

**Review Article**

An Overview on Ajwain (*Trachyspermum ammi*) Pharmacological Effects: Current and Conventional

Muhammad Awais Hanif^{1,*}, Syeda Mona Hassan¹, Shahzad Sharif Mughal¹, Aesha Rehman¹,
Syed Khurram Hassan², Asif Ibrahim³, Huma Hassan⁴

¹Department of Chemistry, Lahore Garrison University, Lahore, Pakistan

²Institute of Quality and Technology Management, University of the Punjab, Lahore, Pakistan

³Department of Mathematics, Lahore Garrison University, Lahore, Pakistan

⁴Department of Chemical Engineering, NFCIE&FR, Faisalabad, Pakistan

Email address:

awaishanif222@yahoo.com (M. A. Hanif)

*Corresponding author

To cite this article:

Muhammad Awais Hanif, Syeda Mona Hassan, Shahzad Sharif Mughal, Aesha Rehman, Syed Khurram Hassan, Asif Ibrahim, Huma Hassan. An Overview on Ajwain (*Trachyspermum ammi*) Pharmacological Effects: Current and Conventional. *Pharmaceutical Science and Technology*. Vol. 5, No. 1, 2021, pp. 1-6. doi: 10.11648/j.pst.20210501.11

Received: June 22, 2020; **Accepted:** June 22, 2020; **Published:** April 30, 2021

Abstract: *Trachyspermum ammi* L. (Apiaceae) is commonly famous as Ajwain. Ajwain, *Trachyspermum ammi* (L.) Sprague is an erect yearly herb with striate stem, India and eastern Persia is the origin of this plant. The most useful element of ajwain is the little fruit like caraway, which always especially admired in Indian delectable recipes, flavorful baked goods, and snacks. In Ayurvedic meds, it is utilized as a restorative plant for its stimulant, carminative, antispasmodic, and tonic properties. Ajwain is grown in arid or partially arid regions where concentration of salts is very high. Ajwain due to its typical odor and sharp tastes is employed in curries as a flavor. Its seed are utilized as flavoring agents in foods as preservatives, for the manufacture of vital oil in perfume industry, in medicine and Essential oil extracted from Ajwain especially thymol helps in relieving cholera. Ajwain seeds are also effective in treating aphrodisiac and premature ejaculation. Among external relieves, Ajwain is effective in treating asthma, delirium, colic earache and rheumatism. Along with the potent antioxidant activity, the Ajwain methanolic extract revealed to exhibit in vivo hepatoprotective activity with 80% defense against an in general deadly dose of paracetamol in pests. The bronchodilatory impact of the decocted concentrate of Ajwain on the asthmatic patients' airways was inspected in an ensuing examination ponders. According to the outcomes, the concentrate has a reasonably bronchodilatory impact on asthmatic airways assessed to the impact of Theophylline at fixations utilized.

Keywords: *Trachyspermum ammi*, Ajwain, Pharmacological Effects

1. Introduction

Trachyspermum ammi L. (Apiaceae) is commonly famous as Ajwain. Ajwain, *Trachyspermum ammi* (L.) Sprague, is an erect yearly herb with striate stem, India and eastern Persia is the origin of this plant. The most useful element of ajwain is the little fruit like caraway, which always especially admired in Indian delectable recipes, flavorful baked goods, and snacks. In Ayurvedic meds, it is utilized as a restorative plant for its stimulant, carminative, antispasmodic, and tonic properties.

[1]

It is likewise a typical home cure utilized for an assortment of health conditions, for example, stomach torment, issues, acid reflux, retching, and stomach distension, intestinal gas, and free stool, diarrhea, breathing inconvenience and heaviness in the belly after dinner. One such plant *Trachyspermum ammi*, usually famous as Ajwain. It belongs to family Apiaceae. It generally grows all over India especially in Rajasthan & Gujarat based on its traditional use [2].

Since a long period of time for treatment of inflammatory

diseases and disorders of the digestive tract, it is often assumed to be safe. It has the advantage over various other plant products, which show antioxidant activity because of its easy availability and cost effectiveness. Since artifact, man has utilized plants to treat basic infectious syndromes and a portion of these customary prescriptions are as yet included as a feature of the routine treatment of different diseases. Worry over pathogenic and deterioration microorganisms in foods is expanding because of the expansion in the occurrence of sustenance borne syndrome. At present, there is a developing enthusiasm to utilize common enemy of bacterial mixes, similar to fundamental oils and concentrates of different types of consumable and restorative plants, herbs, and flavors, which has for long been utilized as regular specialists for sustenance conservation in food and drinks because of the incidence of antimicrobial mixes [3].

Ajwain is grown in arid or partially arid regions where concentration of salts is very high. Ajwain due to its typical odor and sharp tastes is employed in curries as a flavor. Its seed are utilized as flavoring agents in foods as preservatives, for the manufacture of vital oil in perfume industry, in medicine and [4-6]. The seeds of Ajwain have 2-4.4% sunburned colored oil called as Ajwain oil whose essential constituent is thymol. It is used in healing of gastrointestinal diseases i.e. dysentery, diarrhea, lack of appetite and bronchial problems. Chewing a pinch of Ajwain seeds with common salt and clove can treat coughing caused by severe pharyngitis. Nasal blockage can be cured by smelling Ajwain tied in cloth or by keeping Ajwain in your pillow while sleeping. Ajwain seeds are also used as anti-inflammatory agent, liver refresher and for removing paralysis. Ajwain (*Trachyspermum ammi*) has been reported by traditional healers to have blood pressure lowering property [7].

Agroecology: In India, it is found in arid open disturbed lands, lowland plains and mount in the waterless areas. The plant of ajwain is deficiency tolerant. It is said that the herb is extensively grown in dry and semi-arid sectors where the soil occupy high quantity of salts [8]. Ajwain has a straight stem connecting glabrous or minutely pubertal properties, which may cultivate up to 90 cm elevated [9]. The herb is usually developed in October–November and ought to be yield in May–June [10, 11]. Typically, grimy brown seeds or fruits of Ajwain are well thought-out for therapeutic and dietetic purposes. [12]

1.1. Taxonomy, Distribution and Morphology

Kingdom:	<i>Plantae</i> , Plant
Subkingdom:	<i>Tracheobionta</i> , Vascular plants
Superdivision:	<i>Spermatophyta</i> , Seed plants
Division:	<i>Magnoliophyta</i> , Flowering plants
Class:	<i>Magnoliopsida</i> , Dicotyledon
Order:	Apiales
Family:	Apiaceae
Genus:	<i>Trachyspermum</i>
Species:	<i>Ammi</i>

1.2. Essential Oil Content

Ajwain is well known for its brownish vital oil. Actually, occurrence of Ajwain crucial oil is conscientious for its aroma and flavor. Hence, fruits of Ajwain mount up to 5% vital oil in its cubicles [13]. Plants are recognized as bioreactors and are reasonably safe for manufacture of antimicrobial means. Vital oil compositions from individual herbs are identified as suitable agents for antimicrobial characteristics. The value of oil is dependent on the climatic situation in which the plants are cultured. [14, 15]

In the essential oil of Ajwain (E. O. A), the principle active constituents are phenols, mainly thymol (35 - 60%), which majorly contributes to its curative properties [16] In any case, it has additionally been apparent that - when basic oils are improperly utilized, they can offer ascent to unfavorable impacts to human, for example, skin disturbance, cerebral pain and queasiness, if basic oils are to be taken inside or utilized on nourishment wares in view of the conceivable disease causing impacts of some of them [17].

Essential oil extracted from Ajwain especially thymol helps in relieving cholera. Ajwain seeds are also effective in treating aphrodisiac and premature ejaculation. Among external relieves, Ajwain is effective in treating asthma, delirium, colic earache and rheumatism. One precautionary measure for Ajwain oil is that it should not be used by pregnant women without dilution due to its high thymol content [18]. Ajwain seeds are mostly used for curing digestion problems whereas Ajwain leaves are not commonly used at homes. A few investigations have been performed on the examination of *Trachyspermum ammi* basic oil. A few examinations announced that thymol, g-terpinene, and r-cymene were significant constituents of particular seed samples, [19-22] though others detailed carvacrol as primary segment also. [23-25] Similar to some past examinations, in the present work, r-cymene (33.73%), g-terpinene (48.07%), and thymol (17.41%) were found as the primary constituents. [19]. Examinations have demonstrated that distinctions in the rate and kind of substance synthesis inside separated fundamental oil of *Trachyspermum ammi* may because of the area of development and topographical conditions and in addition accumulation time and the extraction procedure [26, 27].

1.3. Phytochemical Constituents of Ajwain

A number of chemical components have been accounted for the herb. moisture (8.9%), tannins, Fiber (11.9%), fat (21.1%), fat (21.1%), carbohydrates (24.6%), glycosides, protein (17.1%), saponins, flavones and other components (7.1%) involving thiamine, calcium, iodine, manganese, phosphorous, iron, cobalt, copper, riboflavin and nicotinic acid are of reported phytochemical components of Ajwain [28-30].

2. Therapeutic Effects

2.1. Insecticidal

Some compounds extorted from plants have insecticidal

action. Plant derived metabolites play a significant function in the plant-insect connections. Essential oil extracted from the seeds of ajwain reveals insecticidal activity in opposition to *Callosobruchus chinensis* in the ova-position step in addition to egg originate and developmental inhibitory actions [31, 32].

2.2. Antibacterial

To assay the antibacterial value of Ajwain, acetone and aqueous extracts were experienced against *Klebsiella pneumonia*, *Salmonella typhi*, *Pseudomonas aeruginosa*, *Enterococcus faecalis*, *Escherichia coli*, *Salmonella typhi-murium*, *Shigella flexneri*, and *Staphylococcus aureus* using agar diffusion assay [33]. The study demonstrated that acetone extract shows more action contrast to the aqueous extract. In an additional study, ethanolic extract of Ajwain showed antibacterial activity against eight strains of *Helicobacter pylori* [34].

2.3. Antifungal

The necessary oil of fruits of *Tchyspermum ammi* exhibited fungitoxicity against *Epidermophyton floccosum*, *Microsporium canis* and *Trichophyton mentagrophytes* persist at 900 ppm concentration. The fungitoxicity of the oil was not exaggerated by temperature action up to 150°C, autoclaving and storeroom up to 240 days. On chemical examination, thymol was secluded as fungitoxic feature and it shows toxicity aligned with the test fungi at 1000 ppm concentration [35].

2.4. Antioxidant

The antioxidant and ameliorative property of Ajwain extract has been evaluated on hexachloro cyclohexane temp oxidative stress and toxicity in an *in vivo* investigation. Accordingly, results revealed that the dietary Ajwain extract would reduce the toxicity resulted from hepatic free radical stress [36].

2.5. Nematicidal

Pine Wilt syndrome is due to the Pinewood Nematode (PWN), *Bursaphelenchus xylophilus*. Nematicidal action of ajwain oil ingredients (myrcene, camphene, thymol, limonene, terpinen-4-ol, terpinene, pinene and carvacrol) are not in favor of PWN. Hydroxyl and Amino groups have been assumed as goal position of methyl isothiocyanate in nematodes. Several fundamental oils have been expressed to upset with the neuromodulator octopamine or GABA gated chloride channels of creepy crawly bugs. Carvacrol and Thymol are exceptionally productive against PWN. These investigations authenticate that the nematicidal action of ajwain oil is predominantly credited to the action of thymol and carvacrol [37, 38].

3. Current Pharmacological Findings

3.1. Anti-Inflammatory Effect

Ajwain was also evaluated for exhibiting anti-

inflammatory effect. Accordingly, both total alcoholic extract and total aqueous extract possess *in vivo* significant anti-inflammatory effect [39].

3.2. Antiflarial and Anthelmintic Activity

Antiflarial activity evaluation of the Ajwain methanolic extract was made as an *in vitro* assay against adult bovine flarial *Setariadigitata* worms. In the examination, a bioassay-guided fractionation was equipped by initiated the simple concentrate to streak chromatography. HPLC investigation was improved the situation both rough concentrate and Active portion [40]. Active portion and also crude extract exhibited a noteworthy movement against grown-up *S. digitata* by both MTT [3-(4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide] and worm motility reduction examine. H-NMR, IR and MS analysis, structurally characterized the inaccessible active principle, which was recognized as a phenolic monoterpene. The compound was then evaluated for *in vivo* antiflarial action not in favor of the human flarial maggot *Brugiamalayi*. Consequences exposed *in vivo* macroflaricidal action and feminine worm infertility against *B. malayi* [40]. The anthelmintic action of Ajwain was endorsed out by considering the *Haemonchus contortus* in sheep and *Ascaris lumbricoides* in people. Results were a result of the loss of vitality capital by intruding with the vitality digestion of vermins through potentiating the ATPase movement. Ajwain has additionally been accounted to uncover cholinergic movement with peristaltic exercises of the gut. Consequently, this reality may help in rejection of intestinal parasites and be a causative factor to its anthelmintic action [41].

3.3. Hypotensive

T. ammi seed was ground into a coarse powder and extracted at room temperature for three days in 70% aqueous methanol; (yield about 13% based on dry seed). The test substances injected included *T. ammi* at doses of 100.0, 30.0, 10.0 and 3.0 mg/kg and acetylcholine. The *T. ammi* extract administered *Intra veins* were found to cause a portion dependent hypertensive outcome extending from about 6% decrease in mean blood vessel pulse (BP) at a portion of 3.0 mg/kg to about 42% decrease in mean blood vessel BP at a dose of 100.0 mg/kg. Acetylcholine additionally caused a hypotensive impact at 1 µg/kg equal in level to the impact of *T. ammi* remove at 30.0 mg/kg. [42].

3.4. Analgesic and Neural Effects

C. copticum has been used in usual medicine for alleviating rheumatic, joint, headache, and neuralgic pain. Dashti-Rahmatabadi et al. demonstrated that analgesic effect of ethanolic extract of *C. copticum* is comparable with morphine and this effect is suggested to be because of its parasympathomimetic through downward pain modulating trails [43]. Analgesic effect of *C. copticum* essential oil in formalin test was also assessed and pain scores were recorded

during one hour (every 5 minutes). Results showed that essential oil affected the late phase of pain by formalin compared to morphine. The mechanism of this effect of the plant was not due to opioid receptors because it was not reversed by naloxone [44]. Study of Ghannadi *et al.* on morphine withdrawal syndrome in mice showed that *C. copticum* leads to suppression of morphine withdrawal. It was suggested that this effect was modulated via potentiation of GABA neurotransmission and suppression of glutamate receptors and nitric oxide pathway [45].

3.5. Hepatoprotective

Along with the potent antioxidant activity, the Ajwain methanolic extract revealed to exhibit *in vivo* hepatoprotective activity with 80% defense against an in general deadly dose of paracetamol in pests. The extract also observed preventive effects against CCl₄-induced prolongation of pentobarbital sleeping time as well as equilibrating the level of Alkaline Phosphatase (ALP), Aminotransferases (AST and ALT) hepatic enzymes, and during liver damage [46].

3.6. Antitussive and Bronchodilatory

Antitussive consequence of Ajwain has been accounted in conventional medical manuscripts. Incidentally, in a study the declared clinical effect of aerosols linked to two dissimilar concentrations of aqueous and macerated extracts of Ajwain seeds as well as saline, Carvacrol and codeine were estimated by counting the number of coughs formed. According to the results, both concentrations of Ajwain seeds exposed major reduction of cough number, which may be a result of its powerful antitussive consequence [47]. Relative investigations demonstrated the inhibitory impact of both Ajwain concentrate and basic oil on Histamine (H1) receptors of isolated guinea-pig tracheal chains. In an additional study, in the field of respiratory, bronchodilatory possessions of dissimilar portions of Ajwain necessary were inspected. Consequences demonstrated that the relaxant and bronchodilatory consequence of essential oil fractions may be because of the quantity of Carvacrol [48]. The bronchodilatory impact of the decocted concentrate of Ajwain on the asthmatic patients' airways was inspected in an ensuing examination ponders. According to the outcomes, the concentrate has a reasonably bronchodilatory impact on asthmatic airways assessed to the impact of Theophylline at fixations utilized.

4. Conclusion

The phytochemicals resulting from medicinal plants serve as valuable sources for isolating and characterizing the lead molecules with specific functions. This approach assist in identifying the compounds that shows bioactivity. It has been suggested that the compounds that possess antioxidant activity, can inhibit the occurrence of diseases because they can scavenge the free radicals or induced antioxidant

enzymes. Due to the phyto anti-mutagens present in these plants their seed extracts show inhibition to formation of free radicals.

With orientation to the stated pharmacological behaviors, Ajwain seeds can be utilized for clinical functions. On the other hand, in spite of a variety of experimental and animal studies, deficiency of broad clinical trials meant on regarded effects silent remains to reconfirm the customary information.

References

- [1] Singh, V. K.; Govil, J. N.; Singh, G. *Recent Prog. Med. Plants* 2002, 1, 187.
- [2] Davidson A, Jaine T. *The Oxford Companion to Food*. USA: Oxford University Press; 2006.
- [3] Nychas, G. J. E., Tassou, C. C., & Skandamis, P. (2003). Antimicrobials from herbs and spices. In S. m. Roller (Ed.), *Natural antimicrobials for the minimal processing of foods* (pp. 176e200). New York: Woodhead Publishers/CRC Press.
- [4] Kunwar, R. M., *et al.*, *Indigenous use and ethnopharmacology of medicinal plants in far-west Nepal*. Ethnobotany research and applications, 2009. 7: p. 005-028.
- [5] Ashraf, M., Salt tolerance of cotton: some new advances. *Critical Reviews in Plant Sciences*, 2002. 21 (1): p. 1-30.
- [6] Munns, R., Comparative physiology of salt and water stress. *Plant, Cell and Environment*, 2002. 25 (2): p. 239-250.
- [7] Chahal, K., *et al.*, *Chemical composition of Trachyspermum ammi L. and its biological properties: A review*. *Journal of Pharmacognosy and Phytochemistry*, 2017. 6 (3): p. 131-140.
- [8] Joshi S. *Medicinal plants*. 1st ed. Delhi: Oxford and IBH Publisher; 2000.
- [9] Dinda, B., *Occurrence and Distribution of Iridoids, in Pharmacology and Applications of Naturally Occurring Iridoids*. 2019, Springer. p. 17-82.
- [10] Chauhan B, Kumar G, Ali M. A Review on phytochemical constituents and activities of *Trachyspermum ammi* (L.) sprague fruits. *AJPTR*. 2012; 2 (4): 329-40.
- [11] Basu, S., *et al.*, *Polysaccharides from Dolichos biflorus Linn and Trachyspermum ammi Linn seeds: isolation, characterization and remarkable antimicrobial activity*. *Chemistry Central Journal*, 2017. 11 (1): p. 1-10.
- [12] Meena, M., *et al.*, *Stability analysis for seed yield and yield component traits in ajwain (Trachyspermum ammi L.)*. *Electronic Journal of Plant Breeding*, 2019. 10 (3): p. 1194-1199.
- [13] Miniya J, Thoppil JE. Essential oil composition of *trachyspermum ammi* (L.) sprague from South India. *Indian J Pharmaceut Sci*. 2002; 64 (3): 250-51.
- [14] Zomorodian K, Moein M, Rahimi MJ, Pakshir K, Ghasemi Y, Sharbatfar S. Possible application and chemical compositions of *Carum copticum* essential oils against food borne and nosocomial pathogens. *Middle East J Sci Res*. 2011; 9: 239-245.

- [15] Asangi, H., et al., *Genetic Variation in Essential Oil Constituents of Ajwain (Trachyspermum ammi L. Sprague) Varieties at Varying Nitrogen Levels under Semiarid Tropics of Northern Karnataka, India*. Journal of Essential Oil Bearing Plants, 2020. 23 (6): p. 1324-1333.
- [16] Tsimidou M, Boskou D. Antioxidant activity of essential oils from the plants of the Lamiaceae family. Charalambous G, editor. Species, Herbs and Edible Fungi. Amsterdam: Elsevier; 1994. p. 273-8.
- [17] Aromacaring. (2004). Using essential oils with vulnerable people. Aromacaring Publications. http://www.aromacaring.co.uk/essential_oils_with_vulnerable_p.htm.
- [18] Bairwa, R., Sodha, R., and Rajawat, B. *Trachyspermum ammi*. Pharmacognosy Reviews, 2012. 6 (11): p. 56.
- [19] Sahaf BZ, Moharramipour S, Meshkatsadat MH. Chemical constituents and fumigant toxicity of essential oil from *Carum copticum* against two stored product beetles. *InsectScience*. 2007; 14: 213-218.
- [20] Rasooli I, Fakoor MH, Yadegarinia D, Gachkar L, Allameh A, Rezaei MB. Antimycotoxigenic characteristics of *Rosmarinus officinalis* and *Trachyspermum copticum* L. essential oils. *Int J Food Microbiol*. 2008; 122: 135-139.
- [21] Khajeh M, Yamini Y, Sefidkon F, Bahramifar N. Comparison of essential oil composition of *Carum copticum* obtained by supercritical carbon dioxide extraction and hydrodistillation methods. *Food Chem*. 2004; 86: 587-591.
- [22] Srivastava M, Baby P, Saxena A. GC-MS investigation and antimicrobial activity of the essential oil of *Carum copticum* Benth & Hook. *Acta Alimentaria*. 1999; 28: 291-295.
- [23] Mohagheghzadeh A, Faridi P, Ghasemi Y. *Carum copticum* Benth & Hook, essential oil chemotypes. *Food Chem*. 2007; 100: 1217-1219.
- [24] Shojaaddini M, Moharramipour S, Sahaf BZ. Fumigant toxicity of essential oil from *Carum copticum* against Indian meal moth, *Plodia interpunctella*. *J Plant Protect Res*. 2008; 48: 411-419.
- [25] Zarshenas MM, Samani SM, Petramfar P, Moein M. Analysis of the essential oil components from different *Carum copticum* L. Samples from Iran. *Pharmacognosy Res*. 2014; 6: 62-66.
- [26] Mahboubi, M. and N. Kazempour, Chemical composition and antimicrobial activity of *Satureja hortensis* and *Trachyspermum copticum* essential oil. *Iranian journal of microbiology*, 2011. 3 (4): p. 194.
- [27] Ranjan B, Manmohan S, Singh SR, Singh RB. Medicinal uses of *Trachyspermum ammi*: a review. *Pharmacogn Rev*. 2012; 6 (11): 56-60.
- [28] Qureshi AA, Kumar KE. Phytochemical constituents and pharmacological activities of *Trachyspermum ammi*. *Plant Archives*. 2010; 10 (2): 955-59.
- [29] Duke, J. A., *Duke's handbook of medicinal plants of Latin America*. 2008: CRC press.
- [30] Chaubey MK. Fumigant toxicity of essential oils from some common spices against pulse beetle, *Callosobruchus chinensis* (Coleoptera: Bruchidae). *Journal of Oleo Science*. 2008; 57 (3): 171-179.
- [31] Kostyukovsky M, Rafaeli A, Gileadi C, Demchenko N, Shaaya E. Activation of octopaminergic receptors by essential oil constituents isolated from aromatic plants: Possible mode of action against insect pests. *Pest Management Science*. 2002; 58 (11): 1101-1106.
- [32] Kaur GJ, Arora DS. In vitro antibacterial activity of three plants belonging to the family Umbelliferae. *Int J Antimicrob Agents*. 2008; 31 (4): 393-95. [Epub 2008 Jan 10].
- [33] Zaidi SF, Yamada K, Kadowaki M, Usmanghani K, Sugiyama T. Bactericidal activity of medicinal plants, employed for the treatment of gastrointestinal ailments, against *Helicobacter pylori*. *J Ethnopharmacol*. 2009; 121 (2): 286-91. [Epub 2008 Nov 8].
- [34] Nahak, G., R. Mishra, and R. Sahu, *Taxonomic distribution, medicinal properties and drug development potentiality of Ocimum (Tulsi)*. *Drug Invention Today*, 2011. 3 (6).
- [35] Anilakumar KR, Saritha V, Khanum F, Bawa AS. Ameliorative effect of Ajwain extract on hexachl-oro-cyclohexane-induced lipid peroxidation in rat liver. *Food Chem Toxicol*. 2009; 47 (2): 279-82. doi: 10.1016/j.fct.2008.09.061.
- [36] Kong, J. O., S. M. Lee, Y. S. Moon, S. G. Lee and Y. J. Ahn, 2006. Nematicidal activity of plant essential oils against *Bursaphelenchus xylophilus* (Nematoda: Aphelenchoididae). *J. Asia-Pac. Entomol.*, 9: 173-178.
- [37] Park, I. K., J. Kim, S. G. Lee and S. C. Shin, 2007. Nematicidal activity of plant essential oils and components from ajowan (*Trachyspermum ammi*), allspice (*Pimenta dioica*) and litsea (*Litsea cubeba*) essential oils against pine wood nematode (*Bursaphelenchus xylophilus*). *J. Nematol.*, 39: 275-279.
- [38] Srivastava KC. Extract of a spice—omum (*Trachyspermum ammi*) shows antiaggregatory effects and alters arachidonic acid metabolism in human platelets. *Prostaglandins Leukot Essent Fatty Acids*. 1988; 33 (1): 1-6].
- [39] Mathew N, Misra-Bhattacharya S, Perumal V, Muthuswamy K. Antifilarial lead molecules isolated from *Trachyspermum ammi*. *Molecules*. 2008; 13 (9): 2156-68.
- [40] Tamura T, Iwamoto H. Thymol: a classical small-molecule compound that has a dual effect (potentiating and inhibitory) on myosin. *Biochem Biophys Res Commun*. 2004; 318 (3): 786-91] [Jabbar A, Khan M, Iqbal Z. In vitro anthelmintic activity of *Trachyspermum ammi* seeds. *Phcog Mag*. 2006; 2 (6): 126-29.
- [41] Heidari, E. F., et al., *Genetic structure and diversity of ajowan (Trachyspermum ammi) populations based on molecular, morphological markers, and volatile oil content*. *Industrial Crops and Products*, 2016. 92: p. 186-196.
- [42] Dashti-Rahmatabadi MH, Hejazian SH, Morshedi A, Rafati A. The analgesic effect of *Carum copticum* extract and morphine on phasic pain in mice. *Journal of Ethnopharmacology*. 2007; 109 (2): 226-228].
- [43] Hejazian SH. Analgesic effect of essential oil (EO) from *Carum copticum* in mice. *World Journal of Medical Science*. 2006; 1: 95-99].

- [44] Ghannadi A, Hajhashemi V, Abrishami R. Effects of the persian Carumcopticum fruit extracts on morphine withdrawal syndrome in mice. *Research in Pharmaceutical Sciences*. 2012; 7 (3): 127–131].
- [45] Gilani AH, Jabeen Q, Ghayur MN, Janbaz KH, Akhtar MS. Studies on the antihypertensive, antispasmodic, bronchodilator and hepatoprotective activities of the Carumcopticum seed extract. *J Ethnopharmacol*. 2005; 98 (1–2): 127–35].
- [46] Saraswat, N., N. Sachan, and P. Chandra, *A review on ethnobotanical, phytochemical, pharmacological and traditional aspects of indigenous Indian herb Trachyspermum ammi (L)*. *Current Traditional Medicine*, 2020. 6 (3): p. 172-187.
- [47] Boskabady MH, Ramazani M, Tabei T. Relaxant effects of different fractions of essential oil from Carumcopticum on guinea pig tracheal chains. *Phytother Res*. 2003; 17 (10): 1145–49].
- [48] Sabar AG. Lithotripsy of different urinary tract stones by using seeds of Carumcopticum. *Iraqi Journal of Pharmaceutical Sciences*. 2010; 19 (2): 38–41.