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Der Pharmacia Lettre, 2018, 10 [8]: 48-56
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ISSN 0975-5071
USA CODEN: DPLEB4

Phytochemicals and Bioactive Potential of *Trachyspermum ammi L.*

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ABSTRACT

Trachyspermum ammi (Bishop's weed, carom seed, ajowan or ajwain) is an erect annual herb from family Apiaceae used most commonly as condiment in Indian kitchen. It has a lot of applications in Indian system of medicine. This is a storehouse of many active compounds with pharmacological effects. The present work highlights the phytochemistry, pharmacological activities and traditional benefits of the plant. The phytochemical investigations have revealed the presence of alkaloids, steroids, glycosides, tannins, saponin and flavonoids, thymene, amino acids, dietary fiber as well as essential oils like thymol, c-terpinene, p-cymene. It also has much nutritional value. This is rich in carbohydrates. Protein, ash and fiber and fat contents are also present. It has inhibitory action against bacteria viz., Bacillus pumilus, Staphylococcus aureus, S. epidermidis, Klebsiella pneumonia and Bordetella bronchiseptica, Enterococcus faecalis, P. aeruginosa, Salmonella typhi, S. typhimurium etc and fungi viz., Acrophialophora fusispora Curvularia lunata, Fusarium chlamydosporum, F. moniliforme, F. poae, Myrothecium roridum, Papulaspora sp., Alternaria grisea, A. tenuissima etc. This possesses various pharmacological activities viz., antidiarrhoeal, antifungal antibacterial, antiviral, antispasmodic, antihypertensive and bronchodilating, abortifacient, galactogogic, antioxidant, antiulcer, anti aflatoxigenic, antifilarial, hepatoprotective and antihyperlipidemic effect. This has digestive stimulant actions. The seeds are highly useful in peptic ulcers. This bears blood pressure lowering potential. Two mericarps are present in fruit. So it is essential to find out its new medicinal uses and pi-anion interactions. The consequences of in silico pharmacokinetic inferred their potential as potent α-glucosidase inhibitor.

Keywords: *Phytochemicals, Nutrition, Ethnobotany, Pharmacology, Trachyspermum ammi*

INTRODUCTION

Trachyspermum ammi (L.) Sprague has been widely used in Ayurveda as a medicine. This is commonly called as Ajwain from family Apiaceae or Umbelliferae. This is a native of Egypt. It is cultivated in Afghanistan Iraq, Iran, Pakistan and India. In India it is grown in West Bengal, Rajasthan, Uttar Pradesh, Gujarat, Maharashtra, Bihar and Madhya Pradesh. The seeds have 2.0-4.4% brown colored oil. The main active component is thymol which is useful in the treatment of lack of appetite, bronchial problems and gastro intestinal troubles. This is anti-spasmodic, germicidal and even fungicidal. Thymol has application in toothpastes and even in perfumery [1]. The health benefits are mainly because of various phytochemicals. The review records published information on pharmacological and phytochemical analysis of the plant. This highlights the importance of this untapped resource in removing against various human ailments.

Ecology and botanical description

It shows its distribution in areas with soils rich in salt concentrations of arid and semi-arid locations in Punjab and Gujarat [2]. Herb mainly profusely branched that reaches to height of 55-85 cm.

Figure 1: Seeds of *T. ammi.*

This bears pinnate leaves with seven pairs of lateral leaflets. It shows compound umbel inflorescence having striated stem. It bears actinomorphic flowers. The petals are five and bilobed. It has five stamens alternating with petals. The ovary being inferior bears knob like stigma. The fruit being cremocarp is ovoid to cordate. It is aromatic. It bears persistent stylopodium. The Fruit shows two mericarps. It is ovoid to grayish brown and compressed. It is two mm long and 1.7 mm wide. The mericarp shows five ridges along with six vittae (Figure 1).

Vernacular names

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

Phyto-constituents

Times to time researchers have investigated *T. ammi* for its many active phytochemicals. They are presented in Table 1.

Table 1: Phytochemicals present in *T. ammi*.

Source	Phytochemicals	Reference
Seeds	Essential oil 2% to 4% brownish colour and have-thymol (35% - 60%), non-thymol fractions called thymene contains p-cymene (50%-55%), β-pinene (4%-5%), limonene with γ-pinenes and β-pinene (30%-35%)	Chopra [3]
	Fiber (11.9%), moisture (8.9%), fat (18.1%), carbohydrates (38.6%), protein (15.4%), mineral matter (7.1%), glycosides, saponins and flavones, calcium, phosphorous, iron and nicotinic acid	Pruthi [4]
	Limonene (38%), carvone (46%) and dillapiole (9%)	Choudhury et al. [5]
	Carvone (48%), limonene (38%) and dillapiole (9%)	Nagalakshmi et al. [6]
	Thymol (35%-60%), p-menth-3-ene-1β, 2β, 5β-triol, Two new glucosides identified as 1-deoxy-L-erythritol ($C_4H_{10}O_3$) and 1-deoxypentitol ($C_5H_{12}O_4$)	Ishikawa et al. [7]
	Carbohydrates (24.6%), fiber (11.9%), tannins, glycosides, moisture (8.9%), protein (17.1%), fat (21.1%), saponins, flavones and other components (7.1%) involving calcium, phosphorous, iron, cobalt, copper, manganese, iodine, riboflavin, thiamine and nicotinic acid	Ranjan et al. [8]
	Non-thymol fraction (Thymene) contains Paracymene, Alpha-pinene, Betapinene, Gamma-terpinene, α-terpinene, Styrene, Delta-3-carene, Betaphyllanderene, terpinene-4-ol and Carvacrol	Mohagheghzadeh et al. [9]
Fruits	Water-soluble extract contains new Monoterpenoid Glucosides namely 7-Dimethyloct- 3 (10)-ene-1, (2S, 6Z)-3, 6-Hydroxythymol 3-O-β-D-Glucopyranoside, 2, 6, 7-Tetrol 1-O-β-D-Glucopyranoside and new Monoterpenoid, 3, 7-Dimethyloct-3 (10)-ene-1, 2, 6, 7-tetrol; new aromatic compound glucosides as 2-Methyl-3-Buten-2- ol-β-D-Glucopyanoside Benzyl-β-D-Glucopyranoside and Glucide - (3R)-2-Hydroxymethylbutane- 1, 2, 3, 4-tetrol	González et al. [10]
	Odor and taste is due to essential oil, fruits of Ajwain bears essential oil up to 5%	Minija and Thoppil, [11]

DISCUSSION

Nutritional value

The *T. ammi* contains fat 4.83%, carbohydrates 47.54% so it is energy enriched. The ash and fiber contents range 4.30% to 20.23%. Yet Javed et al. [12] mentioned that this may be a component diet of humans. It helps in providing proteins, carbohydrates to the body as a source of energy. Because of these bio-active parts it comes in category of useful foods.

Medicinal activity

Anti-diarrhoeal activity

T. ammi extracts of seed have potential at 100 mg/kg to control the diarrhoea. Its 95% total alcoholic extract and aqueous extract in experimental rats resulted a promising control in castor oil induced diarrhoea in concentration dependent manner. The total aqueous and alcoholic extracts decreased the droppings of diarrhoea while comparing to castor oil group [13].

Anti-bacterial activity

Its seeds contain-Thymol that can control the resistant bacteria. It shows differences in antimicrobial property because of different chemical composition of lipopolysaccharides in cell wall. It is bacteriostatic and also works as bactericidal agents. It inhibits two Gram negative food spoiling bacteria *Escherichia coli, Pseudomonas aeruginosa*. The extraction in ethanol was active against *P. aeruginosa* and their acetone extract possessed potential against *E. coli*. Masih et al. [14] evaluated activity against *P. aeruginosa, Salmonella typhi, S. typhimurium, Shigella flexneri, E. coli, Enterococcus faecalis, K. pneumonia* and *S. aureus* in acetone and aqueous extracts [15].

Antiviral activity

An assay for cytotoxicity was evaluated through 3- (4, 5-dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide (MTT) assay technique against in vero cell lines. It showed 80% and 40% virus inhibition at 0.5 mg/ml of ajwain oil in pre-exposure treatment and post-exposure treatment (antiviral activity) respectively [16].

Anti-fungal activity

The increasing resistance to antifungal drugs led to the search for therapeutic alternatives among aromatic plants and their essential oils. Shokari et al. [17] evaluated the antifungal activity of *T. ammi* essential oil (EO) against the most frequent pathogenic fungi including *Candida*, *Aspergillus*, *Chrysosporium* and *Trichophyton* species. Results of susceptibility tests showed that *T. ammi* EO was effective against all the tested strains. The diameters of growth inhibition zone of the EO were between 11 mm and 60 mm. The EO was also the most active, with MIC and MFC values ranging from 0.3 to 2.5 mg/ml and 0.6 to 5 mg/ml, respectively. The EO of *T. ammi* showed a significant degree of antifungal activity against different *Candida* species in comparison with other fungi ($p<0.05$).

Anti-hypertensive, anti-spasmodic and broncho-dilating activity

To find out antihypertensive activity in *T. ammi* an experiment was conducted intravenously *in vivo***.** The *in vitro* results demonstrated blockade of calcium channel mediated the spasmolytic potential in the plant. This advocated the application of *T. ammi* on hyperactive problems in the gut like diarrhoea, colic and during hypertension states [18].

Abortifacient and galactogogic activity

Boskabady et al. [19] found that *T. ammi* was used mostly as abortifacient. Aqueous extract of *T. ammi* seed at 175 mg/kg in rats was 62.5% effective as an abortifacient. In pregnancy cases in spite of herbal drug administration many skeletal and visceral problems were seen.

Digestive stimulant activity

Anwar et al. [20] demonstrated actions through addition of *T. ammi* to the diet *in vivo* and *in vitro* which reduced food transit time from 780 min (control) to 554 min, a 29% reduction ($p<0.05$). This enhanced higher secretion of bile acids and activity of digestive enzymes. They reported that the reduction in food transit time could be due to an acceleration of the overall digestive process as a result of increased availability and potency in digestive secretions. *T. ammi* would increase the secretion of gastric acid.

Detoxification of aflatoxins

The seeds have potential to detoxify aflatoxin G1 (AFG1). If boiled the aflatoxin detoxifying activity normally gets reduced. It was observed to detoxify other aflatoxins viz, AFB1, AFB2 and AFG2 through dialyzed seeds extracts. It was recorded for AFG1 that 78% degradation was found when incubated for 6 h and was degraded more than 91% after 24 h [21].

Anti-oxidant activity

Ajwain is also rich in vitamins and minerals and have health-promoting phytonutrients such as carotenoids (β- carotene and lutein) and flavonoids for providing powerful antioxidant protection. At 1 mg/ml acetone extract showed highest FRAP value (2270.27 ± 0.05μmol/l) as compared to aqueous and methanol extract of ajwain seeds and contribute a highly significant bio-resource of antioxidants to be used in our day-to-day life and in food and pharmaceuticals [22]. *T. ammi* methanol extract possesses strong antioxidant activity against DPPH, and could be used as natural antioxidant in food or pharmaceutical industry.

Anti-ulcer activity

It is now well recorded that if non-steroidal antiinflammatory medicines are used enough result in gastric ulcers. A study was taken to examine *T. ammi* aqueous extract effect in gastric ulcers healing induced by ibuprofen. 30 Wistar adult rats (female) were taken for this empirical study through preparing five groups where Omeprazole or *T. ammi* plant extract was administered at 125, 250 and 500 mg/kg doses twice a day for 2 weeks. At the end formation of gastric ulcers was studied. To work out adverse effects on liver of this medicine the amount of aspartate transferase and alanine transferase liver enzymes were observed in the

serum of animals. Aqueous Ajwain seed extract had a promising effect to heal gastric ulcers when compared with control group ($p<0.05$). The average number and area of the gastric ulcers in the seed extract treated groups was less compared to the negative-controls. The quantity of enzymes of liver also had ($p<0.05$) increased in groups that received the aqueous extractat 250 and 500 mg/kg [23].

Anti-filarial activity

To find out effect of fruit extract (methanolic) of *T. ammi* against *Setaria digitata* worms a study was conducted through MTT [3-(4, 5-dimethylthiazol-2-yl)-2, 5- diphenyltetrazolium bromide] reduction assays. It produced promising result against the adult *S. digitata*. The phenolic monoterpene produced macrofilaricidal activity. This resulted sterility in females under *in vivo* conditions against *B. malayi*. *T. ammi* crude extract showed macrofilaricidal activity. The IC50 values were 0.024 and 0.002 mg/ml, respectively at two incubation periods of 24 and 48 h. Effect of the active fraction-2-isopropyl-5-methyl phenol obtained from seed was also evaluated on the parasite which showed low average percentage of mortality in adults (58.93%) on the group treated with 50 mg/kg than that obtained in the control (19.05%) [24].

Hepato-protective and Anti-hyperlipidemic effect

Gilani et al. [18] reported that Ajwain methanolic extract exhibited *in vivo* hepatoprotective activity with eighty per cent protection against a normally-lethal dose of paracetamol in mice. The extract also possessed preventive effects against CCL_4-induced prolongation of pentobarbital sleeping time as well as equilibrating the level of hepatic enzymes, Alkaline Phosphatase (ALP) and Aminotransferases (AST and ALT) during liver damage. In present scenario it has been well observed that due to cardiovascular troubles throughout the world there is an increase in mortality [18].

This has association with dyslipidemia. They investigated efficacy of methanol and aqueous extracts from *T. ammi* at 1 g/kg, 3 g/kg and at 5 g/kg dose on rats. 45 albino rats (male) were divided and kept into nine equal groups (n = 5) randomly. There was an increase in lipid levels after 24 h when E_a single intraperitoneal injection of Triton X-100 (100 mg/kg) injected. It revealed that extracts at 3 g/kg and at 5 g/kg resulted in low density lipoprotein and increased in high density lipoprotein. It decreased levels of triglyceride, total cholesterol. Methanolic extract at 5 g/kg produced antihyperlipidemic activity which was similar to that of a standard drug.

Estrogenist value

The phytoestrogen value was studied in ajwain seeds that revealed it is 473 ppm. This is the second highest in category of plants for phytoestrogen content [25,26].

Insecticidal activity

The secondary metabolites in medicinal plants have potent insecticidal activity hence useful in plant–insect interactions. Essential oil extracted from ajwain seeds exhibited insecticidal activity against *Callosobruchus chinensis* in the ovi-position step as well as egg hatching and developmental inhibitory activities [27]. The alcoholic seed extract of *T. ammi* was found to be effective on *Aedes aegypti* developmental stages i.e., larva and pupa and considered as eco-friendly remedy. The mortality rate in larva was

three times faster than the pupa [28]. Ajwain oil was found to show fumigant activity against adults of *Oryzaephilus surinamensis*, *Rhyzopertha dominica* and *Tribolium confusum* at different concentrations and exposure times. LC50 values obtained were 1.69, 19.01 and 58.70 µl/Litre air after 24 hrs of exposure, 0.80, 15.2 and 51.96 µl/Litre air after 48 hrs of exposure and 0.43, 12.83 and 47.05 µl/Litre air after 72 hrs of exposure for *O. surinamensis*, *R. dominica* and *T. confusum*, respectively. These values demonstrated that *O. surinamensis* was more susceptible than *R. dominica* and *T. confusum*. *T. confusum* was more resistant than other two pests. Results showed that increasing the exposure time decreased LC50 value against all three tested insects [29]**.**

Wound healing activity

Gilani et al. [30] found anti-bacterial potential of ajwain in healing of wound in rabbits by applying cream with 5% ajwain essential oil. They also compared it with iodine solution. Wound contraction at 15th day in ajwain group was 99.68% as comparable to healing by iodine solution and untreated group which was found to be 100 and 96? 57% respectively indicating great healing power of ajwain.

CONCLUSIONS AND RECOMMENDATIONS

Ajwain has been well known and used as an Ayurvedic medicine since ancient times. Developing drugs from endemic plants from traditional system of medicine are now getting full attention because they are believed to be harmless. In the last decade and currently ethno-botanical applications of natural compounds of plant origin have received much interest. It is because of their having scientifically tested for effectiveness without negative effects. Ajwain has traditionally been used as a medicinal plant for its application like indigestion and dyspepsia and many other gastric disorders. It is rich in protein, carbohydrates, oil, minerals, fiber, calcium, phosphorus, iron, carotene, thiamine, riboflavin and niacin. Presences of a variety of diverse constituents in it are responsible for its different biological properties. The seed extract is effective in healing gastric ulcers and digestion may be by affecting the acid secretion of stomach pump. However more studies need to be conducted for estimation of gastric acid secretion and the pathways involved.

This review clearly demonstrates that *T. ammi* is a popular remedy among various ethnic groups. Traditional health practitioners have used this in different types of ailments. Current investigators are exploring the therapeutic potential of this plant having much more therapeutic properties still not fully known requiring more research to upgrade our knowledge on precise extraction and chemical analyses.

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