays there are a variety of new drugs available in market and the use of drugs is also increasing day by day, which cause a lot of toxicity in the human body, hence it is necessary to promote natural ingredients or foods as dugs to minimize the toxicity of the drugs in the body. In recent years, there has been a significant surge in interest in the ayurvedic approach to medication. Globally, there has been a shift towards embracing herbal medicine. The majority of ayurvedic formulations are derived from various herbs, making them generally regarded as safe for use. Many kitchen ingredients offer numerous health benefits and have been employed in treating various ailments and their associated symptoms. Ajwain (Trachyspermum ammi) is one such element with a long history of traditional use in addressing conditions like cough, bloating, indigestion, infections, and more. Ajwain is rich in medicinally active compounds, exhibiting various pharmacological effects and therapeutic applications. Its composition includes approximately 50% thymol, 7% carvacrol, 35% terpinene, 25% para-cymene, in addition to pinene and limonene.Ajwain plays different pharmacological actions like diuretic, antihypertensive, antispasmodic, antiflatuent, anthelminthic, antiplatelet, bronchodilation, antiulcer, antitussive, analgesic, hepatoprotective and other activities. Furthermore, formulation of *Trachyspermum ammi*, general evaluations, extraction and analysis studies are discussed in detail.

Keywords: *Trachyspermum ammi*, Ajwain, Pharmacological properties, Chemical composition.

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I. INTRODUCTION

Nature has long served as a abundant reservoir of medicinal plants, offering significant therapeutic potential for treating various infectious ailments with minimal side effects [1]. In recent times, there has been a growing preference for herbal compounds as the source of drugs, given the numerous side effects associated with synthetic drugs. This shift has sparked increased interest in herbal remedies among researchers [2,3]. Ayurveda, a widely practiced traditional medicine system in India, has gained popularity among both adults and children and is now expanding its reach globally [4]. Herbs and spices cultivated in diverse regions worldwide have been utilized for various purposes since ancient times [5]. Trachyspermum ammi Linn., an upright and fragrant annual herbaceous plant from the Apiaceae family, is renowned for its global use as a spice and its medicinal properties. Consequently, it has been employed for centuries as part of traditional medicinal systems [6]. The name "Trachyspermum ammi" (ajwain) finds its origins in the Sanskrit terms "ajamoda" or "ajamodika." In modern Indian languages, you can find examples such as Kanada "ajamoda" and Sinhala "asamodagagam" [7]. Trachyspermum ammi, commonly known as ajwain, is an indigenous variety originating from Egypt and is grown in regions including Iraq, Iran, Afghanistan, Pakistan, and India. Within India, it is primarily cultivated in Madhya Pradesh, Uttar Pradesh, Bihar, Gujarat, Maharashtra, Rajasthan, and West Bengal [8]. This herbaceous plant typically reaches a height of 60-90 cm and is usually sown in October-November, with harvesting taking place in May-June [9,10]. Ajwain has a distinctive pungent and bitter taste, resembling the flavors of oregano and anise [11]. The seeds contain approximately 2-4.4% of brown-colored oil, known as ajwain oil. Various parts of the ajwain plant exhibit diverse pharmacological effects, including carminative, anthelmintic, laxative, and stomachic properties. It is also employed to address issues like piles, abdominal pains, and abdominal tumors [12]. Ajwain oil finds applications in treating neurological disorders such as tremors, paralysis, and persistent pain. Thymol, the primary component of this oil (constituting 39.1%), is used to address gastrointestinal problems, lack of appetite, and bronchial issues. Other notable constituents in ajwain include p-cymene (30.8%), γ-terpinene (23.2%), β-pinene (1.7%), terpinene-4-ol (0.8%). An acetone extract of ajwain has been identified to contain 18 components, collectively accounting for 68.8% of the total composition.

Vernacular Names:[13-20]

- **Sanskrit:** Yamini, yaminiki, yaviniki
- **Assamese:** Jain
- **Bengali:** Yamani, yauvan, Yavan, Javan, Yavani, Yoyana
- **English:** Bishop’s weed
- **Gujrati:** Ajma, Ajmo, Yavan, Javain
- **Hindi:** Ajwain, Jevain
- **Kannada:** Oma, Ayanodakan
- **Marathi:** Onva
- **Oriya:** Juani
- **Tamil:** Omam
- **Telugu:** Vamu
- **Punjabi:** Lodhar
- **Kashmiri:** Kath
- **Arabic:** Kamun Mulki

- **Persian:** Nankhah, Zenyan
- **Urdu:** Azwain Desi
- **Armenian:** Hounastan
- **China:** Xi Ye Cao Guo Qin
- **Dutch:** Ajwain

Synonyms:[21-22]

- *Ammi copticum* L.
- *Carum copticum* L.
- *Trachyspermum copticum* L.
- *Sisonammi* L.

Taxonomical Classification:[23]

- **Kingdom-**Plantae
- **Subkingdom-**Tracheobionta
- **Division-**Magnoliophyta
- **Super division-**Spermatophyta
- **Order-**Apiales
- **Class**-Magnoliopsida
- **Subclass-**Rosidae
- **Family**-Apiaceae
- **Genus**-Trachyspermum
- **Species**-ammi

Figure 1: Flower of Ajwain

Figure 2: Leaves of Ajwain

Figure 3: Fruit of Ajwain

1. **Botanical Description:** Ajwain, classified within the Apiaceae (Umbelliferae) family, is a small, highly branched annual herbaceous plant [24]. Trachyspermum ammi is predominantly cultivated in regions characterized by arid and semi-arid conditions [25] due to the elevated salt levels present in the soil [26,27]. This herb typically reaches a height of 60-90 cm and displays branching throughout its annual growth cycle. The stem is marked by striations and features 16 umbellets, with each holding as many as 16

flowers. These flowers exhibit a white coloration and possess actinomorphic characteristics. The leaves are pinnately arranged and consist of a terminal leaflet along with 7 pairs of leaflets. Ajwain's fruits are small, egg-shaped, characterized by their aromatic qualities, and typically display a greyish-brown hue [28].

2. **Geographical Distribution:** Trachyspermum ammi, known for its origins in Egypt and the eastern Mediterranean region, is cultivated in various countries including Iraq, Iran, Afghanistan, Pakistan, and India. It is predominantly grown in arid and semi-arid regions, particularly in soils with notable salt concentrations. In India, ajwain cultivation is most prominent in the states of Rajasthan and Gujarat, while its cultivation is relatively lower in states such as Madhya Pradesh, Uttar Pradesh, Maharashtra, Bihar, West Bengal, and others [21].

3. **Macroscopic Characters:** It is widely grown in arid and semi-arid region [29] where soils contain the high levels of salts [27,30]. Ajwain is a profusely branched annual herb, 60-90 cm tall. Stem is striated; inflorescence compound umbel with 16 umbellets, each containing up to 16 flowers; flowers actinomorphic, white, male and bisexual; corolla 5, petals bilobed; stamens 5, alternating with the petals; ovary inferior; stigma knob-like; fruit aromatic, ovoid, cordate, Cremo carp with a persistent stylopodium; Leaves pinnate, with a terminal and 7 pair of lateral leaflets [31]. Fruit, consists of two mericarps, greyish brown, ovoid, compressed, about 2 mm long and 1.7 mm wide, 5 ridges and 6 vittae in each mericarp, usually separate ,5 primary ridges [32].

4. **Microscopic Character:** Two carpophores are present in the transverse section of the ajwain fruit, according to a microscopic analysis. They are interconnected and have the potential to be hexagonal in systems [30]. A transverse section of the fruit reveals two hexagonal structures joined by carpophores; the epicarps are made up of a single layer of tangentially elongated tubular cells; the mesocarp is made up of moderately thick-walled, rectangular to polygonal tangentially elongated cells with some vittae; the integument is made up of barrel-shaped, tangentially elongated cells with carpophores and vascular bundles; the endosperm is made up of thin-walled cells filled with embryos; and the oil globules are small and round, made up of polygonal thin-walled cells. Groups of endosperm cells and oil globules are visible under a powder microscope.

II. PHYTOCHEMICAL CONSTITUENTS OF AJWAIN

The herb ajwain comprises a variety of chemical components, including moisture (8.9%), tannins, fiber (11.9%), fat (21.1%), carbohydrates (240.6%), glycosides, proteins (17.1%), saponins, flavones, and other elements (7.1%). It also contains essential nutrients such as thiamine, calcium, iodine, manganese, phosphorus, iron, cobalt, copper, riboflavin, and vitamin B [33]. Ajwain fruits are known to yield brownish essential oil, constituting thymols as the major component (35% to 60%) [34]. The non-thymol fraction (thymene) contains para-cymene, γ-terpinene, alpha and beta pinenes, dipentene, alpha terpinene, and carvacrol [35]. Small amounts of camphene, myrcene, and alpha-3-carene have also been detected in the plant. Alcoholic extracts of ajwain contain a highly hygroscopic saponin. A yellow crystalline flavone and steroid-like substance have been isolated from this fruit, along with 6-O-Beta-glucopyranosyloxythymol [36]. A glucoside is present, yielding 25% oleoresin

containing 12% volatile oil, alpha and beta pinene [37]. The primary oil constituents of Trachyspermum ammi include carvone (46%), limonene (38%), and dillapiole (9%) [38].

1. **Ayurvedic View:** Trachyspermum ammi is a frequently used herb in Ayurvedic practices in India, often referred to as 'Ajmoda' in Ayurvedic literature. According to Ayurveda, ajwain is recognized as a potent cleanser with various beneficial properties. It aids in promoting emesis, stimulating the appetite, and improving digestion. It is highly recommended for relieving gas and stomach discomfort. Ajwain is known for its role in balancing the Vata and Kapha doshas while increasing Pitta. It imparts a pungent taste with a subtle bitter undertone [39]. The Rasapanchak of Trachyspermum ammi is presented in the table below.

Rasapanchak of *Trachyspermum ammi* as per Ayurveda [40]

Sanskrit/English	Sanskrit/English
Virya/potency	Ushna/Hot
Vipak/Metabolic property	Katu/Pungent
Guna/Physical property	Laghu/Light, Ruksha/Dry, Tikshan/Sharp
Rasa/Taste	Katu/Pungent

2. **Actions of Ajwain As Per Ayurveda**

- Sansthanik karam wahay: Locally it is used as a Vedna sansthapak analgesic or pain killers.
- Abhiyantar pachansansthan: It works on the gastro-intestinal tract and also used to kill the parasites.
- Raktavah sansthan: It increases the blood circulation.
- Sawashan sansthan: It decrease the Kapha (lubrication) present in the human body.
- Mutrvah sansthan: It is helpful in urination.
- Prajanan sansthan: It has significant fertility properties.

III. Modern View

In the modern context, the degradation of herbal drug quality is primarily attributed to factors such as contamination, adulteration, and misidentification. The terms commonly associated with species adulteration in the drug market include substitution, fraudulent substitution, admixture, mislabelling, contamination, and the use of fillers, among others [41-43]. Adulteration can have severe adverse effects on consumer health [41-43]. To ensure the quality of herbal drugs, it is essential to implement proper authentication and standardization protocols. The manufacturing process of herbal drugs should be conducted with great care, incorporating multiple checkpoints at various stages, ranging from the collection of raw plant materials to the final production of the herbal drug [44].

1. **Pharmacological Activities:** Traditional medicinal uses of Trachyspermum ammi fruits encompass a wide range of therapeutic properties, including being a galactagogue, stomachic, and carminative [45]. Additionally, they are utilized as an expectorant, antiseptic [38], and are effective against conditions such as amoebiasis and as

antimicrobial agents [46]. The seeds, when fried in oil and used as a thin soup, serve as a galactagogue [47] and are employed to treat various ailments, including diarrhea, parasitic infections, amenorrhea, bronchitis, and colic pain [48-49]. Furthermore, these seeds exhibit antipyretic and febrifugal properties [50]. Ajwain seeds are characterized by their bitter and pungent taste, and they act as anthelmintics, carminatives, laxatives, and stomachics. They are also utilized in the treatment of abdominal tumors, abdominal pain, and piles [12]. The presence of terpenes, glycosides, and sterols in the plant has been found to exert active anti-inflammatory effects [53]. Catecholamines originating from the adrenal medulla have been associated with stress-induced release of ACTH and an increase in intracellular cyclic AMP. Catecholamine release is linked to adrenal gland enlargement [51].

2. **Antiflatulent:** Ajwain has been utilized for its long history of relieving gas retention and flatulence. A popular recipe for ajwain used by rural people is to take half a kilogram of uncrushed ajwain and 20 grams of rock, black, and table salts. Place everything in a half-kilogram of lemon juice and let it dry out on its own for a few days. Taking half to one teaspoonful of this specifically made mixture with warm water. It works wonders as a natural home cure for nausea, vomiting, travel sickness, and stomach gas anorexia [53].

3. **Anthelmintic Activity:** Several studies have explored the anthelmintic activity of Trachyspermum ammi and have confirmed its effectiveness against specific helminths, such as Haemonchus contortus and Ascaris lumbricoides, both in humans and sheep. This anthelmintic activity of ajwain is achieved by disrupting the energy metabolism of parasites, leading to the potentiation of ATPase activity and subsequent depletion of energy reserves. Additionally, Trachyspermum ammi has demonstrated cholinergic effects, promoting peristaltic motion within the gut. This action aids in the expulsion of enteric parasites and may contribute to its anthelmintic properties [54,55].

4. **Hepatoprotective Activity:** Ajwain (Trachyspermum ammi) has hepatoprotective properties in vivo. It was found to be 80% protective in mice against a dose of paracetmol (1 g kg -1) that would ordinarily be fatal. It also helped to restore the elevated liver enzyme levels in rats that were caused by liver damage induced by CCl4 [56].

5. **Antiulcer Activity:** Different ulcer rat models were utilized to assess the anti-ulcer potential of Trachyspermum ammi plant [57]. An experiment was conducted to investigate the impact of the aqueous extract of Trachyspermum ammi on gastric ulcers. Female albino rats were selected for this empirical study, and they were divided into five groups. The standard drug omeprazole was administered in one group, while the ajwain plant extract was administered in progressively increasing doses twice a day for two weeks in another group. After the completion of this treatment period, gastric ulcers were evaluated. The findings of the study suggested that the aqueous extract of ajwain seeds exhibited a promising potential for treating gastric ulcers when compared to the control group [58].

6. **Antitussive Activity :** Traditional medical texts have made reference to the antitussive properties of Ajwain. To assess these antitussive effects, an experiment was conducted involving aerosol administration of two different concentrations of aqueous and macerated extracts, as well as carvacrol, codeine, and saline. The number of coughs

produced was counted to evaluate the results. The findings demonstrated a significant reduction in the number of coughs in the presence of both concentrations of aqueous and macerated extracts, as well as codeine ($p<0.001$ for extracts and $p<0.01$ for codeine), indicating its potent antitussive effect [55]. Several related studies have also revealed the inhibitory impact of both Ajwain extract and essential oil on Histamine (H1) receptors in isolated guinea-pig tracheal chains [59].

7. **Broncho-dilatory Effect:** In a research study, the bronchodilatory effects of various concentrations of Ajwain were investigated. The findings indicated that the relaxing and bronchodilatory effects of essential oil concentrations could be attributed to the presence of carvacrol [60]. Additionally, a trial study examined the bronchodilatory impact of a decocted extract of Ajwain on asthma patients' airways. The results revealed that the extract exhibited a relatively bronchodilatory effect on asthmatic airways when compared to the effect of theophylline at various concentrations employed [61].

8. **Analgesic and Antinociceptive Activity:** To assess the analgesic and antinociceptive properties of Ajwain, an in vivo investigation was conducted using a Tail-flick Analgesiometer Device [62]. The study demonstrated a significant increase in Tail-Flick Latency (TFL) within 2 hours following the administration of the ethanolic extract. Another experimental trial compared the antinociceptive effect of the hydroalcoholic extract of Ajwain with morphine sulfate using the formalin test. The findings indicated that the Ajwain extract displayed antinociceptive effects during both the early and late phases [63]. A similar study was conducted on the total essential oil of Ajwain, which exhibited significant effectiveness during the late phase of the formalin test, possibly due to the presence of thymol in the essential oil [64]. Furthermore, in a randomized controlled placebo-controlled clinical trial, the analgesic effect of Ajwain essential oil was assessed in neuropathic feet burn cases. The results showed a significant reduction in feet burn sensation compared to the placebo group [65].

9. **Antiplatelet-Aggregatory:** The extract derived from Trachyspermum ammi demonstrates antiplatelet activity and the ability to inhibit platelet aggregation [66]. In in vitro experiments using blood from human volunteers, it was observed that the dried seed extract of Trachyspermum ammi effectively inhibited platelet aggregation induced by substances such as arachidonic acid, collagen, and epinephrine. This research study aimed to provide scientific support for the traditional use of Trachyspermum ammi in women after childbirth [67].

10. **Antihypertension Activity:** The calcium channel blocking effect of Ajwain plays a role in regulating heart rate and blood pressure, leading to a reduction in both. Researchers observed various cardiovascular effects associated with Ajwain and its components. For instance, the administration of 1-10 mg/kg Thymol in mice resulted in a decrease in blood pressure, and this effect was suggested to be attributed to Thymol's calcium channel blocking property [68].

11. **Amebiasis:** In the Unani system, Ajwain is used to enhance the body’s resistance and is given in Amebiasis [69]. The goal of this study is to promote the researcher to investigate such type of superfoods as it may be very beneficial for human race

12. **Abdominal Pain:** Ajwain can be used traditionally to treat stomach pain by making a standard infusion with 2 tsp of smashed seeds or 1 tsp of ajwain powder in 570 ml of cold water in a small pan. Before filtering and using, boil, lower heat, and simmer for no more than two minutes. Edema, rheumatism, arthritis, gripping pains associated with colic, intestinal and respiratory infections, asthma, and cramping spasms of the muscles can all be treated with this. It can also be administered externally as an antiseptic to treat skin infections and clean wounds. Like all medicinal herbs, ajwain should be produced organically to avoid having its essential characteristics diminished or eliminated by the presence of outside factors [70,57].

13. **Anti-Spasmodic:** Although the oil can also be used, distilling oil at home is a challenging task. The part of ajwain used for medicinal purposes is the seeds. Another way to use the seed is to ground it up in a coffee grinder or other similar tool, then bind it firmly in a thin cloth and inhale the aroma often during the day to relieve severe colds and migraine headaches. Grind together 100g of ajwain, 50g of ginger powder, and 25g of black salt in a dry jar. Two or three times a day, or as needed, take two grams of this powder with warm water as a fast cure for mild to moderate stomach cramps. More rapid pain alleviation can be achieved by applying heat formation to the affected area [71].

14. **Gastro Protective Activity:** Trachyspermum ammi fruit exhibited antiulcer activity in various models, confirming its gastroprotective or antiulcer properties. In these animal models, prior treatment with ajwain extract led to a significant decrease in the percentage of ulceration compared to both the control group and the standard groups of animals [58].

15. **Digestive Stimulant Action:** Traditional healers have historically endorsed ajwain as a digestive stimulant medication [72]. Contemporary research has substantiated these claims by demonstrating that ajwain can enhance the production of gastric acid, bile acids, and the activity of digestive enzymes. Additionally, it has been found to potentially reduce the transit time of food [73,70]. Ajwain's enzyme-modulating properties are evident in its ability to enhance the effectiveness of pancreatic lipase and amylase, further supporting its role as a Digestive Stimulant [74].

16. **Antimicrobial Action:** Research is also done on the antibacterial properties of Trachyspermum ammi, including how well it protects food from microbial deterioration, how well it performs in vitro antimicrobial tests in laboratories, and how it might be used as an antimicrobial in human medicine. Carvacrol and thymol have been identified as the active ingredients in ajwain that are likely to be responsible for its antibacterial effect. Thymol functions as a plant-based, fourth-generation herbal antibiotic formulation since it destroys bacteria that are resistant to even common third-generation antibiotics and multidrug-resistant microbial infections [75,76].

17. **Antifungal activity:** The whole essential oil extracted from the seeds of ajwain was tested for fungicidal effect in order to evaluate its antifungal activity. It shown appropriate action on Curvularia ovoidea and Aspergillus niger at 5000 pmpm as minimum inhibitory concentration [77]. Ten fungi (Acrophialophora fusispora, Curvularia lunata, Fusarium chlamydosporum, Fusarium poae, Myrothecium roridum, Papulaspora sp., Alternaria grisea, Acrophialophora tenuissima, Drechslera tetramera, and Rhizoctonia solani) were tested for the antifungal effect of volatile components of Trachyspermum ammi seeds.

The results showed that all test fungi were inhibited in growth by 72–90%. Depending on the concentration utilized, phenolic substances like thymol and carvacol have been shown to be either bacteriostatic or bactericidal agents[78,79].

18. **Anti-inflammatory potential:** Ajwain was also assessed for its anti-inflammatory properties. Different seed extracts of Trachyspermum ammi were prepared using n-hexane, chloroform, and methanol solvents. The study utilized Wister rat models with Carrageenan-induced paw edema and tested both minimum and maximum doses (500 and 1000 mg/kg) of the extracts. It was observed that the n-hexane solvent extract at a dosage of 1000 mg/kg exhibited the most potent anti-inflammatory activity [80]. This study highlighted the effective anti-inflammatory actions of Trachyspermum ammi seeds, either individually or in combination with ibuprofen, evidenced by reduced paw thickness, arthritis score, and mRNA levels of COX2 and iNOS genes [81]. Consequently, both the total alcoholic extract (TAE) and total aqueous extract (TAQ) demonstrated significant in vivo anti-inflammatory effects. Animals treated with TAE and TAQ exhibited a significant increase in adrenal gland weights. The extracts from ajwain seeds, both TAE and TAQ, display substantial anti-inflammatory potential [54].

19. **Antihyperlipidemic Action:** The antihyperlipidemic characteristic of ajwain is another action that has been demonstrated. Ajwain seed powder has been shown in an in vivo trial to have a significant positive impact on lipid profile, including a reduction in triglycerides, total cholesterol, LDL-cholesterol, and total lipids [82].In albino rats, Trachyspermum ammi seed has been shown to have an antihyperlipidemic effect. By reducing total cholesterol, LDL-cholesterol, triglycerides, and total lipids, it was determined that Trachyspermum ammi powder, taken at a dose rate of 2 g kg-1 body weight, and its corresponding methanol extract, were highly effective in lowering lipid levels [83].

20. **Antilithiasis And Diuretic Activity:** Trachyspermum ammi's in vivo actions against lithiasis and its diuretic effects were evaluated through an experiment involving the inhibition of oxalate urolithiasis in rats. Another study aimed to investigate its potential diuretic effect, but the findings indicated that Trachyspermum ammi did not significantly increase 24-hour urine production. As a result, the experimental evidence did not align with the traditional use of Trachyspermum ammi in the treatment of kidney stones [84].

IV. ABORTIFACIENT AND GALACTAGOGIC ACTIONS

In 1987, a survey conducted in some districts of Uttar Pradesh, India, identified Trachyspermum ammi among 14 indigenous medicinal plants that were reportedly used for inducing abortion. Specifically, in the village of Kallipuschium, Lucknow district, 50 out of 75 pregnant women surveyed (out of a total of 155 women in their fertile period) claimed to have employed Trachyspermum ammi seeds for abortion. However, it should be noted that the herb was not entirely effective, raising concerns about the potential for congenital defects. There was also a heightened risk of potential human fetotoxicity associated with ten plants, including Trachyspermum ammi, based on observed teratogenicity in rat fetuses [85].

Furthermore, the National Dairy Research Institute in India conducted an investigation into the estrogenic content of certain herbs, including Trachyspermum ammi,

traditionally used to boost milk production in dairy cattle. Trachyspermum ammi has also been traditionally employed as a galactagogue in humans [86].

1. **Detoxification of Aflatoxins:** The detoxification of aflatoxins by the seed extract of ajwain aligns with traditional reports [87]. Ajwain seed extract exhibited the highest level of degradation of aflatoxin G1 (AFG1). Notably, the aflatoxin detoxifying activity of the seed extract was significantly diminished when subjected to boiling. Furthermore, significant degradation of other aflatoxins, including AFG1, AFB2, and AFG2, was observed with the dialyzed seed extract. A time course study on the detoxification of AFG1 by the dialyzed Trachyspermum ammi extract demonstrated that more than 91% degradation occurred at 24 hours, with 78% degradation occurring within 6 hours after Incubation [88].

2. **Ameliorative Effect:** The study aimed to assess the impact of ajwain extract on hexachlorocyclohexane (HCH)-induced oxidative stress and toxicity in rats. Pre-treatment with ajwain extract led to elevated levels of GSH, GSH-peroxidase, G-6-PDH, SOD, catalase, and Glutathione-S-Transferase (GST) activities, along with reduced hepatic levels of lipid peroxides. The findings indicated that the administration of HCH resulted in hepatic free radical stress, leading to toxicity, which could be mitigated by the inclusion of ajwain extract in the diet [79].

3. **Nematicidal Activity:** Pine wilt disease, which is caused by the pinewood nematode (PWN) Bursaphelenches xylophilus, has been a major concern. Ajwain oil constituents, including camphene, pinene, myrcene, limonene, terpinene, terpinene-4-ol, thymol, and carvacrol, have demonstrated nematicidal activity against the PWN32. The muscle activity blockers levamisole hydrochloride and morantal tartrate were applied to PWN bodies [89]. It has been hypothesized that amino and hydroxyl groups are targeted by methyl isothiocyanate in nematodes [79]. Some essential oils have been reported to disrupt the neuromodulator octopamine [90] or GABA-gated chloride channels in insect pests [91]. Thymol and carvacrol exhibited significant effectiveness against the PWN. These studies confirm that the nematicidal activity of ajwain oil is primarily attributed to the presence of thymol and carvacrol [92]. The LC50 values for the nematicidal activity of ajwain essential oils were found to be 0.431 mg/ml [93].

4. **Antifilarial Activity:** A methanolic extract of Trachyspermum ammi fruits has been tested for its ability to inhibit Setaria digitata worms in vitro. By using worm motility and MTT reduction assays, the crude extract and active fraction demonstrated noteworthy efficacy against adult S.digitata. When tested for in vivo antifilaraial action against the human filarial worm B. malayi in Masto myscoucha, the isolated active principle phenolic monoterpene demonstrated both macrofilaricidal activity and in vivo sterility of the female worm. The crude extract of Trachyspermum ammi shown macrofilaricidal properties. At two incubation periods of 24 and 84 hours, the IC50 values for the isolated active principle 2-isopropyl-5-methyl phenol were 0.024 and 0.002 mg ml-1, respectively. Using a Masto myscoucha model, the in vivo efficacy of the active principle 2-isopropyl-5-methyl phenol was assessed against the B. malayi parasite. Adults treated with 50 mg kg-1 had a mean percentage mortality that was significantly ($p<0.0001$) greater than that of the control group (19.05%) [94].

5. **Antioxidant Activity:** An in vivo study was conducted to assess the antioxidant and ameliorative effects of ajwain extract in the presence of hexachlorocyclohexane-induced oxidative stress and toxicity. The findings indicated that the dietary inclusion of ajwain extract had the potential to mitigate the toxicity caused by hepatic free radical stress [95].

6. **Anti-Amnesic:** In an in vivo study conducted on mouse models, the anti-amnesic activity of Trachyspermum ammi seed powder supplementation over a period of 10 days was evaluated. Amnesia was induced using alprazolam, scopolamine, and electroshock. Various parameters were assessed during the study, including brain monoaldehyde (MDA), brain reduced glutathione (GSH), and brain nitrate levels. The study demonstrated a significant increase in the stepdown latency in the passive avoidance paradigm (PAP) and an improved discrimination index in the object recognition task (ORT). Additionally, a notable reduction in brain AChE activity, brain MDA levels, and brain nitrate levels was observed, accompanied by an increase in brain glutathione (GSH) levels [96].

7. **Insecticidal Assessment:** The essential oil obtained from ajwain seeds has been documented to demonstrate insecticidal activity during the oviposition stage, as well as inhibitory effects on egg hatching and development in the case of Callosobruchus chinensis [97,98].

8. **Antiviral Activity:** To assess the antiviral potential of ajwain, an in vitro assay was conducted using the methanolic extract of the herb. This extract exhibited notable inhibitory effects on the protease of Hepatitis C Virus (HCV) [99].

9. **Spermicidal Activity:** An in vitro investigation was conducted to investigate the spermicidal activities of aiwain essential oil. The results indicated that the volatile oil exhibited strong spermicidal properties [100]. As such, the oil might be seen as a natural method of birth control.

10. **Estrogen Activity:** 473 ppm of phytoestrogen was found to be present in dry ajwain seed. According to a list of plants examined for total phytoestrogen concentration, the herb ranks second in this category [101]. It should be mentioned that galactagogues have historically used this herb [78].

11. **Toxicity and Teratogenicity:** Ajwain was shown to be teratogenic in rat fetuses, according to reports. Thus, consumption during pregnancy may be hazardous [102].

12. **Medicinal Uses of *T.AMMI:*** A tiny quantity of oil known as ajwain oil is present in ajwain seeds. The fruit smells like thyme because the oil contains thymol, a phenol. Thymol is frequently used to address stomach issues. It also possesses antibacterial and antifungal qualities.

13. **Digestive Health:** Ajwain's active enzymes facilitate better stomach acid flow, which aids in digestion and reduces gas and bloating. The herb is frequently used to treat peptic ulcers as well as ulcers in the intestines, stomach, and esophagus.

14. **Infection Prevention:** Thymol and carvacrol, among other essential oils found in ajwain, have the ability to inhibit the growth of germs and fungi. E. Coli and Salmonella are those. Additionally, they aid in the fight against germs like E. coli, which can cause disease and other digestive issues.

- **Lower Blood Pressure:** Rat studies have demonstrated that the thymol calcium in ajwain can function to prevent blood clots from entering your heart's blood arteries, perhaps lowering your vital signs.

- **Cough and Congestion Relief:** Breathing becomes easier when you use ajwain to clear your nose of mucus and alleviate coughing. Additionally, it may aid in bronchial tube enlargement, which may alleviate asthma.

- **Toothache Relief:** Thymol's and other essential oils' anti-inflammatory qualities, along with those of ajwain, can help lessen toothache discomfort. Thymol combats germs and fungi in the mouth, which may help you have better dental health.

- **Arthritis Pain Relief:** Even pain and swelling can be reduced with the use of ajwain. Joint pain can be treated by applying crushed fruit paste topically. As an alternative, you might take a bath in lukewarm water with a handful of seeds added.

V. FORMULATION

1. **Methi Ajwain Churna:** An Ayurvedic concoction called methi ajwain is offered as churna powder. An Ayurvedic medicine called ajwain churna is useful for lowering cholesterol, treating digestive disorders, and relieving pain. Methi ajwain churna has anti-inflammatory, wound-healing, wound-healing, antioxidant, antibacterial, and antiviral properties. It can be used to control blood sugar levels and has a strong antidiabetic impact. Using this churna helps the body get rid of fluid retention by speeding up salt excretion and urine flow.

2. **Mouthwash:** Herbal treatments are a safe and efficient way to treat a variety of oral health conditions, including as gingivitis, periodontitis, halitosis, mouth ulcers, and tooth decay prevention, according to scientific studies. The primary advantage of utilizing this natural herb is that there haven't been any reported negative effects from consuming it up to this point. Moreover, halitosis-causing substances are avoided while using a herbal mouthwash, which is a positive step toward improved oral hygiene and general health.

- **Toothpaste:** It is a paste or gel dentifrice that patients use as an add-on to their toothbrushes to improve oral hygiene by cleaning and maintaining the appearance and condition of their teeth. Using toothpaste helps you maintain good dental hygiene.

- **Lozenge:** The primary goal is to create a lozenge that can be used to treat GIT disorders, including constipation and upset stomach.

VI. CONCLUSION

Trachyspermum ammi is a significant medicinal plant renowned for its nutritional and therapeutic attributes. This plant boasts a wide range of well-established and undiscovered medicinal uses, warranting scientific exploration to uncover its hidden healing potential. Medicinal plants have made substantial contributions to both traditional and modern medical systems. Trachyspermum ammi, an ancient aromatic spice with global recognition, has long been a staple in numerous home remedies for various ailments. It holds a special place in the Ayurvedic system of medicine. Based on the aforementioned study, it can be inferred that ajwain serves as a source of biologically active compounds with diverse pharmacological properties, as mentioned earlier. The study also suggests that natural superfoods like ajwain may offer potential benefits for human health, particularly in clinical applications.

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