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Variation in essential oil constituents of fennel (*foeniculum vulgare* mill) varieties

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Abstract

Essential oil of seven varieties of fennel released from SKN college of Agriculture, Jobner was extracted and their constituent were analyzed by GC-MS. All the varieties showed significant difference in essential oil content which was ranging from 1.50 % in variety RF-143 to 2.15 % in variety RF-101. Eleven major compounds were identified by GC-MS. 4-allyl anisole was found as main constituent in all the varieties, content of which varied from 34.173 % in variety RF-145 to 70.733 % in variety RF-178. Anethole + Estyragol were the second most important constituent showed large variation from 19.346 % to 61.25 %. Gama terpinene was another constituent showed significant variation in varieties. Studied varieties showed significant genetic variation in essential oil constituents.

Key words: Fennel, 4-allyl anisole, essential oil, essential oil constituents.

Introduction

Fennel (*Foeniculum vulgare* Mill) belonging to family *Apiaceae*, is a cross pollinated diploid species with chromosome number, 2n = 22 and native of Europe and Meditarean region. Fennel is an annual, aromatic herb of 100-180 cm height and one of the most important medicinal plants that are cultivated worldwide,possessing many medicinal uses. Fennel fruits are used against diseases like cholera, bile disturbances, neurological disorders, constipation, dysentery and diarrhea and also used for controlling of diseases attacking chest, lungs, spleen, and kidney and in treating colic pain. In India the seeds are also used for mastication synonyms either alone or with betel leaves (Rathore *et al.,* 2013). The seeds contain about 9.5% protein, 10.0% fat, 42.3% carbohydrates, 18.5% crude fibre and 13.4% minerals (Pasrija *et al.,* 2011). The seeds yield about 0.7 to 6.0% volatile oil depending on the genotype or botanical types. The main constituents of the fennel oil are anethole and fenchone. Fennel is cultivated throughout the temperate and subtropical region in the world mainly in the countries like, Romania, Russia, Hungary, Germany, France, Italy, India, Sri Lanka, Malaysia, Japan, Argentina and USA. In India, it is mainly grown in the states of Rajasthan and Gujarat and to some extent in U.P., Karnataka, A.P., Punjab, M.P., Bihar, Haryana and J & K. Total area under the crop in India is about 0.99 lakh hectares with production of 1.43 MT (Anonymous, 2014).

In Rajasthan, it occupies an area of 15160 hectares with an annual production of 14.28 MT (Anonymous, 2014). It is mainly cultivated in the districts of Sirohi, Jodhpur, Nagour, Tonk, Dausa and Pali and to a limited extent in Bharatpur, Kota and Ajmer. Though the crop is a potential as a cash crop in Rajasthan, limited work has been done as far as its genetic improvement is concerned. The importance of fennel based on its medicinal value and export potential as spices was recognized long back, but it remained neglected for long time from scientific attention for its improvement in its productivity as well as its quality. Research on developing high yielding varieties of fennel was initiated at SKN college of Agriculture, Jobner as a centre of AICRP on spices, ICAR and till date a good number of fennel varieties have been

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developed for different agronomic traits. Present paper analyzed the genetic variation in fennel varieties released from this centre for essential oil constituents.

Experimental plant material

Seeds of seven varieties of fennel were obtained from AICRP on spices, Department of Plant Breeding & Genetics, SKN Agriculture, University, Jobner (India). All the varieties used for profiling were developed and released from AICRP on spices, Jobner, Rajasthan centre.

Extraction of essential oil

Fifty gram ground powder of each fennel varieties were used for essential oil extraction by hydro-distillation using a Clevenger apparatus (Clevenger, 1928) for 6 h and essential oil were recovered and calculated in terms of percentage. The essential oil has a characteristic odour of 4-allyl anisole, Anethole + Estyragol and a mild, sweet, warm, aromatic flavour.

Gas chromatography-Mass Spectroscopy

One microlitres of volatile oil extracted from fennel seeds was injected to a HP 5 MS column (Agilent, USA, 30m×0.250mm film thickness 0.25 μm) using auto sampler (Agilent, 7693). The analysis was carried out under the following conditions: oven temperature was programmed at 50 ºC for 3 min followed by raising at 10 ºC/min till 180 ºC and 45 ºC/min till 280 ºC, injection port temperature was kept 250 ºC; detector temperature 250 ºC; carrier gas: helium; flow rate 1 ml/min, split ratio was 10:1. Authentic standards of major constituents of fennel essential oil were procured from Sigma- Aldrich (USA). These standards were run alone and in combination to get retention time of each constituent. Retention indices of all the constituents were determined by chemstation software (Agilent technologies, USA). The volatile constituents were identified by comparing their retention indices and their identification was confirmed by matching their mass spectral fragmentation patterns of compounds in the NIST-MS library and published mass spectra.

Results and discussion

Table 1 showed the volatile oil content estimated from ground seeds of seven released varieties of fennel. Volatile oil content in seeds of different varieties was ranging from a minimum of 1.50 % in RF-143 to a maximum of 2.15 % in RF-101 (Table-1). It is well documented that genetic constitution and environmental condition influence the yield and composition of volatile oil produced by medicinal plant. (Ramezani *et.al.*, 2009 and Omidbaigi, 2007).

Table 1. Essential oil per cent in fennel varieties

S. No.	Variety	Oil (%)
1	RF-281	1.8
2	RF-101	2.15
3	RF-125	2.1
4	RF-205	1.90
5	RF-178	1.65
6	RF-143	1.50
7	RF-145	2.0
CD at 5%		0.12
CV		3.70

Eleven major compounds were identified in the essential oil extracted from seeds of fennel varieties (Table 2). The composition of essential oil constituents of these samples is given in Table 2 which shows that percentage of compounds identified in essential oils from seeds of different varieties ranged from 80.087 to 100.0 %. All the released varieties showed difference in essential oil constituents. 4-allyl anisole and Anethole + Estyragol were the main constituents in all the samples, the content of which varied from 34.173 % in variety RF-145 to 70.733 % in variety RF-178 and 19.346% in variety RF-178 to 61.25% in variety RF-145, respectively. After 4-allyl anisole and Anethole + Estyragol, Gama terpinene is another constituent found in the range of 2.243 in variety RF-205 to 8.684 % in variety RF-125.

Edoardo *et al.,* 2010 had screened out the essential oil composition of wild Sicilian fennel, they had selected fifty-six samples of wild fennel (*Foeniculum vulgare* Mill.) from different localities

Table 2. Chemo profiling of essential oil (%) from seeds of Fennel (*Foeniculum vulgare* Mill) varieties.

Compounds	RF-281	RF-101	RF-125	RF-205	RF-178	RF-143	RF-145
α- Pinene	0.60	0.66	0.87	0.19	0.60	0.66	0.25
Camphene	0.06	0.06	0.06	0.01	0	0.06	0.03
β- Pinene	0.04	0.02	0.02	0.01	0.02	0.03	0.02
Myrecene	0.17	0.05	0.26	0.05	0.13	0.16	0.11
Cymene/Cymol	0.07	0.17	0.08	0.07	0.07	0.07	0.05
gamma terpinene	5.37	6.86	8.68	2.24	8.19	4.30	3.73
4-allyl anisole	45.84	59.62	70.51	41.55	70.73	48.07	34.17
Geraniol	0.02	0.03	0.01	9.47	0.81	0.03	0.23
p-anisaldehyde	0	4.59	0	0	0	0	0
anethole+estyragol	45.24	23.09	19.46	26.07	19.34	43.54	61.25
Geranyl acetate	0.03	0.35	0.00	0.39	0.07	0.06	0.12
	97.46	95.55	99.99	80.08	100	97.02	100

of Sicily and analysed for their contents in seed essential oils. The GC-FID-MS analysis allowed identifying 78 compounds, representing more than 98% of the oils.

Similar observations were also made by Ramasamy *et al.* 2007 while characterizing aroma of coriander (*Coriandrum sativum* L.) oil samples. They collected coriander (*Coriandrum sativum* L.) seeds from eight regions of India and examined them for their volatile constituents and found large variation in essential oil content as well as their constituents.

Another important constituent is α- Pinene, the content of which varied from 0.199 in variety RF-205 to 0.87 % in variety RF-125. p-anisaldehyde is the constituent which was observed only in variety RF-101, among the analysed varieties.

In addition to 4-allyl anisole, anethole+estyragol, gamma terpinene and α- Pinene several other compounds like Myrecene, β- Pinene, Camphene, Cymene/Cymol, and Geranyl acetate also contributed to the characteristic aroma of fennel fruits 28. In the present study varieties RF-178 and RF-125 had higher percentage of major constituents of essential oil of fennel (Table 2).This variation can be utilized in breeding of varieties with higher essential oil content.

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