Trachyspermum ammi

Ranjan Bairwa, R. S. Sodha, B. S. Rajawat

School of Pharmaceutical Sciences, Jaipur National University, Jaipur, Rajasthan, India

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ABSTRACT

Trachyspermum ammi commonly known as 'Ajwain' is distributed throughout India and is mostly cultivated in Gujarat and Rajasthan. The fruit possesses stimulant, antispasmodic and carminative properties and is used traditionally as an important remedial agent for flatulence, atonic dyspepsia, diarrhea, abdominal tumors, abdominal pains, piles, and bronchial problems, lack of appetite, galactogogue, asthma and amenorrhoea. Medicinally, it has been proven to possess various pharmacological activities like antifungal, antioxidant, antimicrobial, antinociceptive, cytotoxic, hypolipidemic, antihypertensive, antispasmodic, broncho-dilating actions, antilithiasis, diuretic, abortifacient, antitussive, nematicidal, anthelmintic and antifilarial. Further, studies reveal the presence of various phytochemical constituents mainly carbohydrates, glycosides, saponins, phenolic compounds, volatile oil (thymol, γ-terpinene, para-cymene, and α- and β-pinene), protein, fat, fiber and mineral matter containing calcium, phosphorous, iron and nicotinic acid. These studies reveal that *T. ammi* is a source of medicinally active compounds and have various pharmacological effects; hence, it is encouraging to find its new therapeutic uses.

Key words: Apiaceae, antimicrobial, ajwain, fruit (seed), *trachyspermum ammi*

INTRODUCTION

Trachyspermum ammi is a native of Egypt and is cultivated in Iraq, Iran, Afghanistan, Pakistan, and India. In India, it is cultivated in Madhyapardesh, Uttarpardesh, Gujarat, Rajasthan, Maharashtra, Bihar and West Bengal.[1] *Trachyspermum ammi* L. belonging to family Apiaceae is 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 colored oil known as ajwain oil. The main component of this oil is thymol, which is used in the treatment of gastro-intestinal ailments, lack of appetite and bronchial problems. The oil exhibits fungicidal,[2] antimicrobial[3] and anti-aggregatory effects on humans.[4] Ajwain is a traditional potential herb and is widely used for curing various diseases in humans and animals. The fruit possesses stimulant, antispasmodic and carminative properties. It is an important remedial agent for flatulence, atonic dyspepsia and diarrhea.[5] 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.[6] 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.[7]

Address for correspondence:
Mr. Ranjan Bairwa, School of Pharmaceutical Sciences, Jaipur National University, Jaipur - 25, Rajasthan, India.
E-mail: ranjanbairwa@gmail.com

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Other names[1]

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, Yom, Omu*
Malayalam:	*Oman, Ayanodakan*
Marathi:	*Onva*
Oriya:	*Juani*
Tamil:	*Omam*
Telugu:	*Vamu*

Taxonomical classification[8]

Kingdom:	*Plantae,* Plant
Subkingdom:	*Tracheobionta*, Vascular plants
Superdivision:	*Spermatophyta*, Seed plants
Division:	*Magnoliophyta*, Flowering plants
Class:	*Magnoliopsida,* Dicotyledons
Order:	Apiales
Family:	Apiaceae
Genus:	*Trachyspermum*
Species:	*Ammi*

BOTANICAL DESCRIPTION

It is widely grown in arid and semi-arid regions[9] where soils contain high levels of salts[10,11] 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.[12] 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.[1]

Microscopic description[1]

Transverse section of fruit shows two hexagonal structures attached with each other by 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 radically 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 microscopy shows the presence of oil globules and groups of endosperm cells.

PHYTOCHEMICAL STUDIES

Ajwain seed analysis has revealed it to contain fiber (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.[13] Ajwain fruits yield 2% to 4% brownish essential oil, with thymol as the major constituent (35% to 60%).[14] The nonthymol fraction (thymene) contains para-cymene, γ-terpenine, α- and β-pinenes, dipentene, α-terpinene, and carvacrol.[15] Minute amounts of camphene, myrcene, and α-3-carene also have been found in the plant. Alcoholic extracts contain a highly hygroscopic saponin. From the fruits, an yellow, crystalline flavone and a steroid-like substance has been isolated and it also contains 6-O-β-glucopyranosyloxythymol,[16] glucoside and yields 25% oleoresin containing 12% volatile oil (thymol, γ-terpinene, para-cymene, and α- and β-pinene).[17] The principal oil constituents of *T. ammi* are carvone (46%), limonene (38%), and dillapiole (9%).[18]

PHARMACOLOGICAL ACTIVITIES

Ajwain with its characteristic aromatic smell and pungent taste is widely used as a spice in curries. Its seeds are used in small quantities for flavoring numerous foods, as preservatives, in medicine and for the manufacture of essential oil in perfumery.[13] In Indian system of medicine, *ajwain* is administered for curing stomach disorders, a paste of crushed fruits is applied externally for relieving colic pains; and a hot and dry fomentation of the fruits is applied on chest for asthma.[19,20] *T. ammi* has been shown to possess antimicrobial,[21] hypolipidemic,[22] digestive stimulant,[23] antihypertensive, hepatoprotective, antispasmodic, broncho-dilating,[24] antilithiasis, diuretic,[25] abortifacient,[26] galactogogic,[27] antiplatelet-aggregatory,[28] antiinflammatory,[29] antitussive,[30] antifilarial,[31] gestroprotective,[32] nematicidal,[33] anthelmintic,[34] detoxification of aflatoxins,[35] and ameliorative effects.[36] Therapeutic uses of *T. ammi* fruits include; stomachic, carminative[37] and expectorant, antiseptic[38] and amoebiasis, antimicrobial.[39] Seeds soaked in lemon juice with *Prunus amygdalus* (badam) are given in curing amenhorroea[40] and it is also used as antipyretic, febrifugal and in the treatment of typhoid fever.[41,42]

Antihypertensive, antispasmodic and broncho-dilating activity

The antihypertensive effect of *T. ammi* administered intravenously *in vivo*, and the antispasmodic and broncho-dilating actions *in vitro* showed that calcium channel blockade has been found to mediate the spasmolytic effects of plant materials and it is being considered that this mechanism contributed to their observed result and supported the traditional use of *T. ammi* in hyperactive disease states of the gut such as colic and diarrhea as well as in hypertension.[24]

Hepatoprotective activity

The hepatoprotective actions *in vivo* showed that *T. ammi* was 80% protective in mice against a normally-lethal dose of paracetamol (1 g/kg), it prevented the CCl_4-induced prolongation of pentobarbital sleeping time in mice, and it tended to normalize the high serum levels of liver enzymes caused by CCl_4-induced liver damage in rats.[24]

Antilithiasis and diuretic activity

Antilithiasis and diuretic actions *in vivo* of *T. ammi* on inhibiting oxalate urolithiasis induced in rats are also studied. In a further study of a possible diuretic effect, it was found that *T. ammi* was not effective in increasing the 24-h urine production. The results concluded that the traditional use of *T. ammi* in the treatment of kidney stones was not supported by their experimental evidence.[25]

Abortifacient and galactogogic actions

Trachyspermum ammi is 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 *T. ammi* seed for abortion. The herb was not 100% effective and so the possibility of causing congenital defects was of concern. There was a high risk of potential human fetotoxicity of ten plants including *T. ammi*, based on teratogenicity observed in rat foetuses.[26]

The National Dairy Research Institute in India investigated the estrogenic content of some herbs (including *T. ammi*) that are traditionally used to increase milk yield in dairy cattle. *T. ammi* has also been traditionally used as a galactogogue in humans. The total phytoestrogen content of dry *T. ammi* seed was 473 ppm, which was the second highest in the list of eight herbs tested (total phytoestrogen contents 131-593 ppm).[27]

Antiplatelet-aggregatory

Antiplatelet-Aggregatory experiments *in vitro* with blood from human volunteers, it showed that a dried ethereal extract of *T. ammi* seeds, inhibited aggregation of platelets induced by arachidonic acid, collagen and epinephrine. Research study was intended to support the traditional use of *T. ammi* in women post parturition.[28]

Anti-inflammatory potential

Anti-inflammatory potential of the total alcoholic extract (TAE) and total aqueous extract (TAQ) of the Ajwain seeds was determined. 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 anti-inflammatory potential.[29]

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).[30]

Antifilarial activity

In vitro activity of the methanolic extract of the 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* showed macrofilaricidal activity and female worm sterility *in vivo* against *B. malayi. T. ammi* crude extract exhibited macrofilaricidal activity. The IC50 values for the isolated active principle 2- isopropyl-5-methyl phenol at two incubation periods 24 and 48 h were 0.024 and 0.002 mg/ml, respectively. The *in vivo* effect of the active principle 2-isopropyl-5-methyl phenol was evaluated against the *B. malayi* parasite in a *Mastomys coucha* model. The mean percentage mortality of adults (58.93%) in the group treated with 50 mg/kg was significantly *(P*<0.0001) higher than that was obtained in the control group (19.05%).[31]

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 suggest that the extract showed significant protection (p<0.001) by reducing ulcerative lesions when compared with control group of animals.[32]

Detoxification of aflatoxins

The seed extract of ajwain showed the maximum degradation of aflatoxin G1 (AFG1). The aflatoxin detoxifying activity of the seeds extract was significantly reduced upon boiling. Significant levels of degradation of other aflatoxins viz., AFB1, AFB2 and AFG2 by the dialyzed seeds extract were also observed. Time course study of AFG1 detoxification by dialyzed *T. ammi* extract showed that more than 91% degradation occurred at 24 h and 78% degradation occurred within 6 h after incubation.[35]

Ameliorative effect

Effects 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.[36]

Antimicrobial actions *in vitro*

The antimicrobial actions of *T. ammi*, in the protection of foodstuffs against microbial spoilage, conducting laboratory assays of antimicrobial efficacy *in vitro*, and its use as antimicrobials in humans, are also investigated. The active principles thought to be responsible for the antimicrobial activity of ajwain were reported to be carvacol and thymol.[43] 'Thymol kills the bacteria resistant to even prevalent third generation antibiotics and multi-drug resistant microbial pathogens and thus works as a plant based 4th generation herbal antibiotic formulation.[44] Antifungal action of volatile constituents of *T. 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*) was tested and found to inhibit the growth of all test fungi by 72-90%.[45] Phenolic compounds, such as thymol and carvacol, are known to be either bactericidal or bacteriostatic agents depending on the concentration used.[46]

Hypolipidemic action *in vivo*

Antihyperlipidemic effect of *T. ammi* seed has been obtained in albino rabbits. It was assessed that *T. ammi* powder at a dose rate of 2 g/kg body weight and its equivalent methanol extract were extensively effective in lipid lowering action by decreased total cholesterol, LDL-cholesterol, triglycerides and total lipids.[47]

Digestive stimulant actions *in vivo* and *in vitro*

T. ammi would increase the secretion of gastric acid; the addition of *T. ammi* to the infusion increased the amount of gastric acid. Gastric acid secretion was increased nearly four-fold by *T.*

ammi.[23] In experimental rats *in vivo*, the addition of *T. 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. [48]

Nematicidal activity

Pine Wilt disease is caused by the pinewood nematode (PWN), *Bursaphelenchus xylophilus*. Nematicidal activity of ajwain oil constituents (camphene, pinene, myrcene, limonene, terpinene, terpinen- 4-ol, thymol and carvacrol) is against PWN.[33] PWN bodies are treated with the muscle activity blockers levamisole hydrochloride and morantal tatrate.[49] Amino and hydroxyl groups have been hypothesized as target sites of methyl isothiocyanate in nematodes.[50] Some essential oils have been reported to interfere with the neuromodulator octopamine[51] or GABA-gated chloride channels of insect pests.[52] Thymol and carvacrol are very effective against PWN. These studies confirm that the nematicidal activity of ajwain oil is mainly attributed to the activity of thymol and carvacrol.[53] Nematicidal activity of ajwain essential oils LC_{50} values was 0.431 mg/ml.[54]

Anthelmintic activity

Anthelmintic activity of *T. ammi* shows its effect against specific helminths, e.g. *Ascaris lumbricoides* in humans and *Haemonchus contortus* in sheep.[54] Anthelmintic activity of *T. ammi* exerts by interference with the energy metabolism of parasites through potentiation of ATPase activity and thus loss of energy reserves.[55] 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.[56,57]

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