

16 Ajowan

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16.1. Introduction

Ajowan, or bishop's weed (*Trachyspermum ammi* L. Sprague ex. Turill, syn. *T. copticum* Linn and *Carum copticum* Hiern), belonging to the family Apiaceae, is an important seed spice. It is used as a spice in certain areas of Asia only. It is a small seed-like fruit, egg-shaped and greyish in colour. The plant has a similarity to parsley. Because of their seed-like appearance, the fruit pods are sometimes called ajwain seeds, or bishop's weed seeds. It is found mostly in Indian cooking, where it is also known as bishop's weed or carom. It is particularly suited to the delicate vegetarian cuisine from the state of Gujarat. Table 16.1 illustrates the export of ajowan to various countries from India. Pakistan and Saudi Arabia are the leading importers (Malhotra and Vijay, 2004).

The greyish-green ajowan seeds are striped and curved (similar to cumin or caraway seeds in appearance), often with a fine silk stalk attached. They are usually sold whole. The seeds are often chewed on their own for medicinal value, tasting bitingly hot and bitter, leaving the tongue numb for a while. Cooking is found to mellow ajowan; when crushed, the seeds have a strong and distinctive thyme-like fragrance.

Ajowan possesses a harsh thyme-like flavour with a bit of a kick, leaving a milder, pleasant aftertaste (<http://www.theepicentre.com/Spices/ajowan.html>; Malhotra and Vijay, 2004).

16.2. Botany and Uses

Botany

Ajowan is an annual herbaceous, 30–70 cm (1–2 ft) in height, bearing feathery leaves and red flowers. When the seeds are ripe, they are dried and threshed. Ajowan is native to India, but is also cultivated in Iran, Egypt, Pakistan and Afghanistan.

The plant is profusely branched, having a height of 60–90 cm, erect, with soft fine hair. It has feather-like leaves, pinnately divided into two or three with linear segments. The flowers appear as a terminal compound umbel. The minute greyish-white fruits are ovoid in nature. The fruits are similar to parsley in size and shape and measure 1.7–3.0 mm long, 1.5–2.4 mm broad and 0.5–1.4 mm thick. Each mericarp has five ridges and the odour is similar to thyme. The diploid chromosome number of ajowan is $2n = 18$. The flowers are protandrous and cross-pollination occurs through insects.

Table 16.1. Export of ajowan seed from India from 1996/97 to 2000/01 (quantity in tonnes and value in US\$ million).

	1996/97		1997/98		1998/99		1999/2000		2000/01	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
Pakistan	–	–	–	–	–	–	–	–	335	1.68
Saudi Arabia	401	3.5	207	1.9	283	3.06	236	3.31	159	1.48
USA	41	0.4	21	0.24	33	0.55	39	3.56	55	0.66
UAE	46	0.37	15	0.11	28	0.24	5	0.04	79	0.64
Malaysia	35	0.2	29	0.28	20	0.11	–	–	62	0.55
Indonesia	40	0.28	35	0.22	–	–	–	–	45	0.35
Nepal	2	0.006	35	0.13	4	0.02	1	0.15	31	0.28
South Africa	29	0.31	11	0.13	6	0.11	13	0.22	14	0.22
Kenya	22	0.17	0.7	0.006	44	0.37	9	0.08	25	0.22
Bangladesh	–	–	–	–	–	–	–	–	44	0.2
Canada	16	0.17	3	0.04	29	0.2	9	0.15	22	0.2
UK	60	0.53	42	0.4	63	0.71	50	0.068	20	0.17
Other countries	212	1.37	99	0.71	150	1.48	53	0.75	71	0.52
Total	904	7.4	498	4.22	660	6.88	465	8.95	962	7.17

Source: Malhotra and Vijay (2004).

Uses

Raw ajowan smells almost exactly like thyme because it also contains thymol, but is more aromatic and less subtle in taste, as well as slightly bitter and pungent. Even a small amount of raw ajowan will dominate the flavour of a dish completely.

Ajowan has a particular affinity to starchy foods like savoury pastries and breads, especially parathas. Snacks like Bombay mix and potato balls get an extra kick from ajowan. It is also good with green beans and root vegetables, lentil dishes and recipes using chickpea flour ('Besan' or Bengal gram flour). It is occasionally an ingredient of curry powder (<http://www.theepicentre.com/Spices/ajowan.html>).

In Indian cuisine, ajwain is almost never used raw, but either dry-roasted or fried in ghee or oil. This develops a much more subtle and complex aroma, somewhat similar to caraway but 'brighter'.

Flatulence caused by beans is reduced when ajowan is cooked with the beans. It may be used as a substitute for cumin as well. It is also known traditionally as a digestive

aid and an anti-emetic (<http://en.wikipedia.org/wiki/Ajwain>). The whole ajowan seed, powder and oil are used as adjuncts for flavouring foods, as antioxidants and as a preservative in confectionary, beverages and pan mixtures. Ajowan oil is also used in the preparation of lotions and ointments in the cosmetic industries (Malhotra and Vijay, 2004; Malhotra, 2006).

Products

The characteristic odour of ajowan oil is due to the high content of thymol (61%). Thymol easily crystallizes out from the oil and is sold in Indian markets as ajowan *kaphool*, or *sat-ajowan*, and is much valued in medicines. Thymol is used as an ingredient of deodorants, mouthwashes, toothpastes and many pharmaceutical preparations. The leftover residue after distillation contains 15–17% protein and 20–25% fat and is valued as cattle feed. The major processed products are ajowan oil, oleoresin, thymol, thymol crystals, dethymolized oil (thymene) and fatty oils (Malhotra and Vijay, 2004).

Ajowan oleoresin prepared from seeds gives a warm, aromatic and pleasing flavour to food products and is used in processed foods, snacks, sauces and various vegetable preparations. Ajowan oil can be treated with aqueous alkaline solution to extract thymol (Pruthi, 2001). Fatty oils produced from ajowan seed have their use in various pharmaceutical and cosmetic industries, are used in the soap industry for flavouring and as a deodorant. They are also used for perfuming disinfectant soaps and as an insecticide. A thymol-free fraction of the oil, known as 'thymene', finds application in soap perfumes (Malhotra and Vijay, 2004).

16.3. General Composition

Ajowan seed contains generally 8.9% moisture, 15.4% protein, 18.1% fat (ether extract), 11.9% crude fibre, 38.6% carbohydrates, 7.1% mineral matter, 1.42% calcium, 0.30% phosphorus and 14.6 mg/100 g iron, with a calorific value of 379.4 per 100 g. The percentage of seed oil extracted with *n*-hexane is 31.80%, while that with ethanol is 28%. The neutral lipid component of the oil includes hydrocarbons, esters, sterol esters, triglycerides, free fatty acids, diglycerides, sterols and monoglycerides, whereas the polar lipid components are phosphatidyl ethanolamines and phosphatidyl cholines (Qasim and Khan, 2001).

The oleoresin yield of ajowan is 24.66%, containing 12.15% volatile oil and 87.85% non-volatile material. The oleoresin samples can be kept cold (8–10°C), as well as at ambient temperature (25–30°C), for 60 days without any significant changes in their quality (Nagalakshmi *et al.*, 2000).

The chemical composition of ajowan (ground spice) is given in Table 16.2.

16.4. Chemistry

Ajowan oil is extracted from the seed by the steam distillation method. The two kinds of oils, i.e. essential oil (volatile oil) and non-volatile fatty oils, are extracted. Two

Table 16.2. Chemical composition of ajowan (ground spice per 100g).

Composition	Content
Carbohydrate (g)	24.6
Protein (g)	17.1
Fibre (g)	21.2
Water (g)	7.4
Food energy (calorie)	363
Minerals (g)	7.9
Ca (g)	1.525
P (g)	0.443
Na (mg)	56
K (mg)	1.38
Fe (mg)	27.7
Thiamine (mg)	0.21
Riboflavin (mg)	0.28
Niacin (mg)	2.1

Source: Malhotra and Vijay (2004).

integrated methods are available to recover both these oils from the crushed seeds: the sequential method and the combined extraction method. Ajowan seeds contain 3–4% essential oil and 26% fatty oils (Malhotra and Vijay, 2004).

The composition of the volatile oil, which determines the odour and flavour characters, has been of particular interest to chemists. Ajowan oil is composed of phenols, terpenes and *p*-cymene. The essential oil contains more than 27 compounds, of which thymol (61%) is the major one, the others being paracymene (15.6%), γ -terpinene (11.9%), β -pinene (4–5%), dipentene (4–6%), camphene and myrcene. The essential oil composition of ajowan seed is given in Table 16.3.

The oil also contains, in addition to thymol, a liquid hydrocarbon, which is called cymol or crymene. It is also probable that the oil contains another hydrocarbon, which is isomeric with oil of turpentine (Malhotra and Vijay, 2004).

Saharkhiz *et al.* (2005) studied the effects of different harvesting stages on the essential oil content and composition of ajowan cultivated in Iran. The essential oils of the fruits were extracted by hydrodistillation and analysed by capillary gas chromatography (GC) and GC-MS. The essential oil content of fruits harvested at pasty and ripe

Table 16.3. Essential oil composition of ajowan seed.

Component	Essential oil (%)
<i>Phenolic part</i>	
Safrole	0.10
Thymol	87.75
Carvacrol	11.17
<i>Non-phenolic part</i>	
α -Thujene	0.27
α -Pinene	0.28
β -Pinene	2.38
Myrcene	0.81
<i>p</i> -Cymene	60.78
Limonene	8.36
γ -Terpinene	22.26
Terpinolene	0.13
Linalool	0.27
Camphor	0.28
(<i>Z</i>)- β -Terpineol	0.19
(<i>E</i>)- β -Terpineol	1.35
Borneol	0.49
Terpinen-4-ol	0.12
α -Terpineol	0.22
Carvone	0.15
Safrole	0.16

Source: Malhotra and Vijay (2004).

stages was 7.1 (w/w) and 3.2% (w/w) based on dry weights, respectively. The major components of the oil of fruits harvested at the pasty stage were γ -terpinene (43.2%), thymol (32.4%) and *p*-cymene (20.7%), while the main components of the oil of ripe fruits were thymol (36.7%), γ -terpinene (36.5%) and *p*-cymene (21.1%).

Nagalakshmi *et al.* (2000) indicated the proximate composition of ajowan seeds

and the physico-chemical characteristics of the volatile oil. The GC-MS analysis of the volatile oil shows the presence of 17 constituents, of which thymol (39.36%), γ -terpinene (30.97%), *p*-cymene (19.47%), β -pinene (5.45%) and α -pinene (1.48%) were the major constituents. Malhotra and Vashishtha (2005) reported the effect of seed rate and row spacing on growth, yield and essential oil of ajowan genotypes. Figure 16.1 illustrates the structures of the major volatiles of ajowan.

Mineral nutrition and oil composition

Studies on the effect of the interaction of nitrogen and phosphorus on the seed and essential oil yield of ajowan show an increase in the essential oil yield, with increasing levels of P and N interactions. (Krishnamoorthy and Madalageri, 2000).

Akbarinia *et al.* (2004) reported the effect of different rates of chemical fertilizer, manure and a mixture of both on seed yield and composition of the essential oil of ajowan. An increase in N and P fertilizer rate to 90 and 60 kg/ha, respectively, increased seed yield but had no effect on the essential oil content. An increase in the application rate of green manure also increased seed yield and oil content. The integrated treatments give the highest seed and essential oil yields. Nitrogen at 60 kg/ha, 40 kg P/ha and 20 t manure/ha increased thymol content, while it decreased *p*-cymene content. The integrated treatments also gave the highest essential oil and thymol contents (Akbarinia

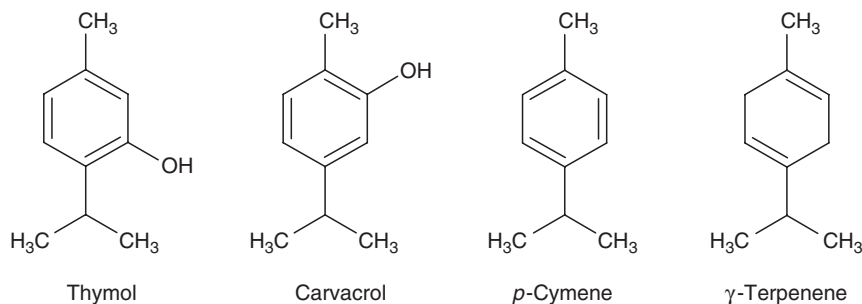


Fig. 16.1. Major volatiles of Ajowan.

et al., 2005). Nitrogen and P application had no effect on the essential oil content in comparison with the control, whereas the manure applied, separately or with NP, increased the essential oil content. The highest oil content was recorded in the N:P (30:20) kg/ha + 35 t manure/ha treatment, followed by the 30 t manure/ha and N:P (60:40) kg/ha + 25 t/ha treatments. Nine components were identified in the oil of ajowan seed, with thymol, δ -terpinene and *p*-cymene as the major constituents. Application of N:P (90:60) kg/ha or 20 t manure/ha increased thymol but decreased *p*-cymene. Application of N and P or manure had no significant effect on δ -terpinene. Compared with separate application of N and P or manure, the NP + manure treatment recorded the highest thymol. There were no significant differences between the NP + manure treatments regarding the major constituents (Akbarinia, *et al.*, 2005).

16.5. Medicinal and Pharmacological Properties

Ajowan seed has been popular from ancient times for its use in folk medicines. The seeds contain an essential oil with 50% thymol, which is a strong germicide, antispasmodic and fungicide. Thymol is also used in toothpaste and perfumery. It is used in a steeped liquid form against diarrhoea and flatulence. In India, the seeds are used as a household remedy for indigestion and colic and are used in poultices to relieve asthma and arthritis. It is also reported to have aphrodisiac properties (<http://en.wikipedia.org/wiki/Ajwain>; <http://www.theepicentre.com/Spices/ajowan.html>). Thymol isolated from the oil is a powerful antiseptic and an ingredient in a number of skin ointments/powders, deodorants, mouthwashes, toothpastes and gargles.

Ajowan has long been used in indigenous medicines for the treatment of diarrhoea, dysentery, atonic dyspepsia, cholera, flatulence and indigestion. The oil has properties for using as an expectorant in emphysema, bronchial pneumonia and respiration ailments, and also possesses an antidiuretic effect. Alcoholic extract of ajowan exhibited

potent antimicrobial effects, inhibiting the growth of *Bacillus subtilis*, *Escherichia coli* and *Saccharomyces cerevisiae*. The methanolic extracts of ajowan seeds possess natural antioxidant properties. The aqueous portion left after the separation of essential oil from ajowan is known as *omum*-water (ajowan water) in India, which is used against flatulence and in gripe water preparations for children. Hajare *et al.* (2005) described the aflatoxin inactivation potential of aqueous extract of ajowan. Sharangi and Datta (2005) also described the anti-helminthic, carminative, laxative, diuretic, flatulence preventive and dyspepsia preventive properties of ajowan.

Antibacterial activity

The antibacterial activity of homogenized seed oil and residues indicates that the powdered seeds of *C. copticum* exhibit antibacterial activity against *Staphylococcus aureus* only and not *E. coli*. The oil extracted with *n*-hexane exhibited antibacterial activity against both organisms, while the oil extracted with ethanol and *n*-hexane did not. The residue left after ethanol extraction exhibits antibacterial activity against *E. coli* only (Qasim and Khan, 2001).

The antimicrobial activity of ajowan oils against *Aspergillus niger*, *S. cerevisiae*, *Mycoderma* sp., *Lactobacillus acidophilus* and *B. cereus*, as estimated by the paper disc agar diffusion method, has been reported by Meena and Sethi (1994).

Antioxidant activity

The oils of ajowan show excellent antioxidant effects (better than those of the synthetic antioxidant and butylated hydroxytoluene; Gurdip *et al.*, 1998). Mehta *et al.* (1994) demonstrated ajowan as a source of natural lipid antioxidant. Soybean oil treated with methanolic extracts has been subjected to storage and heating tests, which showed a marked decrease in oxidation of the oil as measured using peroxide values, conjugated diene

values and GC analysis of oxidized fatty acid methyl esters. The formation of primary and secondary oxidation products of oxidized soybean oil was significantly lower for oil treated with ajowan extracts than control.

Mehta and Zayas (1995) showed anti-oxidant properties in a methanolic extract of ajowan using linoleic acid.

Phytomedicine

Ajowan is known to traditional healers to have hypotensive properties. Bioassay-directed fractionation of seeds results in the isolation of thymol. In anaesthetized rats, thymol (1–10 mg/kg, i.v.) produces dose-dependent reductions in blood pressure and heart rate (Aftab *et al.*, 1995).

Among other products, ajowan salt is prepared commercially by mixing finely ground rock salt and is used mostly for folk remedies of digestive problems (Malhotra and Vijay, 2004). Ajowan seeds are reported to be useful in flatulence, colic, atonic dyspepsia, diarrhoea, cholera, hysteria and spasmodic affections of the bowel. The seed produces a feeling of warmth and relieves the sinking and fainting feelings which accompany bowel disorders. Ajowan seed in conjunction with asafoetida, myrobalan and rock salt proved beneficial in stomach ache problems. A hot poultice of seed is used as a dry fomentation to the chest in asthma and expectoration from bronchitis (Malhotra and Vijay, 2004).

Indian folk remedies suggest that ajowan seed with a little rock salt mixture daily after meals improves indigestion and

irregular diet. Buch *et al.* (1988) report the effect of ajowan volatile oils on ejaculated human spermatozoa. The volatile oils are instantaneously spermicidal in varying dilutions and their action is dependent on concentration and time.

Ajowan seed and its extract do not appear to have any significant toxicity. Normally, the concentrations of compounds in ajowan do not pose a health threat for consumption or to fieldworkers handling the plants (Malhotra and Vijay, 2004).

16.6. Specifications

Saxena *et al.* (2004) established the quality standards of whole ajowan and ajowan powder. The whole and powdered forms of ajowan (dried fruits) being sold in Indian markets have been evaluated. The moisture content, organic extraneous matter, inorganic extraneous matter, damaged/shrivelled/immature seeds and volatile oil content of whole ajowan and the moisture, total ash, acid-insoluble ash, non-volatile ether extract, crude fibre and volatile oil content of powdered ajowan are used as quality parameters. Agmark grade specifications of ajowan seed are given in Table 16.4.

16.7. Conclusion

Ajowan, or bishop's weed (*Trachyspermum ammi*), is an important seed spice particularly suitable to delicate vegetarian cuisine. It has a strong and distinctive thyme-like

Table 16.4. Agmark grade specifications of ajowan seed.

Grade designation	Special characteristics			
	Inorganic matter (% by foreign weight maximum)	Organic damaged, discoloured matter (% by weight weight maximum)	Shrivelled, immature, and weevilled (% by maximum)	Moisture
Special	0.24	0.50	1.0	11
Good	0.50	0.75	2.0	11
Fair	1.00	1.00	3.0	11

Source: Malhotra and Vijay (2004).

fragrance, leaving a milder, pleasant after-taste to the food. The characteristic odour of ajowan oil is due to the high content of thymol in the oil. It is used as an ingredient in deodorants, mouthwashes, toothpastes and many other pharmaceutical preparations. The major processed products are ajowan oil, oleoresin, thymol crystals, dethymolized oil and fatty oils. In the new era of ethnic foods, ajowan possesses a great future.

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