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ANASON (*Pimpinella anisum* L.) ÇEŞİT VE EKOTİPLERİNİN BAZI TEKNOLOJİK ÖZELLİKLERİ ÜZERİNE ORGANİK ve İNORGANIK GÜBRE UYGULAMALARININ ETKİSİ

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ÖZET*
Bu çalışma, Aydın ekolojik koşullarında organik ve inorganik gübre uygulamalarının Anason (*Pimpinella anisum* L.) çeşit ve ekotiplerinin bazı teknolojik özellikleri üzerine etkisini belirlemek amacıyla yapılmıştır. Deneme, 2005 üretim sezonunda Adnan Menderes Üniversitesi Ziraat Fakültesi Uygulama Çiftliğinde yürütülmüştür. Araştırmada üç farklı anason ekotipi (Çeşme, Fethiye-Seki, Denizli-Acıpayam) ve bir tescilli çeşit (Gölhisar) ile altı farklı gübre uygulaması (kontrol, ticari gübre, ahır gübresi, organik gübre, ticari gübre x organik gübre ve ticari gübre x ahır gübresi kombinasyonu) denenmiştir. Çalışmada; uçucu yağ oranı, uçucu yağ verimi, uçucu yağ bileşimi, uçucu yağın yoğunluğu incelenmiştir. Uçucu yağ oranının en yüksek değeri (%1.863) ticari gübre x organik gübre uygulaması ile Çeşme ekotipinden, en düşük değeri ise kontrol (%1.267) uygulaması ile Gölhisar çeşidinden elde edilmiştir. Uçucu yağın en önemli bileşeni olan Trans-anethol oranı % 97.50-98.49 arasında değişmiştir. Organik gübre uygulaması ve organik-inorganik gübre kombinasyonu uygulamasında uçucu yağın veriminin arttığı, fakat gübre uygulamalarının uçucu yağın bileşenlerini etkilemediği belirlenmiştir.
Anahtar kelimeler: Anason, *Pimpinella anisum* L., Organik gübre, Ticari x organik gübre kombinasyonu, teknolojik özellikler.

Impacts Of Organıc And Inorganic Fertilizer Applications Over Some Technological Characteristics Of Anise (*Pimpinella anisum* L.) Variety And Ecotypes*

ABSTRACT
This study was conducted to determine the impacts of organic and inorganic fertilizer applications over some technological characteristics of anise (Pimpinella anisum L.) variety and ecotypes under Aydın ecological conditions. Experiments were carried out over the experimental fields of Adnan Menderes University Agricultural Faculty during the production season of the year 2005. Three different anise ecotypes (Çeşme, Fethiye-Seki, Denizli-Acıpayam), one registered variety (Gölhisar) and six different fertilizer applications (control, commercial fertilizer, livestock manure, organic fertilizer, commercial x organic fertilizer and commercial fertilizer x livestock manure combination) were used in this research. Essential oil content, yield, composition and density were analyzed. While the highest essential oil content (1.863%) was observed in Çeşme ecotype with commercial x organic fertilizer application, the lowest value (1.267%) was observed in control treatment of Gölhisar variety. Trans-anethol ratio of essential oil varied between 97.50-98.49%. It was concluded that fertilizer application and organic-inorganic fertilizer combination increased the essential oil yield but didn't affect the composition of essential oil.
Key Words: Anise, *Pimpinella anisum* L., organic fertilizer, commercial x organic fertilizer combination, technological characteristics.

INTRODUCTION

Anise (*Pimpinella anisum* L.) is an annual aromatic plant from the Apiaceae family of Apiales order. This very old cultivar is Eastern Black sea-originated plant. It is cultivated in Turkey, Italy, Mexico, Spain, Germany, India, Central and South America (İlisulu, 1968; Ceylan, 1996). It has a significant utilization in medicine, spice and food industries.

Seeds and essential oil are the utilized parts of anise. Anise seeds are the fruits of the plant in botany. They are called fruits (Fructus Anisi) in drug trade and pharmacopeia. Anise fruits contain essential oil and the oil is used in medicines and as aromatiser in perfume, soap, detergent, cream and lotions to eliminate the nasty odors of cosmetics. It is also used in production of toothpaste and tooth cleaning powders and in regulation of the taste of these products (Goulden et al., 1966; Başer, 1997). It is also reported that anise and essential oil were used as flavorer in food products, alcoholic beverages and soft drinks, frozen dairy products, gelly and puddings and used as aromatiser in pipe tobacco (Anonim, 1970; Kılıç, 1996).

Anise essential oil is mostly used for raki production in Turkey. It is the source of its special flavor. Anise seeds contain 2-5% essential oil. Characteristic smell of the essential oil comes from Trans-anethol in compound of oil. Trans-anethol constitutes 75-94% of essential oil obtained by water vapor distillation from anise fruits. Anise essential oil

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is a tangy, colorless or pale yellow oil. Dilution with water causes raki to turn a milky-white color due to trans-anethol (Başer, 1997). Also, aniseed liquor is produced in several parts of the world.

Anise has an inflammatory, siccative, inhale facilitating and pain relieving character. It facilitates digestion and is recommended as a medice in children for mucositis over alimentary canal, intestinal colics and gas colics. Anise essential oil takes part in compounds of medicines used in medicine and pharmacy for treatment of stomach, lung and chest diseases (asthma, inhalation) (Zeybek and Zeybek, 1994). It has antifungal, spasm relieving and diuretic effects. It also takes part in compounds of antitussives and pastils. Anise essential oil is known for being breast milk enhancer, exudater and diuretic. It is also used against moth and itching (Baytop, 1963; Ceylan, 1996; Arslan et al., 2000). It relieves tension during the menstruation period and has a treater impact on insomnia. It is also an inflammation treater spice (Özer, 2004). The essential oil is used in treatment of hepatitis and prostate cancer (Anonymus, 2005a).

Besides the utilization as medicine, anise is also used as nourishment and spice. It is used as flavorer and aromatiser in bread, bagel, cookie, cake, pastry, marmalade and cheese (İlisulu, 1968; İncekara, 1979; Khan and Zaidi, 1983).

Anise cultivation is carried out in Turkey to produce drug fructus and essential oil and it has significant place among exported medicinal plants. Anise cultivation is carried out in Aegean, Mediterranean and Marmara Regions and some provinces of Central Anatolia Region of Turkey.

Anise has an aromatic characteristic since it contains secondary products, the essential oils, and it has a redolence because of essential oil contents (Ceylan, 1996; Baytop, 1999).

Ratios of secondary compounds in plants are effected from ecological conditions and varied depending on climate, soil texture and nutrients in soil (type and amount of fertilizer), period of the year, hours of the day (Ceylan, 1995). For instance; it was reported that high temperature and light intensity increased the synthesis of flavor and aroma compounds like vitamin C, sugars, esters, aldehydes and ketones (Schupman, 1961; Brohi, 1991). Phenylalanine lyse enzyme activity is a significant regulator of secondary metabolism and it is significantly affected by factors like nutrition level, hormone, light, fungal infection and damages (Lagouri et al., 1993; Taiz and Zeiger, 1991). Researchers wonder about the impacts of ecological factors over the yield and quality of secondary materials.

Implementations of ecological agriculture and utilization of ecological agricultural products are having great attention in recent years to reduce the impacts of agricultural chemicals over human health and environment. Organic agriculture is not only a mean of food production but also has significant impacts in bio-diversity preservation, erosion and desertification prevention and reducing the impacts of factors causing climate change (Anonymus, 2005b). All these factors directs the attention of researchers, producers and consumers to ecologic agricultural inputs and organic agricultural products (Soyarat and Fitil 2002).

This study was carried out to determine the impacts of organic and inorganic fertilizer applications of anise varieties and ecotypes. Determination of differences between the impacts of organic fertilizers and chemical fertilizers on quality of medicinal plants will lead the way of organic producers, exporters and consumers.

MATERIAL and METHOD

Experiments were carried out over the experimental fields of Adnan Menderes University Agricultural Faculty during the production season of the year 2005. Seeds of Fethiye, Çeşme and Denizli ecotypes and Gölhisar variety were used as the plant material of this study.

Mediterranean climate with hot and dry summers and warm and rainy winters is dominant in Aydın Province. Long- term average monthly temperature of the research site between the months January-July is 17.1^{0}C and annual total precipitation is 468.7 mm. Soils of research site has loamy texture with heavy alkaline, non-saline characteristics and high lime content, poor in organic material, medium in phosphorus and rich in potassium (Table 1).

Split plots experimental design with 3 replications was used in experimental setup.

Table 1: Soil analysis results of research site

Saturation (%)	**Texture**	**Total Salt (%)**	**pH (H_2O)**	**CaCO3 (%)**	**Organic Material (%)**	**P (ppm)**
48.5 -	Loamy -	0.023 Non-saline	8.42 Heavy Alkaline	3.05 High Lime	0.62 Very Low	10.1 Medium
K (ppm)	**Ca (ppm)**	**Mg (ppm)**	**Na (ppm)**	**Fe (ppm)**	**Zn (ppm)**	**Mn (ppm)**
263 High	2425 Medium	245 High	159 Medium	6.2 Sufficient	0.5 Deficient	4.8 Sufficient

Fertilization applications formed the mail plot and anise variety and ecotypes formed the sub-plot. Plots were arranged in 4 m long 4 rows with 40 cm row spacing. Control, commercial fertilizer, livestock manure, organic fertilizer, commercial x organic fertilizer and commercial fertilizer x livestock manure combination were applied to main plots and seeds of Çeşme, Fethiye-Seki and Denizli-Acıpayam originated ecotypes and Gölhisar variety were sown in sub-plots. Sowing was performed into 2-3 cm deep rows opened with a marker as to have 2.5 kg seed per decare. Amount of all fertilizers was calculated based on 4 kg/da pure N (Ceylan, 1996). Livestock manure was mixed into the soil on 07.01.2005. Commercial fertilizer was applied during the sowing and 33% NH_4NO_3 was used as commercial fertilizer. Phosphorus (6 kg/da) and potassium (8 kg/da) fertilizers were also applied to plots in which commercial fertilizers were used (Sarı and Bilgin, 2004). Organic fertilizer was in powder form prepared for organic producers and sols in markets. Livestock manure and organic fertilizer analysis were carried out laboratories of Soil Science Department of Adnan Menderes University Agricultural Faculty and analysis results were presented in Table 2.

Some agronomical processes carried out during the experiments were given in Table 3. Essential oil content, yield, composition and density were analyzed in this research. Essential oil content was determined with neo-Clevenger apparatus in accordance with water distillation method (Witchl, 1971). Essential oil yield was obtained by multiplying essential oil contents with grain yield. Essential oil composition was determined by using gas chromatographer. Operational conditions of the device were; Column length: 3 m (glass column), Column material : Stable phase: 3% OV1- Support material: Gas chrome Q, Temperature: Column temperature: 110 °C – Detector temperature: 250 °C – Injector temperature: 250 °C Speed of transporter gases: Nitrogen: 25 ml/min - Hydrogen: 1.5 kg/cm^2 – Dry air: 1.5 kg/cm^2; Detector type: FID, Printer: Beckman, Integrator: Spectra physics, Paper speed: 0.5 cm/min, Injected sample: 0.5 µl (Hamilton), Utilized solvent: Chloroform

Density of essential oil was determined by picnometer at 20 °C.

Statistical analysis of experimental results were performed in accordance with TARIST ver. 4.01 software (Açıkgöz et al., 1994) and significant ones found in variance analysis were grouped based on LSD test.

RESULTS and DISCUSSION

Experimental results of the research carried out to determine the impacts of organic and inorganic

Table 2: Results of manure and organic fertilizer analysis

Fertilizers	**Elements**								
used in experiements	**Fe (ppm)**	**Zn (ppm)**	**Mn (ppm)**	**Na (%)**	**K (%)**	**Ca (%)**	**Mg (%)**	**Organic Material (%)**	**N (%)**
Organic	953	218	209.2	1.088	2.78	4.68	0.8	61.5	3.075
Manure	982	262	79.1	0.064	1.02	1.11	0.73	58.0	2.9

Table 3: Some agronomical processes carried out during the experiments of *Pimpinella anisum* L.

Process	**Date**	**Vegetation Period**
Sowing	18.03.2005	_
Fertilization	07.01.2005 (Manure)	Before sowing
	18.03.2005 (Other)	During sowing
Germination	04.04.2005	_
Hoing	21-22.04.2005 (1.)	3-4 leafed period
	13-14.05.2005 (2.)	Before flowering
	7-8.06.2005 (3.)	50% flowering period
Irrigation	29.04.2005 (1.)	3-4 leafed period
	23.05.2005 (2.)	Before the initiation of flowering period
Flowering	05.06.2005	50% flowering period
Harvest	08.07.2005	Fruit ripening period

fertilizer applications over some technological characteristics of anise (*Pimpinella anisum* L.) variety and ecotypes were given below.

Essential oil content

Differences in impacts of fertilizers on essential oil content of anise were found to be insignificant, variety – ecotype and fertilizer x variety – ecotype interaction were found to be significant (Table 4). The highest essential oil content (1.863%) was obtained from Çeşme ecotype with commercial x organic fertilizer application and the lowest value (1.267%) was observed in control treatment of Gölhisar variety.

Tayşi et al. (1977) carried out a research on Spain, Çeşme and Isparta originated anises under Bornova ecological conditions and determined essential oil content of Çeşme ecotype as 2-2.5%; Kevseroğlu (1982) determined the essential oil contents of Balıkesir, Burdur, Çeşme, Denizli, Isparta, Spain and Egypt originated anises as between 2.1-2.83%; Kaya (1990) performed a study on Çeşme, Karaburun, Urla and Gölhisar originated varieties and obtained the essential oil contents of Çeşme and Gölhisar varieties respectively as 2.91% and 1.82%; Bayram (1992) conducted a research to investigate some agronomical and technological characteristics of culture anises (*Pimpinella anisum* L.) under Bornova ecological conditions and found the essential oil contents of Çeşme and Denizli ecotypes respectively as 2.1% and 2.8%; Satıbeşe (1992) investigated the effects of storage duration on essential oil content of anise and observed the essential oil contents of materials from Çeşme, Burdur, Tavşanlı and Acıpayam as between 2.45-3.14%; Kılıç (1996) carried out a research on biological and physical characteristics of anise seeds from different seeds and obtained the essential oil contents of between 1.3-3.7%. The values obtained in this study were similar to lower limit values specified in Kılıç (1996) and lower than the values obtained by Tayşi et al. (1977), Kevseroğlu (1982), Kaya (1990), Bayram (1992), Satıbeşe (1992). The highest values obtained from organic fertilizer applications indicate the positive impacts of nutrients on the amount of active substance. However, lower values than the ones specified in literatures put forward the impacts of the other ecological factors (climate) on the amount of active substance. The secondary metabolite contained in anise is essential oil. The amount of active substance in a plant varies based on genetic variability, morphogenetic variability (variation of active substance within the same organ or between the different organs), ontogenetic variability (variation in active substance during the growth periods), diurnal variability (variation of active substance during 24 hours of a day) and variability of ecological factors. Among these factors, only the genetic variability does not change. However, the variability created by the genes may disappear within the variability created by morphogenetic, ontogenetic and ecological factors (Ceylan, 1995).

Essential oil yield

Differences in impacts of fertilizers, variety – ecotype and fertilizer x variety – ecotypes interaction on essential oil yield of anise were found to be significant (Table 5). Considering the fertilizer x variety – ecotype interaction, it was observed that average essential oil yield varied between 37.68-167.49 l/da. When the essential oil yields of variety - ecotypes and fertilizers are compared, it was seen that while commercial fertilizer yielded the highest value (128.73 l/da) in Gölhisar variety, commercial fertilizer x manure combination (157.48 l/da) in Fethiye ecotype, organic fertilizer (167.49 l/da) in Denizli ecotype, commercial x organic fertilizer combination (135.92 l/da) in Çeşme ecotype; livestock manure yielded the lowest essential oil content in Gölhisar variety and Çeşme ecotype (44.86 l/da, 51.56 l/da, respectively) and control treatment yielded the lowest value in Fethiye and Denizli ecotypes (43.40 l/da, 37.68 l/da, respectively). Results revealed that the highest essential oil yield of anise (167.49 l/da) was obtained from Denizli ecotype with organic fertilizer application and the lowest yield (37.68 l/da) was observed in control treatment of Denizli ecotype.

Table 4: Impacts of different fertilizer applications on essential oil content of anise (*Pimpinella anisum* L.) variety and ecotypes (%)

	Variety and Ecotypes				
Fertilizers	**Gölhisar**	**Fethiye**	**Denizli**	**Çeşme**	**Mean**
Control	1.267	1.443	1.330	1.343	1.40
Commercial fertilizer	1.353	1.653	1.503	1.793	1.57
Livestock manure	1.730	1.670	1.430	1.470	1.51
Organic fertilizer	1.497	1.450	1.837	1.540	1.57
Commercial fertilizer x Manure	1.717	1.797	1.473	1.647	1.65
Commercial x Organic fertilizer	1.287	1.447	1.423	1.863	1.49
Mean	1.47	1.57	1.49	1.60	
LSD	Fertilizers (G): insignificant Variety - Ecotype (ÇE)$_{(5\%)}$: 0,102 GxÇE$_{(0.1\%)}$: 0,250				

Table 5: Impacts of different fertilizer applications on essential oil yield of anise (*Pimpinella anisum* L.) variety and ecotypes (l/da)

	Variety and Ecotypes				
Fertilizers	**Gölhisar**	**Fethiye**	**Denizli**	**Çeşme**	**Mean**
Control	55.63	43.40	37.68	69.41	55.81
Commercial fertilizer	128.73	128.78	93.78	133.71	121.25
Livestock manure	44.86	60.54	84.89	51.56	56.17
Organic fertilizer	51.97	46.10	167.49	70.04	83.90
Commercial fertilizer x Manure	56.74	157.48	113.13	73.77	100.28
Commercial x Organic fertilizer	98.02	74.64	128.22	135.92	109.20
Mean	72.65	85.15	114.18	89.06	
LSD	Fertilizers (G)$_{(0.1\%)}$: 14,939		Variety-Ecotypes (ÇE)$_{(0.1\%)}$: 11,638		GxÇE$_{(0.1\%)}$: 28,508

Gangrade et al. (1989) investigated the effects of micro nutrients on yield and quality of anise in India for three years and observed essential oil yields between 2.93-2.98 kg/da. Scheffer et al. (1992) conducted a research to determine the effect of organic fertilizer on essential oil composition and yield of *Achillea millefolium* L. (yarrow) and observed increasing essential oil yields; Ram et al. (2003) performed a study about the effects of organic mulch on nitrogenous fertilizer utilization efficiency, herbal and essential oil yield of *Pelargonium graveolens* (geranium) in India between the years 1996-1998 and observed that the plots with organic mulch had 23-27% herbal and essential oil yield than control plots without organic mulch.

Essential oil composition

Since the essential oil composition analyses were carried out with reputation, statistical evaluation was not performed. Trans-anethol, methylchavicol and anisaldehyde were determined as essential oil components and trans-anethol was specified as the most significant essential oil component. Trans-anethol ratio varied between 97.50-98.49%, methylchavicol between 0.37-2.49% and anisaldehyde between 0.31-1.60% (Table 6). Anisaldehyde was not observed in most of the fertilizer applications. When the essential oil compositions were compared based on variety – ecotype and fertilizer applications, it was observed that the highest trans-anethol ratio (98.49%) was obtained from Fethiye ecotype with commercial x organic fertilizer application and the lowest value (97.50%) was seen in Çeşme ecotype with commercial fertilizer application. With regard to other essential oil components of anise, methylchavicol and anisaldehyde, Gölhisar variety had lower ratios than Fethiye, Denizli and Çeşme ecotypes. The highest methylchavicol ratio (2.49%) was obtained from Çeşme ecotype with commercial fertilizer application and the highest anisaldehyde ratio (1.60%) from Gölhisar variety with organic fertilizer application.

Baytop (1963) observed trans-anethol ratios of 75.5-78.3%; Kubeczka and Bohn (1986) found a ratio of 94.14%; Kaya (1990) determined ratios of 95.84-97.18% and Satıbeşe (1992) observed the ratios as 98.25-99.98%. Scheffer et al. (1992) investigated the effects of organic fertilizer on essential oil compositions and yield of *Achillea millefolium* L. (yarrow) and observed increasing essential oil yield and non-changing essential oil composition with fertilizer applications; Ram et al. (2003) investigated the effects of organic mulch on nitrogenous fertilizer utilization efficiency, herbal and essential oil yield and composition of *Pelargonium graveolens* (geranium) in India between the years 1996-1998 and pointed out that essential oil components of citronellal and geranial were not affected from organic mulch and nitrogenous fertilizer applications. The results found in this study are higher than the ones observed in Baytop (1963), Kubeczka and Bohn (1986). Positive impacts of organic inputs were seen herein. Results are similar with the ones found by Kaya (1990), Scheffer et al. (1992), Satıbeşe (1992) and Ram et al. (2003).

Density of essential oil

Essential oil densities for different fertilizers and different variety-ecotypes were presented in Table 7. The density varied between 0.134-1.019 (20 °C). The highest density was observed in Fethiye ecotype with commercial fertilizer application and the lowest value was seen in control treatment of Fethiye ecotype.

Baytop (1963) observed essential oil densities between 0.982-0.986 (20 °C). The results of this study is lower than lower limit value and higher than upper limit value of that study.

CONCLUSION

In this study, impacts of organic and inorganic fertilizer applications over some technological characteristics of anise (*Pimpinella anisum* L.) varieties and ecotypes were investigated. With regard to technological characteristics, organic fertilizer application increased the essential oil yield and essential oil composition was not effected from fertilizer applications. This research was design for implementation and variety and ecotypes exhibited

Table 6: Impacts of different fertilizer applications on essential oil composition of anise (Pimpinella anisum L.) variety and ecotypes (%)

Fertilizers	Variety and Ecotypes					
	Gölhisar			Denizli		
	Methyl - chavicol (%)	Anis- aldehyde (%)	Trans- anethol (%)	Methyl - chavicol (%)	Anis- aldehyde (%)	Trans- anethol (%)
Control	1.55	-	98.44	2.05	-	97.94
Commercial fertilizer	1.70	-	98.29	1.86	-	98.13
Livestock manure	1.66	-	98.33	2.16	-	97.83
Organic fertilizer	0.37	1.60	98.01	1.88	-	98.11
Commercial fertilizer x Manure	1.58	-	98.41	1.87	-	98.12
Commercial x Organic fertilizer	1.60	-	98.39	2.10	-	97.89
Fertilizers	**Variety and Ecotypes**					
	Fethiye			**Çeşme**		
	Methyl - chavicol (%)	**Anis- Aldehyde (%)**	**Trans- anethol (%)**	**Methyl - chavicol (%)**	**Anis- aldehyde (%)**	**Trans- anethol (%)**
Control	1.84	0.41	97.73	1.61	-	98.39
Commercial fertilizer	1.98	-	98.01	2.49	-	97.50
Livestock manure	2.31	-	97.68	2.12	-	97.87
Organic fertilizer	1.85	0.50	97.63	1.78	-	98.21
Commercial fertilizer x Manure	2.01	0.31	97.66	2.15	-	97.84
Commercial x Organic fertilizer	1.50	-	98.49	1.75	-	98.24

Table 7: Impacts of different fertilizer applications on essential oil density of anise (Pimpinella anisum L.) variety and ecotypes

Fertilizers	Variety and Ecotypes			
	Gölhisar	Fethiye	Denizli	Çeşme
Control	0.638	0.134	0.981	0.190
Commercial fertilizer	0.377	1.019	0.266	0.604
Livestock manure	0.512	0.413	0.729	0.612
Organic fertilizer	0.871	0.818	0.640	0.540
Commercial fertilizer x Manure	0.511	0.780	0.727	0.676

significant differences. It was concluded that commercial x organic fertilizer and commercial fertilizer x livestock manure combinations can be used for essential oil content. Utilization of organic inputs should be encouraged to prevent the negative impacts of chemical inputs on human health and environment during the cultivation of significant plants in food, cosmetic and health sectors.

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