

1-1-2004

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### Recommended Citation

ARSLAN, NEŞET; GÜRBÜZ, BİLAL; SARIHAN, ERCÜMENT O.; BAYRAK, ALİ; and GÜMÜŞÇÜ, AHMET (2004) "Variation in Essential Oil Content and Composition in Turkish Anise (*Pimpinella anisum* L.) Populations\*," *Turkish Journal of Agriculture and Forestry*. Vol. 28: No. 3, Article 4. Available at: <https://journals.tubitak.gov.tr/agriculture/vol28/iss3/4>

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## Variation in Essential Oil Content and Composition in Turkish Anise (*Pimpinella anisum* L.) Populations\*

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Received: 06.08.2003

**Abstract:** This research was carried out at the University of Ankara, Faculty of Agriculture, Field Crops Department and the laboratories of the Food Engineering Department. Twenty-nine anise seed samples were collected from different locations in 9 producer provinces in Turkey and were used as the study materials in order to determine essential oil and essential oil compositions. According to the results, essential oil levels varied from 1.3% to 3.7%. The major component of the essential oil was *trans*-anethole. This compound ranged from 78.63% to 95.21%. Population 26 may be recommended for *trans*-anethole percentage and populations 8 and 22 for essential oil content.

**Key Words:** Anise populations, *Pimpinella anisum*, essential oil content, essential oil composition, *trans*-anethole

### Türk Anason Populasyonlarının Uçucu Yağ Miktarı ve Bileşiminin Değişimi

**Özet:** Bu araştırma, Ankara Üniversitesi, Ziraat Fakültesi, Tarla Bitkileri Bölümü ve Gıda Mühendisliği Bölümü laboratuvarlarında yürütülmüştür. Farklı anason üretim yörelerinden toplanan 29 tohum örneği araştırma materyali olarak kullanılmış ve bunların uçucu yağ miktarı ve bileşenleri belirlenmiştir. Araştırma sonuçlarına göre anason populasyonlarının uçucu yağ oranları %1.3-3.7 arasında değişmiştir. Uçucu yağların ana bileşeni olan *trans*-anetol oranı % 78.63 – 95.21 arasında değişim göstermiştir. Uçucu yağ içeriği bakımından 8 ve 22 numaralı populasyonlar, *trans*-anetol için 26 nolu populasyon önerilmiştir.

**Anahtar Sözcükler:** Anason populasyonları, *Pimpinella anisum*, uçucu yağ miktarı, uçucu yağ bileşimi, *trans*-anetol.

### Introduction

Anise (*Pimpinella anisum* L.) is an annual aromatic crop, belonging to the family Apiaceae. The genus *Pimpinella* contains 23 species, 8 of which are endemic in Turkey (Davis, 1972). Anise is native to the Middle East and it has been known since the time of ancient Egypt (Hemphill and Hemphill, 1988).

Anise is cultivated in Turkey for domestic consumption and export with a planting area of about 21,000 ha and annual seed production of about 11,000 tons (State Institute of Statistics, 2002). Important anise

producing countries are India, Mexico, Egypt, Italy, Spain, Syria, France, Bulgaria and Tunisia (Reineccius, 1994).

The Romans discovered that anise seeds and others aromatic spices helped digestion and they used anise as an ingredient of a special cake. They also used anise seed in perfumes. The peoples of Asia Minor and Greece used it for many medicinal applications (Dwyer and Rattray, 1997).

*P. anisum* is primarily cultivated for its fruits, commercially called "seed" that are currently used for flavouring. In addition the essential oil of anise is a

\* This research was supported by the Research Fund of Ankara University

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valuable commodity in medicine and perfumery. In Turkish folk medicine this plant, and especially its seeds has been used as an appetiser, diuretic and tranquilliser. Anise seed is used extensively in an alcoholic beverage (raki) in Turkey (Gülçin et al., 2003).

In previous studies, the essential oil content of anise seed was recorded between 2.1% and 2.8%, and important compounds were determined as *trans*-anethole, methyl chavicol and anisaldehyde (Bayram, 1992). Satıbeşe (1992) reported that essential oil in anise populations varied from 2.66% to 3.14%.

The aim of the present study was to determine the variation in essential oil content and composition of anise seeds collected from major producer provinces in Turkey.

### Materials and Methods

This research was carried out at the University of Ankara, Faculty of Agriculture, Field Crops Department and the laboratories of the Food Engineering Department.

Twenty-nine anise seed samples collected from different production areas were used as the study material. The sample numbers and origins of the seed materials are shown in Table 1.

Seed materials of populations were analysed after 3 months from harvesting in order to determine essential oil content and compositions. Essential oil content (% v/w) was determined by hydrodistillation method with 2 replications for 3 h, using Clevenger apparatus, and the oil composition was investigated by gas chromatography (GC).

#### The GC operating conditions were as follows:

Apparatus:	Thermo Quest 2000
Column:	Stabilwax, 15 m, ID 0.25 mm, film thickness 0.25 µm
Injector temperature:	250 °C
Detector temperature:	250 °C
Column temperature:	Programmed from 100 °C to 200 °C at 2 °C min <sup>-1</sup> (1 min hold)
Carrier gas:	Nitrogen for GC

Split ratio:	60:1
Sample injected:	0.5 µl
Detector:	FID

### Results and Discussion

Sample numbers and the origins of the seed materials are presented in Table 1.

As shown in Figure 1, the essential oil contents of anise seed samples varied between 1.3% and 3.7%. The average value was 2.66%. There was a difference of 2.4% between the highest and the lowest value. There was important variation among the anise seed samples in Turkey in respect of oil content. In general, essential oil content was highest value in the Balıkesir, Burdur, Denizli and İzmir populations. Significant differences were found among the essential oils of anise populations and 9 different groups were observed statistically.

The highest essential oil content was recorded in populations 8 and 22 (3.7%), and the lowest ratio was obtained in populations 7 and 12 (1.3%) (Figure 1). In previous studies, the essential oil contents of anise seeds were reported by Reineccius (1994), Schuster (1992), Ashurst (1999) and Baytop (1984) as 1.5-6.0 %, 1.5 - 6.0 %, 2.5 % and 2.0-4.0%, respectively. Our results were between the lowest and the highest values reported. The amounts of secondary compounds like essential oils are affected by genetic factors, climate, soil and cultivation techniques (Pitarevic et al., 1985; Verzar-Petri et al., 1985).

The essential oil compositions of our samples are shown in Table 2. The main component of the essential oil was *trans*-anethole. Santos et al. (1998) also recorded that *trans*-anethole was the main compound of anise essential oil.

Table 1. The sample numbers and origins of anise seed populations.

Sample number	Origin
1,2	Afyon
3,4,5,6	Antalya
7,8	Balıkesir
9,10,11,12,13,14,15,16,17	Burdur
18,19	Bursa
20,21,22,23,24	Denizli
25,26	İzmir
27,28	Muğla
29	Uşak

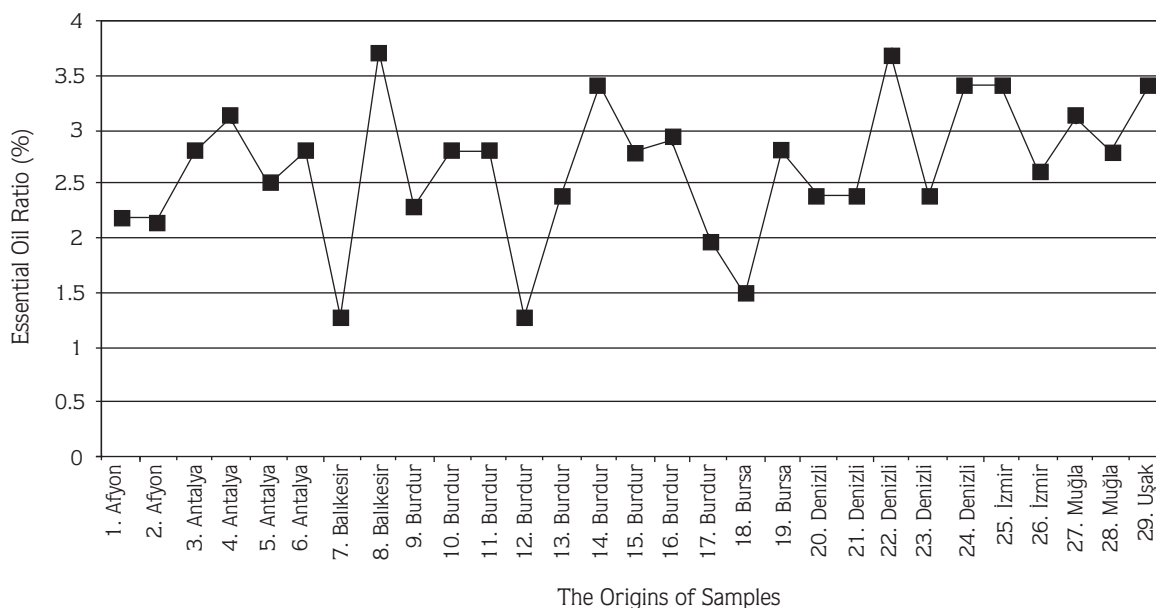


Figure 1. The variation of essential oil contents in anise (*Pimpinella anisum* L.) in Turkey.

Table 2. Essential oil composition of anise seed samples from various provinces (%).

Compounds	Samples													
	Afyon		Antalya				Balıkesir		Burdur					
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
$\alpha$ - pinene	-	0.01	tr	tr	tr	-	-	-	0.01	tr	0.01	0.01	0.01	tr
camphene	-	-	tr	0.01	0.01	-	-	-	-	tr	-	-	-	-
$\beta$ - pinene	-	-	0.01	0.01	tr	-	0.01	-	0.01	0.04	-	tr	-	tr
sabinene	-	-	tr	tr	-	-	-	-	0.05	-	-	-	-	0.01
myrcene	-	-	tr	tr	tr	-	-	-	-	-	0.02	0.01	0.04	-
$\Delta$ - 3-carene	0.01	tr	0.03	0.04	0.04	-	tr	0.01	-	tr	0.01	0.01	-	tr
$\alpha$ - phellandrene	-	-	tr	tr	tr	-	-	-	0.06	0.03	-	0.02	-	0.03
$\alpha$ - terpinene	-	-	-	-	-	-	-	-	-	-	0.01	0.01	0.01	-
$\beta$ - phellandrene	-	-	0.01	0.01	-	-	-	-	-	-	0.01	0.02	0.01	-
1,8 - cineole	tr	-	-	tr	-	-	-	tr	0.08	tr	-	-	-	tr
cis - ocimene	tr	tr	-	-	-	tr	0.01	tr	-	-	0.02	-	-	-
trans - ocimene	0.01	tr	0.01	0.01	0.01	0.01	tr	-	0.03	0.01	tr	-	-	0.01
$\gamma$ - terpinene	0.03	0.02	tr	0.01	tr	0.02	-	tr	1.90	tr	0.04	-	0.05	0.01
p - cymene	0.01	tr	0.02	0.03	0.02	0.01	-	tr	1.51	-	0.39	0.49	0.54	tr
terpinolene	0.01	tr	-	0.02	0.02	-	-	tr	-	0.03	0.12	0.14	0.12	0.01
linalool	0.01	tr	1.62	2.38	2.65	0.01	0.21	0.01	-	2.34	0.31	0.41	0.30	2.40
linalyl acetate	-	-	-	-	-	0.01	-	-	-	-	-	-	-	-
terpinene -4- ol	tr	tr	0.46	0.67	0.65	0.14	tr	0.01	-	0.38	-	-	-	0.30
methyl chavicol	2.61	2.42	0.41	0.65	0.47	2.67	2.40	0.39	-	0.53	0.08	0.08	0.07	0.44
$\alpha$ - terpineol	1.50	0.97	-	-	-	0.54	0.74	0.54	-	-	-	-	-	-
cis - anethole	-	-	-	-	0.13	0.17	-	-	-	-	-	-	-	-
trans - anethole	89.76	89.48	89.71	92.23	92.94	94.46	89.50	84.70	80.36	91.51	92.80	93.39	90.50	94.03
methyl eugenol	0.38	1.18	0.40	-	0.51	0.02	1.01	0.30	-	0.02	0.01	-	-	-
anisaldehyde	0.03	0.25	0.03	0.74	0.01	0.53	0.20	0.24	0.03	0.58	0.01	tr	tr	0.73
anisic acid	0.03	0.24	0.20	0.04	0.22	0.02	0.16	0.21	0.67	0.03	0.02	0.01	0.01	0.02
acetoanisole	0.01	0.19	0.03	0.05	0.05	0.03	0.11	0.19	-	0.31	0.58	0.39	0.42	0.03
anisyl alcohol	0.03	0.27	0.05	0.04	0.07	0.04	0.08	-	-	0.15	0.01	0.05	0.01	0.02
isoeugenol	-	0.17	0.07	0.13	0.06	0.08	-	0.19	-	0.18	tr	tr	0.01	0.09
Number of identified compounds	17	18	21	22	21	17	14	16	11	19	18	17	15	19
Total	94.43	95.20	93.06	97.07	97.86	98.76	94.43	86.79	84.71	96.14	94.45	95.04	92.10	98.13

tr < 0.01

Table 2. (continued).

Compounds	Samples															Average (%)
	Burdur			Bursa		Denizli				İzmir		Muğla		Uşak		
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	
$\alpha$ - pinene	tr	0.01	tr	tr	-	-	-	-	0.01	tr	-	-	-	-	-	0.010
camphene	0.01	0.02	-	-	-	-	-	-	0.01	0.01	-	-	-	tr	-	0.012
$\beta$ - pinene	0.01	tr	-	-	-	-	-	tr	0.01	0.01	-	-	-	-	-	0.014
sabinene	-	tr	-	-	-	-	-	-	tr	tr	-	-	-	-	0.01	0.023
myrcene	tr	-	-	0.01	-	-	-	tr	0.01	tr	-	-	-	-	-	0.018
$\Delta$ -3-carene	-	0.03	-	0.01	tr	-	tr	tr	0.03	0.04	0.01	-	-	-	0.01	0.022
$\alpha$ - phellandrene	0.03	tr	-	-	-	-	-	-	0.03	tr	-	0.01	-	-	tr	0.030
$\alpha$ - terpinene	-	-	-	-	-	-	-	-	-	-	-	-	-	-	tr	0.010
$\beta$ - phellandrene	-	tr	-	tr	-	-	-	-	0.02	0.01	-	-	-	-	tr	0.013
1.8 - cineole	-	-	tr	-	tr	-	-	tr	-	tr	-	tr	-	tr	tr	0.080
cis - ocimene	-	-	0.01	tr	0.01	-	tr	-	-	-	tr	tr	-	tr	0.01	0.012
trans - ocimene	0.01	0.02	tr	0.01	tr	-	tr	0.02	0.02	0.02	tr	0.01	tr	0.01	tr	0.014
$\gamma$ - terpinene	tr	0.01	0.03	0.03	0.03	0.01	0.02	0.01	0.01	0.01	-	0.02	0.02	0.04	0.03	0.112
p - cymene	0.02	0.03	0.01	0.01	0.01	0.08	0.01	0.01	0.03	0.04	0.01	-	-	-	0.01	0.157
terpinolene	0.02	0.03	0.01	tr	0.03	0.09	0.01	0.05	0.03	0.03	0.05	0.01	-	0.01	0.12	0.046
linalool	2.42	2.32	0.01	0.01	0.01	0.30	0.01	0.04	1.81	2.03	0.01	0.01	-	0.01	0.01	0.833
linalyl acetate	-	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	0.010
terpinene -4- ol	0.39	0.26	1.83	tr	1.93	0.56	1.68	0.81	0.82	0.53	0.02	0.17	-	0.01	0.01	0.582
methyl chavicol	0.30	0.41	0.01	0.03	0.55	2.54	0.01	0.49	0.57	0.39	0.61	0.06	0.70	2.67	tr	0.836
$\alpha$ - terpineol	0.04	-	1.55	1.01	0.60	3.94	1.82	0.13	0.05	-	0.57	1.07	0.39	1.60	0.36	0.968
cis - anethole	-	-	-	-	-	-	-	-	-	-	-	-	-	0.13	-	0.143
trans - anethole	93.30	85.45	89.58	91.95	92.01	84.10	88.86	91.06	91.95	92.44	83.65	95.21	78.63	85.35	87.87	89.544
methyl eugenol	0.09	-	1.93	2.44	0.90	0.04	-	-	0.03	-	0.28	0.03	0.24	1.35	1.20	0.618
anisaldehyde	0.77	0.64	0.21	0.01	0.03	0.09	5.76	0.48	0.44	0.63	0.23	0.01	0.20	0.33	0.30	0.520
anisic acid	0.18	0.03	0.13	0.02	0.04	0.12	0.16	0.24	0.03	0.19	0.19	0.05	0.20	0.29	0.30	0.140
acetovanisole	0.04	0.03	0.06	0.04	0.06	1.97	0.10	0.12	0.08	0.13	0.17	0.03	0.16	0.10	0.23	0.204
anisyl alcohol	0.09	0.02	0.03	-	0.05	0.11	0.04	0.30	0.08	0.08	0.02	0.14	0.15	0.19	0.22	0.090
isoeugenol	0.91	0.05	0.04	-	0.14	-	-	0.06	0.06	0.08	0.09	-	0.26	0.38	0.48	0.177
Number of identified compounds	17	21	18	18	18	13	15	18	23	22	16	16	18	18	14	
Total	98.63	89.37	95.44	95.58	96.85	93.95	98.48	93.82	96.13	96.67	85.91	96.83	81.08	92.34	91.17	93.81

tr &lt; 0.01

In this study, *trans*-anethole varied between 78.63% and 95.21%. The highest percentage was recorded in population 26 and the lowest in population 27. Lawrence (1976) reported 94.7% *trans*-anethole in anise oil. Akgül (1993) reported that *trans*-anethole ranged from 80% to 90%. The other relatively important components in our samples were  $\alpha$ -terpineol, methyl chavicol and linalool. The numbers of identified compounds in the essential oil of the 29 anise samples ranged from 11 to 23. Total percentages of identified compounds however, varied from 81.08% to 98.76%. The average value of the totally identified compounds was 93.81% (Table 2).

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