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# Ethano-botanical, Phytochemical, and Pharmacological Scence of *Trachyspermum ammi* (Ajwain): A Systematic Review

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## Abstract
The aim of this present work was to systematic review on Trachyspermum ammi L. (ajwain) coming from the family Apiaceae and it is widespread medicinally lively, aromatic plant. The plant ajwain is extensively spread in the course of the area. The seeds of ajwain include approximate three-5% brownish crucial oil and this species additionally incorporate thymol as the principle chemical constituent at the side of a few different important constituent like β-pinene, α-terpinene, α-pinene, p-cymene, γ-terpinene and many others. Imputable to presence of various kinds of chemical ingredients in ajwain it possesses numerous pharmacological and biological properties have been described. based on conventional information diverse natural medicinal drug used for various health ailments on human beings so that you can have growing the interest via many researchers to work on ajwain and find out its therapeutic and organic properties. Thinking about this present look at is a try to pick up all of the facts considering ethno botanical, their chemical composition and Pharmacognostical take a look at homes of Trachyspermum ammi.

**Keywords**
*Trachyspermum ammi,* Chemical composition, GC-MS, pharmacological properties.

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## INTRODUCTION:
Because of the relatively call for of herbal compounds as origin of drugs, the used of artificial remedy notably decreased due to the undesirable or undesirable side results. For that reason, the researchers have gained hobby on natural product because flowers are considered as economically safe and bioreactors. Based totally on traditional expertise, it has been said that various medicinal vegetation was used for the control of human illness. There are legion references of medicinal plant in pharmaceutical and medical holographs of traditional based totally medication [1, 2] by using considering the active additives of the plant, diverse herbal drugs being prepared. Many researchers have been mentioned that one of the most usually used components for herbal formulations was medicinal oil or crucial oil.

Trachyspermum ammi L (ajwain) is most generally recognized vintage herb from the own family Apiaceae. It's far extraordinarily precious medicinally active spice. The herb ajwain is a conventional lively

and it is used for healing diverse illnesses in humans. Ajwain or ammi oil is used on neurological disorders including tremor, paralysis and continual pains. The extract of T. ammi (ajwain) has been previously used for the treatment of ophthalmic infections. The Seeds of the plant has been very powerful in opposition to gastrointestinal diseases. The ajwain become also covered as diuretic and aphrodisiac agent. The main constituent of ajwain oil is thymol. That is received from the seed of the plant. This oil displaying extensive houses like antifungal [3], antiviral and antibacterial [4] , antitussive[5] analgesic[6] antioxidant . It is also a considerable remedial element for diarrhea, flatulence, and atonic dyspepsia.

**SYNONYMS, SCIENTIFIC CLASSIFICATION AND MORPHOLOGY OF *TRACHYSPERMUM AMMI***

**1. VERNACULAR NAMES:** [7]

Assamese: *Jain*
Hindi: *Ajwain, Jevain*
English: *Bishop's weed*
Tamil: *Omam*
Kannada: *Oma, Yom, Omu*
Telugu: *Vamu*
Bengali: *Yamani, Yauvan, Yavan, Javan, Yavani, Yoyana*
Sanskrit: *Yamini, Yaminiki, Yaviniki*
Malayalam: *Oman, Ayanodakan*
Gujrati: *Ajma, Ajmo, Yavan, Javain*

**2. SCIENTIFIC CLASSIFICATION** [8]

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

FIGURE 1: AJWAIN FLOWER

FIGURE 2: LEAVES OF AJWAIN

FIGURE 3: FRUITS OF AJWAIN

**ECOLOGY AND BOTANICAL DESCRIPTION:**

Ajwain is extensively grown in desiccate and semi-desiccate areas. [9] The plant is advanced within the area in which the soils comprise eminent tiers of salts. [10, 11] probably in Egypt. This plant additionally cultivated in Afghanistan, Pakistan Iraq, Iran, Greeks, and India [12]. In India, the plant ajwain is advanced within the states of Uttar Pradesh, Rajasthan, Punjab, Gujarat, Madhya Pradesh, Tamil Nadu, Bihar and Andhra Pradesh and so on. Ajwain develops well on dirt soil at a pH variety 6.5-eight.2 at temperature of between 10 -25 ºC and RH (relative humidity) between 65-70%. Commonly the harvesting of this plant is accomplished during earlier in spring and later in wintry weather. The plant ajwain is an abundantly branched fragrant annual herb and approximately almost 60-ninety cm in peak. The Stem is blossoming compound containing sixteen umbellets and striates every umbellets retaining up to sixteen floras. The flora is white actinomorphic. It

contains 5corolla, 5 stamens petals and bilobed. Also, the fruit of the plant are aromatic, cordate, and ovoid (FIGURE1). Leaves are pinnate on terminal and contain 7nos of pairs of lateral leaflets (FIGURE 2). [13] Fruit is grayish brown in color, ovoid and compressed and it includes 2nos of mericarps (FIGURE3).

**MICROSCOPIC CHARACTERS:**

The microscopic evaluation of the transverse part of the ajwain fruit indicates the presence of two carpophores. They may be hexagonal in systems and relate to every different. The epicarps of the end result includes a unmarried layer of tangentially extended tabular cells and the mesocarp includes averagely square to polygonal tangentially prolonged tabular cells bearing about carpophores, vittae and vascular bundles reveal as a groups of thick walled significantly extended cells. The endosperm of the result bearing skinny surrounded cells, which might be packed with oil globules, embryo, round and small polygonal cells. [14].

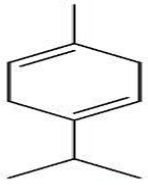
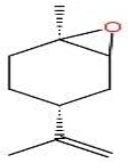
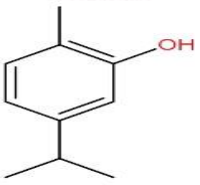
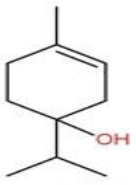
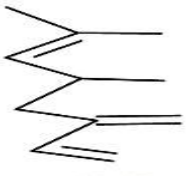
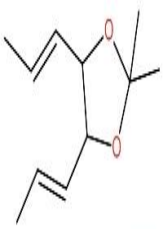
**PHARMACOGNOSTIC PROFILE:**

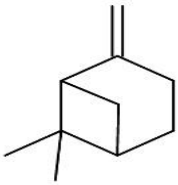
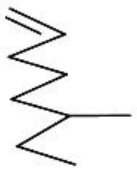
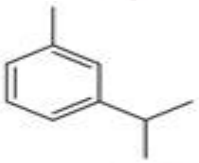
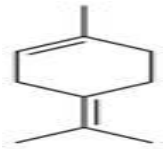
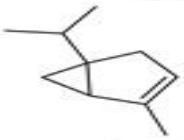
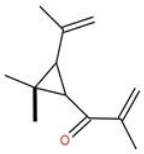
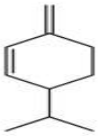
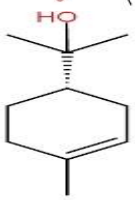
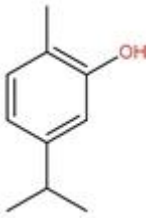
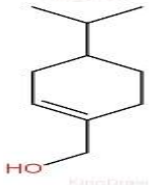
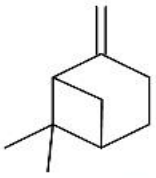
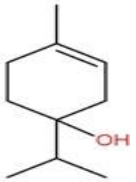
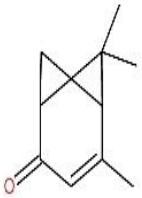
A Pharmacognostical assessment of any herb serves as identification marks over and above it additionally assists in the standardization of drug concerning their purity and first-rate. It demonstration in detail about organoleptic and physicochemical residences of the crude drug Hardel Danendra kumar et al [15] described in an element about Organoleptic and Physicochemical homes of the drug Trachyspermum ammi L (ajwain) given in TABLE.1.

**TABLE 1: Organoleptic and Physicochemical Characteristics of Ajwain Powder**

| APPEARANCE | POWDER |
|---|---|
| Colour | Light brown |
| Taste | Pleasant |
| Odour | Characteristic |
| Foreign matter (% w/w) | 2.4 |
| Loss on drying (LOD) (%w/w) | 4.7 |
| pH of 1% w/v solution | 3.23 |
| pH of 10% w/v solution | 3.35 |
| Total ash (%) | 8.6 |
| Acid-insoluble ash (%) | 0.49 |
| Water-soluble extractive | 42 |
| Alcohol-soluble extractive | 17.9 |

**TABLE 2: Chemical Constituent and Their Structure Obtained From *Trachyspermum Ammi* Fruits:**

| No | Chemical constituent | Structure | No | Chemical constituent | Structure |
|---|---|---|---|---|---|
| 1. | γ-Terpinene 4-methyl-1-isopropyl- 1.4-Cyclo hexadiene |  | | Limonene-1.2-oxperoxide |  |
| 3. | Thymol 2-isopropyl-5-Methyl phenol |  | | 4-Terpinenol 4-methyl-1- isopropyl-3-cyclohexen-1-ol |  |
| 5. | β-Myrcene 7-methyl-3- methylene -1.6 octadiene |  | | 2.2-dimethyl-4.5- bis-1-propene- 1.3-Dioxalane |  |

| | | | | |
|---|---|---|---|---|
| 7. | β-Pinene 6.6dimethyl-2-methylenbicycle [ 3.1.1] heptane |  | 6-methyl octene-1 |  |
| 9. S | m-Cymene 1-methyl-3-isopropyl benzen |  | Terpinolene 1-methyl-4-(1-methyleth ylidene)-cyclohexene1 |  |
| 11. | α-Thujen 2-methyl-5-isopropyl bicycle [ 3.1.0] hex-2-ene |  | 1-(3-isopropy liden-2.2- dimethyl cyclopropyl)-isopropanon-1 |  |
| 13. | β-Phellandrene 4-methylen-1-isopropyl-2-cyclohexen |  | α-Terpinol 1-*p* menten-8-ol |  |
| 15. | Carvacrol 2-methyl-5-isopropyl phenol |  | 1-hydroxymethil-4-isopropyl-1.4-cyclohexadiene |  |
| 17. | α-Pinene 2.6.6-trimethyl bicyclo [3.1.1] hept-2-en |  | Piperitole 4-methyl-1-isopropyl-3-cyclohexen-2-ol |  |
| 19. | 4-Carene 4.7.7-Trimethyl bicyclo [4.1.0] hept-3-en |  | 4.6.6 trimethyl bicyclo [3.1.1]- hept-3-ene-2-one |  |

**QUALITATIVE PHYTOCHEMISTRY:**

The qualitative investigation of the *Trachyspermum ammi,* powder shows the presence of various secondary metabolites such as carbohydrates, glycosides, fixed Oils and Steroids. The ethanolic extract of the ajwain seeds indicate the presence of Tannins and reducing sugar along with the ether and petroleum extract demonstrate the presence of proteins, alkaloid, Sterols, amino acids. Katasani D, Srinu B *et al* [16] described in detail about phytochemical properties of the ajwain seed.

**PHYTOCHEMICAL CHARACTERISTICS:**

The various phytochemical constituent obtained from the ajwain is decided by using numerous parameters including nature of soil, climatic situations like temperature, pressure, humidity, and extraction time additionally indicates massive effect on the overall % yield and chemical composition of ajwain oil.

From the GC–MS research of the vital oil o culmination of T. ammi are verified in TABLE 2. It disclosed that the presence of just about twenty

compounds. The important oil of the ajwain accommodates 2 aromatic terpenes along with thymol and carvacrol. The aromatic terpenes of the oil constituted about 37.38% of thymol. However, the most important elements are acyclic monoterpene, monocyclic monoterpenes and bicyclic terpenes. The cell of acyclic monoterpene β-Myrecene. Monocyclic monoterpenes are m-Cymene (21.44 %), γ-Terpinene (26.01%), 4-Terpinenol (0.81%) and β-Phellandrene (1.60%) [17] (TABLE 2). And the bicyclic terpenes are α-Pinene and β-Pinene, four-Caren, β-Pinene and α-Thujen. similarly, the crucial oil of the ajwain fruits additionally contained a few non-terpenoid kind of components that are 1-(3-isopropyliden-2.2-dimethylcyclopropyl)-isopropanon; 14.6.6-trimethyl-bicyclo[three.1.1]-hept-three-ene-2- one; 6-methyl-octene-1; 2.2-dimethyl-four.5- bis-1-propene-1. three-Dioxalane . Also, many of the researchers have looked its many active phytoconstituent obtaining from the seed and leaves of the plant *T. ammi* (ajwain). They are demonstrated in TABLE 3.

TABLE 3: Phytochemicals Present in The Seed, Fruits and Leaves Of The *T. Ammi:*

| No | Sources | Phytoconstituent | Acknowledgement |
|---|---|---|---|
| 1 | Seed | Phyto screening of alcoholic the extract also indicates the presence of carbohydrates, glycosides, saponins, flavones, Fiber, moisture, fat, protein, mineral remember, phosphorous, calcium, nicotinic acid and iron and so forth. | Pruthi [18] |
| 2 | Fruits | The crucial oil acquired from the ajwain fruits include especially thymol as the foremost detail and the nonthymol element contains α- and β-pinenes, paracymene, α-terpinene, and γ-terpenine, dipentene, carvacrol19 | Ishikawah[19] Chopra RN [20] |
| | | The fruits additionally incorporate steroid and flavone like content and also incorporate oleoresin, risky oil consisting of γ-terpinene, thymol, α- and β-pinene and glucopyranosyloxythymol20 | Nagalakshmi S [21] |
| 3 | Leaves | The vital oil extracted from the leaves of ajwain was also determined to be complied with terpene group like monoterpenoids, diterpine and sesquiterpenoids and many others. | Farooq [22] |

**GEOGRAPHICAL CLIMATIC AND THEIR RELATIONSHIP WITH CHEMICAL CONSTITUENT OF AJWAIN:**

The numerous chemical constituents of ajwain is stricken by exclusive geographical climatic circumstance. From the various investigations it became stated by using many scientists. The outcomes of the various findings disclosed the presence of thymol, β-pinene, o-cymene γ-terpinene, p-cymen and γ-terpinolene as a major factor. But, the ajwain gathered from the Pakistan suggests the presence of p-cymene-three-ol as a primary issue and additionally display the presence of α-pinene, carvacrol and β-myrcene as a minor constituents. [23,24,25,26] further the vital oil from the ajwain seed collected from Iran (Sabzevar) establishes the presence of various chemical constituent as compared to other studies research. almost approximately 50 predominant compounds comprising ninety-five.5 % of the full essential oil had been authenticated [27]. One research scientists from the Egypt additionally has reported the presence of non-terpenoids as a wealthy supply and and the δ-cadinene (3.5 %) ,hexadecanoic acid (27.5 %), germacrene D (4.3 %), isobutyl phthalate (5.8 %), α-cadinol (4.7 %), ethyl linoleate (8.5 %), and 6-methyl-α-ionone (8.0 %), as a constituent from the ajwain seed amassed from Egypt [28] . The crucial oil received from the ajwain seed accrued from the India also encompass monoterpenes group including β-selinene, β-phellandrene, cymene, α-pinene, β-pinene, γ-terpinene, terpinolene, myrcene, α-thujene.

**PHARMACOLOGICAL PROPERTIES:**

Primarily based at the conventional know-how there are numerous healing makes use of of ajwain (Trachyspermum ammi ) culmination which include: antimicrobial, galactogogue, antiseptic, stomachic, expectorant, carminative ,weight reduction, antipyretic , amoebiasis, diarrhoea, amenhorroea , colic ache , Parasiticidal, Bronchitis, anthelmintic, carminative, laxative, piles and abdominal pains, febrifugal . It extensively utilized for curing the belly tumors and many others. Which are described briefly inside the underneath followings.

1. **Antihypertensive, broncho-dilating and antispasmodic activity:**

To decide the antihypertensive effect T. ammi, one in vivo test become carried out wherein drug are administered intravenously. The effects of in vitro

installed that the calcium channel blocker intermediated the spasmolytic potency within the ajwain plant and by way of considering this mechanism introduced to their locating outcome and confirmed that the conventional healing use of T. ammi in infection of intestine, diarrhea and colic as well as in the remedy hypertension [29]

**2. Hepatoprotective and Anti-hyperlipidemic activity:**

The hepato protecting pastime of the methanolic extract of ajwain became said with the aid of the Gilani et al. [29] in that file it turned into showed that Trachyspermum ammi established in vivo hepatoprotective pastime in mice approximately 80 percent against a normally-LD of the paracetamol at a dose 1g/kg of body weight The methanolic extract of ajwain additionally indicates preventive results towards CCL4-accelerated continuation of drug pentobarbital sound asleep time , which confirming the hepatoprotective interest of the extract other than it also balancing the extent of Alkaline Phosphatase (hepatic enzymes) and Aminotransferases(hepatic enzymes) all through severe damaging circumstance of liver.

From the investigation finished via the researcher gilani et al. [29] it additionally confirmed the anti-hyperlipidemic efficacy of aqueous and methanol extracts of ajwain at a slow dose from 1 to five gram per kg rats. It disclosed that dose of extract at 3 g/kg and at 5 g/kg exposed the led to LDL and accelerated in HDL. The extract of ajwain tested the antihyperlipidemic assets.

**3. Antiplatelet-aggregatory activity:**

Antiplatelet-aggregatory attempts out in vitro in human volunteers and the document hooked up that the dried ethanolic extract of ajwain seeds, suppressed the accumulation of platelets decreased by using collagen, arachidonic acid and epinephrine. [30]

**4. Nephrolithiasis and diuretic activity:**

The nephrolithiasis and diuretic activity of Trachyspermum ammi changed into studied in vivo through suppressing the oxalate urolithiasis stimulated inside the albino rats. In further examine of ajwain extract it turned into also located that the diuretic effect of Trachyspermum ammi was not effective in urine production inside 24hr. From experimental evidence it was concluded that the traditional use of ajwain within the curative cause of nephrolithiasis became now not defended. [31]

**5. Abortifacient and galactogogic actions:**

Based totally on the survey carried at the conventional information it comes to recognise that the seed of Trachyspermum ammi (ajwain) was used within the reason of abortion in a few countries of India. Specifically in the metropolis Lucknow. In that fifty to 75 % of the pregnant girl who were accompanied exacted to have utilized ajwain seed for abortion. From the survey it as clean that the herb became not good and there was a opportunities higher hazard of human fetotoxicity. [32]

The NDRI (country wide Dairy research Institute in India) become also appeared into the estrogenic capability of the plant Trachyspermum ammi based totally on traditional information that is used to boom milk production in cows. Trachyspermum ammi also has been used traditionally as boom milk manufacturing e in humans. [33]

**6. Anti-ulcer activity:**

An experiment changed into taken to test aqueous extract of T. ammi to reveal the impact on gastric ulcers. In that test waster albino rats (woman) have been taken for this empirical look at via preparing 5groups of rats, where the drug omeprazole used as a general and ajwain plant extract as a test became administered at a progressively increasing doses twice an afternoon for two weeks and after of entirety of the time gastric ulcers become examined. From the commentary it changed into concluded that the aqueous extract of ajwain seed had a predicting effect to therapy gastric ulcers when equated with manipulate organization. [34]

**7. Anti-inflammatory activity:**

The hobby of anti- inflammatory of the aqueous extract and alcoholic extract of the ajwain seeds became reported by using Thangam C et al. In that document it changed into confirmed that the extract of ajwain tested sizable ($P<0.001$) anti -inflammatory belongings inside the animal models like rats. Within the conclusion of that test, it was stated that increasing inside the weights of the adrenal glands in extracted handled animals. Both the extract aqueous and alcoholic demonstrated the vital anti-inflammatory potency. [35]

**8. Antitussive effects:**

The antitussive pastime of various concentrations of macerated and aqueous extracts as a check drug and codeine and carvacrol as a popular drug were examined via thinking about the no of coughs raised. The outcomes established that an crucial decrease within the number of cough located inside the presence of ajwain extract of various concentrations. [36]

**9. Gastro protective Activity:**

The antiulcer property of the plant *T. ammi* fruit was studied by using dissimilar animal's models having ulcer the observation established the gastro protective or antiulcer activity. The animals models were first pre-treated with ajwain extract which depicted significant reduction in percentage the

entire animal models when it compared with control group and standard groups of animals. [37]

**10. Anthelmintic Activity:**

The anthelmintic activity of *Trachyspermum ammi* was investigated by some researcher and established that the plant ajwain shows the anthelmintic activity against some particular helminthes like *Haemonchus contortus* and *Ascaris lumbricoides* in humans and in sheep. *Trachyspermum ammi* exhibit anthelmintic activity maintain by disturbance with the parasites energy metabolism by synergism of ATPase action. The plant *Trachyspermum ammi* has also been exhibited cholinergic action with peristaltic motions of the gut, hence assisting in expulsion of enteral parasites which may also be a contributing component to its anthelmintic property. [38,39]

**DISCUSSION AND CONCLUSIONS:**

Trachyspermum ammi (Ajwain) is an essential widely known and used medicinal plant on account that historic instances , this specific plant have wide founded and hidden medicinal and dietary used. Formulating drugs from indigenous plants from conventional knowledge primarily based of drugs at gift turning into proper interest because of the secure, innocent and without difficulty available. From final decade to present various natural compounds of plant foundation that have ethno-botanical applications have getting to a good deal problem. Trachyspermum ammi (Ajwain) have various traditional applications like gastrointestinal illnesses, antihypertensive, broncho-dilating and antispasmodic hepato protective and anti-hyperlipidemia and plenty of different illnesses. This plant is fertile in carbohydrates, protein, vital oil, phosphorus, calcium, minerals, fiber, carotene iron, and numerous nutrients like thiamine, riboflavin, and niacin. Because of the presences of an expansion of essential issue it's far answerable for its numerous organic and healing properties.

This assessment is a try to furnish nicely accumulated clinical information of the Trachyspermum ammi.

**REFERENCES:**

1. Krishnaraju AV, Rao TV, Sundararaju D, Vanisree M, Tsay H-S and Subbaraju GV: Assessment of bioactivity of Indian medicinal plants using brine shrimp (Artemia salina) lethality assay. International Journal of Applied Sciences and Engineering 2005; 3(2): 125-34.
2. Emami M, Nazarinia MA, Rezaeizadeh H, Zarshenas MM. Standpoints of traditional Persian physicians on geriatric nutrition. J Evid Based Complementary Altern Med. 2014; 22: 281-291.
3. Natanzian Ghahfarkhi M, Sattari M, Yadegari MH, Goudarzi GR, Saharkhiz MJ. Antifungal activity of essential oil and alcoholic extract of Carumcopticumagainst fluconazole-resistant and susceptible Candida albicans isolated.Modares J Med Sci. 2008;11: 91-98.
4. Oskuee RK, Behravan J, Ramezani M. Chemical composition, antimicrobial activity and antiviral activity of essential oil of Carum copticum from Iran. Avicenna J Phytomed. 2011;1: 83-90.
5. Boskabady MH, Jandaghi P, Kiani S, Hasanzadeh L. Antitussive effect of Carum copticum in guinea pigs. J Ethnopharmacol. 2005; 97:79-82.
6. Dashti-Rahmatabadi MH, Hejazian SH, Morshedi A, Rafati A. The analgesic effect of Carum copticum extract and morphine on phasic pain in mice. J Ethnopharmacol. 2007;109: 226-228.
7. Anonymous. The Wealth of India. Publication and Information Directorate (CSIR), New Delhi. 1959, 266-268.
8. USDA- Natural Resources Conservation Service, Plant Profile: *Trachyspermum ammi L.* Sprague ex Turrill-Ajowan caraway. Available from: http://plants.usda.gov/java/profile?symbol=TRAM13
9. Zarshenas MM, Moein M, Samani SM, Petramfar P. An overview on Ajwain (Trachyspermum ammi) pharmacological effects: modern and traditional. J Natural Remedies. 2013;14: 98-105.
10. Ashraf M. Salt tolerance of cotton, some new advances. Crit Rev Plant Sci. 2002; 2:1–30.
11. Munns R. Comparative physiology of salt and water stress. Plant Cell Environ. 2002;25: 239–50.
12. Chatterjee S, Goswam N, Bhatnagar P. Estimation of phenolic components and *in vitro* antioxidant activity of fennel (*Foeniculum vulgare*) and ajwain (*Trachyspermum ammi*) seeds. Journal of Life Sciences. 2012; 3(2):109-118.
13. Anonymous. The Ayurvedic Pharmacopoeia of India, Government of India, Ministry of Health and Family Welfare; Department of Ayush; 01(01). p. 170-71.
14. Dwivedi SN, Mishra RP, Alava S. Phytochemistry, pharmacological studies and traditional benefits of *Trachyspermum ammi* L. Sprague. International Journal of Pharmaceutical and Life Sciences. 2012; 3(5):1705-1709
15. Hardel D, Sahoo L , Patel J. Pharmacognostic studies on *Trachyspermum ammi* linn. A powder analysis. IJRAP 2011; 2 (4): 1272-1277.
16. Katasani D, Srinu B, Bala R. Phytochemical screening, quantitative estimation of total Phenolic, flavanoids and antimicrobial evaluation of *Trachyspermum ammi.* Journal of Atoms and Molecules 2011; 1(1): 1-8
17. Ahmed M. H. Ali1, Emad M. Abdallah Adil A. H. Mujawah and Elena Yu. Avdeeva. Chemical Composition, Larvicidal and Antibacterial Activity of the Essential Oil of *Trachyspermum ammi* Fruit. Journal of Natural Remedies. 2019; 19 (2): 2320-3358
18. Pruthi JS. Spices and Condiments. (9th edn) New Delhi: *National Book Trust,* 2014. 322
19. Ishikawah T, Sega Y, Kitajima J. Water-soluble constituents of ajowan, Chem Pharm Bull 2001; 49: 840-844

20. Chopra RN. Chopra's Indigenous Drug of India, 2nd ed. Calcutta (INDIA): Academic Publishers; 1982.
21. Nagalakshmi G, Shankar Acharya NB, Puranaik J. Studies on chemical and technological aspects of ajwain (*Trachyspermum ammi*) syn (*Carum copticum* Hiren) seeds. Journal of Food Science and Technology. 2000; 37(3):277-281.
22. Farooq MO, Osman SM, Ahman MS. The fixed oil from the seeds of *Carum copticum* Benth. Journal of the Science of Food and Agriculture. 1953; 4:132-134.
23. Minija J, Thoppil, JE. Essential oil composition of *Trachyspermum ammi* L. sprague from South India. Indian Journal of Pharmaceutical Sciences. 2002; 64(3): 250-251.
24. Lucchesi ME, Chemat F, Smadja J. An original solvent free microwave extraction of essential oil from spices. Flavour and Fragrance Journal. 2004; 19:134-138.
25. Mahboubi M, Kazempour N. Chemical composition and antimicrobial activity of *Satureja hortensis* and *Trachyspermum copticum* essential oil. Iranian Journal of Microbiology. 2011; 3(4):194-200
26. Sharanappa K, Kadabinakatti Patil S, Kulkarni GV, Kumar R, Arya MC. Potential of *Trachyspermum ammi* (Linn.) seed extract against larva and pupa of Aedes species. *Natural Sciences*. 2015; 13(12):127-130.
27. Shojaaddini M, Moharramipour S, Saha ZB. Fumigant toxicity of essential oil from *Carum copticum* against Indian meal moth, *Plodia interpunctella*. Journal of Plant Protection Research. 2014; 48:411-419.
28. Hashem A, Bhnam M, Hasan R. Characterization of chemical composition and antioxidant properties of *Trachyspermum ammi* seeds as a potential medicinal plant. Journal of Chemical Health Risks. 2014; 4(4):9-16.
29. Gilani AH, Jabeen Q, Ghayur MN, Janbaz KH, Akhtar MS. Studies on the antihypertensive, antispasmodic, bronchodilator and hepato protective activities of the *Carumcopticum* seed extract. Journal of Ethnopharmacology, 2005; 98(12): 127-135
30. 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: 16.
31. Ahsan SK, Shah AH, Tanira MO, Ahmad MS, Tariq M, Ageel AM. Studies on some herbal drugs used against kidney stones in Saudi folk medicine. Fitoterapia. 1990;61: 435–26.
32. Nath D, Sethi N, Srivastav S, Jain AK, Srivastava R. Survey on indigenous medicinal plants used for abortion in some districts of Uttar Pradesh. Fitoterapia. 1997; 68:223–5.
33. Kaur H. Estrogenic activity of some herbal galactogogue constituents. Indian J Anim Nutr. 1998; 15:232–4.
34. Komeili, G., et al. The therapeutic effect of *Carum copticum* seed aqueous extract on peptic ulcers induced by ibuprofen in rat. *Zahedan J Res Med Sci*, 2002**.** 14: 21-24.
35. Thangam C, Dhananjayan R. Antiinflammatory Potential of The Seeds Of Carum Copticum Linn. Indian J Pharmacol. 2003;35: 388–91.
36. Boskabady MH, Jandaghi P, Kiani S, Hasanzadeh L. Antitussive effect of Carum copticum in guinea pigs. J Ethnopharmacol. 2005; 97:79–82.
37. Ramaswamy S, Sengottuvelu S, Haja SS, Jaikumar S, Saravanan R, Prasadkumar C, Sivakumar T. Gastroprotective Activity of Ethanolic Extract of *Trachyspermum ammi* Fruit. International Journal of Pharma and Bio Sciences 2010; 01(01): 01-15.
38. Tamurab T, Iwamoto H. Thymol - a classical small molecule compound that has a dual effect (potentiating and inhibitory) on myosin. Biochemical and Biophysics Research Communications 2004; 18: 786-80.
39. Jabbar A, Iqbal Z, Khan MN. In vitro anthelmintic activity of *Trachyspermumv ammi* seeds. Pharmacogonosy Magazine 2006; 2:126-129.