

**TRACHYSPERMUM AMMI (AJWAIN): A COMPREHENSIVE REVIEW**Kamal Jeet<sup>1\*</sup>, Nisha Devi<sup>1</sup>, Thakur Narendra<sup>1</sup>, Tomar Sunil<sup>1</sup>, Shalta Lalit<sup>1</sup>, Thakur Raneev<sup>2</sup><sup>1</sup>Vinayaka College of Pharmacy, Kullu (H.P), India<sup>2</sup>College of Ayurvedic Pharmaceutical Sciences, Jogindernagar (H.P), India

Article Received on: 11/03/12 Revised on: 20/04/12 Approved for publication: 08/05/12

\*E-mail: express\_pharma@yahoo.com

**ABSTRACT**

The use of plants as medicine is as old as human civilization. People of all ages in both developing and developed countries use plants in an attempt to cure various diseases and to get relief from physical sufferings. Natural products are a source for bioactive compounds and have potential for developing some novel therapeutic agents. *Trachyspermum ammi* commonly known as 'Ajwain' belonging to family *apiaceae* is distributed throughout India and it is mostly cultivated in Gujarat and Rajasthan. The plant is used traditionally as a stimulant, carminative, flatulence, atonic dyspepsia, diarrhoea, abdominal tumors, abdominal pains, piles, and bronchial problems, lack of appetite, galactagogue, asthma and amenorrhoea. Medicinally, it has been proven to possess various pharmacological activities like antifungal, antioxidant, antimicrobial, antinociceptive, cytotoxic activity, Hypolipidaemic, Antihypertensive, antispasmodic, broncho-dilating actions, Antilithiasis, diuretic, Abortifacient, Antitussive, Nematicidal, Anthelmintic and Antifilarial Activity. Over the past decades, many reports have appeared in mainstream scientific journals describing its nutritional and medicinal properties. The available literature on this plant divulges that it contains many phytoconstituents including carbohydrates, glycosides, saponins, phenolic compounds, volatile oil (thymol,  $\gamma$ -terpinene, para-cymene, and  $\alpha$ - and  $\beta$ -pinene), protein, fat, fibre and mineral matter containing calcium, phosphorous, iron and nicotinic acid. The present review summarizes the information concerning the pharmacognostic, phytochemistry and pharmacological studies of *Trachyspermum ammi*.

**KEYWORDS:** *Trachyspermum ammi*, Apiaceae, Fruit, Antimicrobial, Ajowan, Ajwain

**INTRODUCTION**

It is native of Egypt and is cultivated in Iraq, Iran, Afghanistan, Pakistan, and India. In India, it is cultivated in Madhya Pradesh, Uttar Pradesh, Gujarat, Rajasthan, Maharashtra, Bihar and West Bengal<sup>1</sup> *Trachyspermum ammi* L. belonging to family Apiaceae a highly valued medicinally important seed spice. The roots are diuretic in nature and the seeds possess excellent aphrodisiac properties. The seeds contain 2–4.4% brown coloured oil known as ajwain oil. The main component of this oil is thymol, which is used as gastrointestinal ailments, lack of appetite and bronchial problems. The oil exhibits fungicidal<sup>2</sup> antimicrobial<sup>3</sup> and anti-aggregatory effects on humans<sup>4</sup>. Ajwain is traditional potential herbs, is widely used for curing various diseases in humans and animals. It is an important remedial agent for flatulence, atonic dyspepsia and diarrhoea<sup>5</sup>. The seed of ajwain is bitter, pungent and it acts as anthelmintic, carminative, laxative, and stomachic. It also cures abdominal tumours, abdominal pains and piles<sup>6</sup> and bears anti-inflammatory and antioxidant activity<sup>7</sup>. Seeds contain an essential oil containing about 50% thymol which is a strong germicide, anti-spasmodic and fungicide. Thymol is also used in toothpaste and perfumery<sup>8</sup>.

**Synonyms<sup>1</sup>**

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

**Classification<sup>9</sup>**

Kingdom	: Plantae- Plant
Division	: Magnoliophyta-Flowering plants
Class	: Magnoliopsida-Dicotyledons
Order	: Apiales
Family	: Apiaceae
Genus	: <i>Trachyspermum</i>
Species	: <i>ammi</i>

**Macroscopic Characters**

It is widely grown in arid and semi-arid regions<sup>8</sup> where soils contain the high levels of salts<sup>10-11</sup>. 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, cremocarp with a persistent stylopodium; Leaves pinnate, with a terminal and 7 pairs of lateral leaflets<sup>12</sup>. Fruit, consists of two mericarps, grayish 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<sup>1</sup>.

**Microscopic Characters**

Transverse section of fruit shows two hexagonal structures attached with each other by a carpophores, epicarps consists of a single layer of tangentially elongated tabular cells, mesocarp consists of moderately thick-walled, rectangular to polygonal tangentially elongated cells having some vittae, carpophores and vascular bundles present as groups of thick-walled radially elongated cells, integument, barrel shaped of tangentially elongated cells, endosperm consists of thin walled cells filled with embryo, oil globules, small and circular, composed of polygonal thin walled cells. The powder microscopic shows the presence of oil globules and groups of endosperm cells<sup>1</sup>.

**Pharmacognostic Profile**

A pharmacognostic profile of any plant helps in identification as well as in standardization of the quality and purity of the plant drug. Hardel Danendra kumar *et al*<sup>13</sup> reported a detail Organoleptic and Physicochemical characteristics of the drug given in Table.1.

**Qualitative Phytochemistry**

Crude drug powder shows the presence of (Glycosides, Fixed Oils, Steroids, Terpenes)<sup>13</sup>. Ethanol Extract of seeds shows the presence of (Reducing sugar, Tannins, Glycoside)<sup>14</sup>. Ethanol and Pet. Ether Extract shows the presence of

(Alkaloid, Amino acids, Proteins, Sterols, Terpenes, Glycosides)<sup>15</sup>. A detail Phytochemical study by Katasani Damodar *et al*<sup>16</sup> on Methanol, Acetone, Chloroform and Hexane extract of seed is given in Table 2.

#### Quantitative Phytochemistry

Quantitative estimation of total phenolic content and flavanoids content is given in Table 3. Standard graph of total phenolic compound given as Fig 1<sup>16</sup> and standard graph of total flavonoids compound given as Fig 2<sup>16</sup>. Ajwain seed analysis has revealed it contain fibre (11.9%), carbohydrates (38.6%), tannins, glycosides, moisture (8.9%), protein (15.4%), fat (18.1%), saponins, flavone and mineral matter (7.1%) containing calcium, phosphorous, iron and nicotinic acid<sup>17</sup>. The Ajwain fruits yields 2% to 4% brownish essential oil, with thymol as the major constituent (35% to 60%)<sup>18</sup>. The nonthymol fraction (thymene) contains para-cymene,  $\gamma$ -terpinene,  $\alpha$ - and  $\beta$ -pinenes, dipentene,  $\alpha$ -terpinene, and carvacrol<sup>19</sup>. Minute amounts of camphene, myrcene, and  $\alpha$ -3-carene also have been found in the plant. Alcoholic extracts contain a highly hygroscopic saponin. From the fruits, a yellow, crystalline flavone and a steroid-like substance have been isolated and also contain 6-O- $\beta$ -glucopyranosyloxythymol<sup>20</sup>, a glucoside and a yield of 25% oleoresin containing 12% volatile oil (thymol,  $\gamma$ -terpinene, para-cymene, and  $\alpha$ - and  $\beta$ -pinene)<sup>21</sup>. The principal oil constituents of *Trachyspermum ammi* are carvone (46%), limonene (38%), and dillapiole (9%)<sup>22</sup>.

#### Pharmacological Profile

Traditional therapeutic uses of *Trachyspermum ammi* fruits include: galactagogue, stomachic, carminative<sup>23</sup>, Expectorant, Antiseptic<sup>24</sup>, Amoebiasis, Antimicrobial<sup>25</sup>, seeds fried in oil and used as a thin soup as a galactagogue<sup>26</sup>, used in curing diarrhoea, Parasitocidal, and given in treatment of amenorrhoea<sup>27</sup>, Bronchitis, colic pain<sup>28</sup>, Antipyretic, febrifugal<sup>29</sup>. The seed of ajwain is bitter, pungent, and it acts as anthelmintic, carminative, laxative, and stomachic. It also cures abdominal tumors, abdominal pains, and piles<sup>30</sup>. Catecholamines from the adrenal medulla would have contributed either to a stress associated release of ACTH or to a rise in intracellular cyclic AMP and catecholamine release is associated with enlargement of adrenal gland<sup>31</sup>. Presence of terpenes, glycosides and sterols in plant has been found to exert active anti-inflammatory effects<sup>32</sup>.

#### Antihypertensive, antispasmodic and broncho-dilating activity

The antihypertensive effect of *Trachyspermum ammi* administered intravenously *in vivo*, and the antispasmodic and broncho-dilating actions *in vitro*. The studied of calcium channel blockade that has been found to mediate the spasmolytic effects of plant materials and considered that this mechanism contributed to their observed result and supported the traditional use of *Trachyspermum ammi* in hyperactive disease states of the gut such as colic and diarrhoea as well as in hypertension<sup>33</sup>.

#### Hepatoprotective activity

The Hepatoprotective Actions *in vivo* showed that *Trachyspermum ammi* was 80% protective in mice against a normally-lethal dose of paracetamol (1 g/kg), it prevented the CCl<sub>4</sub>-induced prolongation of pentobarbital sleeping time in mice, and it tended to normalise the high serum levels of liver enzymes caused by CCl<sub>4</sub>-induced liver damage in rats<sup>34</sup>.

#### Antilithiasis and diuretic activity

Antilithiasis and diuretic actions *in vivo* of *Trachyspermum ammi* on inhibiting oxalate urolithiasis induced in rats. In a further study of a possible diuretic effect the results found

that *Trachyspermum ammi* was not effective in increasing the 24 hour urine production. The results concluded that the traditional use of *Trachyspermum ammi* in the treatment of kidney stones was not supported by their experimental evidence<sup>34</sup>.

#### Abortifacient and galactogogic actions

*Trachyspermum ammi* was listed in 14 indigenous medicinal plants that were reported to have been used for abortion in some districts of Uttar Pradesh (India) in their survey conducted in 1987. Specifically, in the village of Kallipuschium, Lucknow district, 50 of the 75 pregnant women who were surveyed (of a total of 155 women in the fertile period) claimed to have used *Trachyspermum ammi* seed for abortion. The herb was not 100% effective so the possibility of causing congenital defects was of concern. There was a high risk of potential human foetotoxicity of ten plants including *Trachyspermum ammi*, based on teratogenicity observed in rat foetuses<sup>35</sup>.

The National Dairy Research Institute in India investigated the oestrogenic content of some herbs (including *Trachyspermum ammi*) that are traditionally used to increase milk yield in dairy cattle *Trachyspermum ammi* has also been traditionally used as a galactagogue in humans<sup>36</sup>.

#### Antiplatelet-aggregatory

Antiplatelet-Aggregatory experiments *in vitro* with blood from human volunteers, it showed that a dried thereal extract of *Trachyspermum ammi* seeds, inhibited aggregation of platelets induced by arachidonic acid, collagen and epinephrine. Research study was intended to support the traditional use of *Trachyspermum ammi* in women post parturition<sup>37</sup>.

#### Anti-inflammatory potential

Anti-inflammatory principles of the total alcoholic extract (TAE) and total aqueous extract (TAQ) of the Ajwain seeds. TAE and TAQ exhibited significant ( $P < 0.001$ ) antiinflammatory activity in both the animal models. The weights of the adrenal glands were found to be significantly increased in TAE and TAQ treated animals. TAE and TAQ extracts from the ajwain seeds exhibit significant antiinflammatory potential<sup>38</sup>.

#### Antitussive effects

The antitussive effects of aerosols of two different concentrations of aqueous and macerated extracts and carvacrol, codeine, and saline were tested by counting the number of coughs produced. The results showed significant reduction of cough number obtained in the presence of both concentrations of aqueous and macerated extracts and codeine ( $p < 0.001$  for extracts and  $p < 0.01$  for codeine)<sup>39</sup>.

#### Antifilarial activity

*In vitro* activity of a methanolic extract of fruits of *Trachyspermum ammi* (Apiaceae) against *Setaria digitata* worms has been investigated. The crude extract and the active fraction showed significant activity against the adult *S. digitata* by both a worm motility and MTT [3-(4, 5-dimethylthiazol-2-yl)-2, 5- diphenyltetrazolium bromide] reduction assays. The isolated active principle phenolic monoterpene screened for *in vivo* antifilarial activity against the human filarial worm *B. malayi* in *Mastomys coucha*, showing macrofilaricidal activity and female worm sterility *in vivo* against *B. malayi*. *Trachyspermum ammi* crude extract exhibited macrofilaricidal activity<sup>40</sup>.

#### Gastro protective Activity

*Trachyspermum ammi* fruit showed antiulcer activity by using different ulcer models. Animals pre-treated with ethanolic extract showed significant decrease in ulcer index

and percentage ulcer protection in all models. The results suggests that the extract showed significant protection ( $p < 0.001$ ) by reducing ulcerative lesions when compared with control group of animals<sup>41</sup>.

#### Detoxification of aflatoxins

Aqueous extract of ajowan seeds was found to contain an aflatoxin inactivation factor (IF). Thin layer chromatography analysis of the toxins after treatment with IF showed relative reduction of aflatoxin  $G1 > G2 > B1 > B2$ . Quantification of toxin using a fluorotoxin meter as well as the Enzyme Linked Immunosorbent Assay (ELISA) confirmed these findings. An approximate 80% reduction in total aflatoxin content over the controls was observed. This observed phenomenon of reduction in total toxin was referred to as toxin inactivation. Temperature was found to influence the rate of toxin inactivation. At 45 °C, it was found to be rapid during the initial 5 h and slowed later. The IF was found to retain considerable activity even after boiling and autoclaving, indicating partial heat stability. The activity was lost below pH 4.0. Above pH 4.0, it increased gradually, reaching the maximum at pH 10.0. IF was found to be stable to gamma irradiation. Toxin decontamination in spiked corn samples could be achieved using IF. This study emphasizes the potential of ajowan IF in aflatoxin removal from contaminated food commodities<sup>42</sup>.

#### Ameliorative effect

Effect of ajwain extract on hexachlorocyclohexane (HCH)-induced oxidative stress and toxicity in rats were investigated. Pre-feeding of ajwain extract resulted in increased GSH, GSH-peroxidase, G-6-PDH, SOD, catalase, glutathione S-transferase (GST) activities and decreased hepatic levels of lipid peroxides. It was concluded that HCH administration resulted in hepatic free radical stress, causing toxicity, which could be reduced by the dietary ajwain extract<sup>43</sup>.

#### Antimicrobial actions in vitro

The antimicrobial action of *Trachyspermum ammi*, in the protection of foodstuffs against microbial spoilage, conducting laboratory assays of antimicrobial efficacy *in vitro* was studied. The active principles thought to be responsible for the antimicrobial activity of ajwain were reported to be carvacol and thymol<sup>44</sup>. 'Thymol' kill the bacteria resistant to even prevalent third generation antibiotics and multi-drug resistant microbial pathogens and thus work as a plant based 4th generation herbal antibiotic formulation<sup>45</sup>. Antifungal action of volatile constituents of *Trachyspermum ammi* seeds on ten fungi (*Acrophialophora fusispora*, *Curvularia lunata*, *Fusarium chlamydosporum*, *F. poae*, *Myrothecium roridum*, *Papulaspora* sp., *Alternaria grisea*, *A. tenuissima*, *Drechslera tetramera*, and *Rhizoctonia solani*). *Trachyspermum ammi* seeds were found to inhibit the growth of all test fungi by 72-90%<sup>46</sup>. Phenolic compounds, such as thymol and carvacol, are known to be either bactericidal or bacteriostatic agents depending on the concentration used<sup>47</sup>.

#### Hypolipidaemic action in vivo

Antihyperlipidaemic effect of *Trachyspermum ammi* seed has been obtained in albino rabbits. It was assessed that *Trachyspermum ammi* powder at dose rate of 2 g/kg body weight and its equivalent methanol extract were extensively effective lipid lowering action by decreased total cholesterol, LDL-cholesterol, triglycerides, total lipids<sup>48</sup>.

#### Digestive stimulant actions in vivo and in vitro

*Trachyspermum ammi* would increase the secretion of gastric acid; the addition of *Trachyspermum ammi* to the infusion

increased the amount of gastric acid. The gastric acid secretion was increased nearly fourfold. *Trachyspermum ammi* affect on the food transit time in experimental rats *in vivo*, the addition of *Trachyspermum ammi* to the diet reduced food transit time and also enhanced the activity of digestive enzymes and/or caused a higher secretion of bile acids<sup>49</sup>.

#### Nematicidal Activity

Pine wilt disease caused by the pinewood nematode (PWN) *Bursaphelenchus xylophilus*. Ajwain oil constituents (camphene, pinene, myrcene, limonene, terpinene, terpinen-4-ol, thymol and carvacrol) showed nematicidal activity against PWN32. PWN bodies treated with the muscle activity blockers levamisole hydrochloride and morantol tetratate<sup>50</sup>. Amino and hydroxyl groups have been hypothesized as target sites of methyl isothiocyanate in nematodes<sup>51</sup>. Some essential oils have been reported to interfere with the neuromodulator octopamine<sup>52</sup> or GABA-gated chloride channels of insect pests<sup>53</sup>. Thymol and carvacrol were very effective against PWN. These studies confirm that the nematicidal activity of Ajwain oil was mainly attributed to the activity of thymol and carvacrol<sup>54</sup>. Nematicidal activity of ajwain essential oils LC50 values was 0.431mg/ml<sup>55</sup>.

#### Anthelmintic Activity

Anthelmintic activity of *Trachyspermum ammi*, shows its effect against specific helminths, e.g. *Ascaris lumbricoides* in humans and *Haemonchus contortus* in sheep<sup>55</sup>. Anthelmintic Activity *Trachyspermum ammi* exert by interference with the energy metabolism of parasites through potentiation of ATPase activity and thus loss of energy reserves<sup>56</sup>. The plant has also been reported to possess cholinergic activity with peristaltic movements of the gut, thus helping in expulsion of intestinal parasites which might also be a contributory factor to its anthelmintic activity<sup>57-58</sup>.

#### DISCUSSION

*Trachyspermum ammi* is an important medicinal plant, which has both nutritional as well as medicinal uses. This particular have a wide established and hidden therapeutic uses. This medicinal plant needs a scientific explore to the hidden curative and therapeutic potential. This review is an attempt to provide well assembled scientific data on the behalf of *Trachyspermum ammi*. It is expected that this review will attract attention towards medicinal potential, applications and commercialization of various Pharmacognostic, Phytochemical and Pharmacological profiles of *Trachyspermum ammi*.

#### ACKNOWLEDGMENT

All authors are thankful to Vinayaka College of Pharmacy, Kullu (H.P), India, and College of Ayurvedic Pharmaceutical Sciences, Jogindernagar (H.P), India, to providing us appropriate facilities to carry out this work.

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Table.1-Organoleptic and Physicochemical characteristics of the drug powder

Appearance	Powder
Colour	Light brown
Taste	Pleasant
Odour	Characteristic
Foreign matter(% w/w)	2.4
Loss on drying(%w/w) Mean (n=3) ±SD	4.7±0.29
pH of 1% w/v solution Mean (n=3) ±SD	3.23±0.09
pH of 10% w/v solution Mean (n=3) ±SD	3.35±0.317
Total ash (%) Mean(n=6)±SD	8.6±0.29
Acid-insoluble ash (%) Mean(n=6)±SD	0.49±0.02
Water-soluble extractive Mean(n=6)±SD	42±0.32
Alcohol-soluble extractive Mean(n=6)±SD	17.9±0.80
Tap density Mean(n=3)±SD	0.45±0.005
Bulk density Mean(n=3)±SD	0.32±0.015
Angle of repose Mean(n=3)±SD	50±0.1126
Hausner ratio Mean(n=3)±SD	1.28±0.0611
Carr's index Mean(n=3)±SD	27.39±1.724

Table. 2 Phytochemical studies

S. No	Sec. Metabolites	Test names	Methanol	Acetone	Chloroform	Hexane
1	Carbohydrates	Molisch's test	+	+	+	-
2	Reducing sugars	Fehling test	+	+	-	-
3	Monosaccharide	Barfoed's test	+	-	-	-
4	Tannins	1. Ferric chloride	+	+	-	+
		2. Lead sub acetate				
5	Saponins	Frothing test	-	-	-	-
6		Shinoda's Test	+	+	-	+
7	Terpenes/steroids	Liebermann -Burchard's Test	+	-	+	+
8	Alkaloids	1. Mayer's Wagner's reagent	+	+	-	+
		2. With KI				
9	Cardiac Glycosides	Sodium nitroprusside	+	+	-	-
10	Proteins	Copper sulphate and Folin Ciocalteu solution	-	-	-	-
11	Amino acids	Ninhydrin	-	-	-	-
12	Anthraquinones	Borntrager's test	+	+	-	-

Table.3 Quantitative estimation of total Phenolic and Flavanoids content

Extract	Total Phenolic content. mg of Catechin equivalents /mg dried extracts.	Total content. mg of Catechol equivalents /mg dried extracts.
Methanol	11.51	15.32
Acetone	7.37	6.47
chloroform	9.24	12.38
Hexane	7.59	7.25

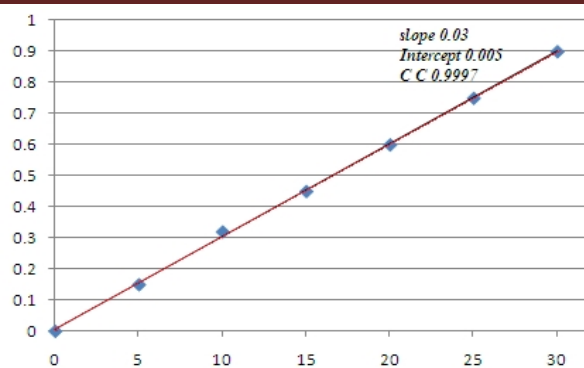


Fig. 1: Standard graph of total phenolic compound

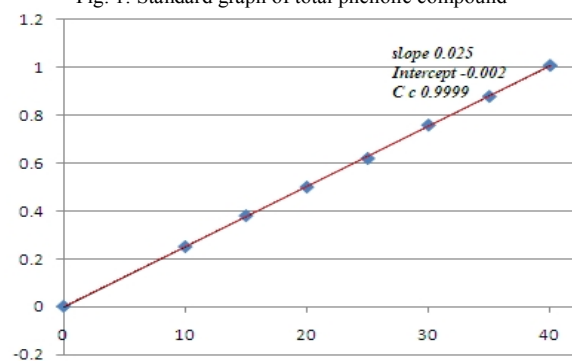


Fig 2: Standard graph of total flavonoids compound

Source of support: Nil, Conflict of interest: None Declared