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The authentication of the botanical origin, physicochemical properties, antioxidant and antimicrobial activities of East Mediterranean honey

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ABSTRACT

The pollen composition, physico-chemical properties and antimicrobial activities of the honey samples from İçel region (Eastern Mediterranean Part of Turkey) were examined. The floral sources of honey samples were the multifloral. A total of 84 taxa were identified in 35 family. The secondary pollen taxa were *Astragalus* sp., *Castanea* sp., *Salix* sp., *Hedysarum* sp., *Styrax officinalis* and *Trifolium* sp. respectively. Occurence of *Styrax officinalis* sp. as a secondary pollen taxon in the honey samples is the first report. Physicochemical parameters are in generally well with the European standarts. All honey samples revealed antimirobial and antioxidant potentialities. Hence, honey from the investigated region of Eastern Mediterranean part of Turkey could be consumed as a rich source of healthy compounds coming from the nature.

Keywords: *içel, honey, pollen, melitopalynology, antimicrobial, antioxidant*.

1. INTRODUCTION

The edible honey in our daily life, is a sweet and energy providing substance which is naturally produced by honey beeworkers. The flowers'nectars and plant secretion or secretions from insects fed with plant juice are the main bio-sources for honey production. Upon after collection, unprocessed raw materials were initially transformed and then, combined with their spesific substances. The processed new product was stored in their combs for the development and maturation stages of honey bees [1, 2]. This sweet food source is the combination of bio-originated polymers and the significant sources of variety of minerals, organic acids, phenolic compounds [3]. Nutritional and medicinal aspects of the honey have been used as one of the most ancient therapeutic agents since centuries [4, 5]. Furthermores, bio benefits of honey such as antimicrobial, anti-inflammatuar, wound and ulcer healing, antoxidant antimicrobial activity, gastrointestinal regulator have also been reported [6, 7].

The production of honey is of economical significance in both different regions as well as rural areas of many countries. Consumers living in densely populated areas tend to buy honey from rural areas because of the quality and spesific properties in concern [8]. In many countries, the regional and international criteria have been available for defining the honey quality including sensory, chemical, physical and microbiological characteristics [9, 10, 11].

As of date, pollen identification, physicochemical properties, antioxidant and antibacterial activities of the honey are not reported from İçel region (Eastern Mediterranean region), and therefore, the present study is the first report on natural honey samples of the investigated region.

2. EXPERIMENTAL SECTION

2.1. Samplings and Pollen Analyses. Honey samples were collected from the counties of Anamur, Gülnar, Tarsus, Erdemli, Çamlıyayla, Toroslar I and Toroslar II (İçel region, Eastern Mediterranean region). All samplings were preserved in dark at room temperature prior to assays. The pollen slides from the samples was analyzed using the melissopalynological method [12]. Louveaux et al. (1978)'s classification was used for the clustering of pollen taxa using as follows; ≥45% and more: dominant; 16-44%: seconder; 3-15: minor and <3%: trace [13].

2.2. Physicochemical analyses. The pH of honey solution (10%, w/v) was recorded with a pH meter (Thermo scientific, Singapore) [14]. A titrimetric method was used for the total acidity measurement of each honey specimen [15]. The content of the total soluble solids (°Brix) was measured using a digital refractometer at 20°C (Krüss Optronic, Germany). A conductivity meter (Hanna EC 215 model Hanna Instruments, USA) was employed for the determination of the electrical conductivity [9]. A digital refractometer (Krüss Optronic, Germany) was used for determining the refractive index at 20 °C. The moisture content (%) was based on the interaction between refractive index and water content [15]. A Conica Minolta colorimeter (Chroma Meter CR-400 Japan) was used for the color of each honey sample (L, a and b) [16].

2.3. Total phenolic plus flavonoid content and antioxidant assay. Total phenolic and flavonoid content of honey samples were employed using the method of Meda et al. [17]. DPPH assay was based on the method of Alves et al. [18].

2.4. Antimicrobial assay. Mueller Hinton Agar medium (MHA, CM 337, Oxoid Ltd. Basingstoke, UK) and Potato Dextrose Agar medium were the test media for bacterial and yeast species, respectively. Antimicrobial activities were tested using the agar well diffusion assay on *Enterobacter hormaechei* ATCC 700323,

Enterococcus casseliflavus ATCC 700327, *Enterococcus faecalis* ATCC 29212, *Escherichia coli* ATCC 25922, *Klebsiella pneumoniae* ATCC700603, *Pseudomonas aeruginosa* ATCC 27853, *Staphylococcus aureus* ATCC 29213, *Staphylococcus aureus* ATCC BAA-977, *Candida parapsilosis* ATCC 22019 and *Candida albicans* ATCC14053. According to the Mac Farland Unit (0.5), turbidity of the freshly grown microorganism was regulated in the saline solution in the agar well diffusion assay. An aliquot (0.1 ml) from each suspension was plated onto appropriate agar medium. Each plate was punched for producing four wells (8 mm in diameter) using with a sterile cork borer. Honey solutions were prepared at 15%, 35%, 55%, 75% using with 0.1 % saline solution as a diluent. A 0.05 ml from each concentration was aseptically loaded into each agar-well. The standard antibiotics agents; AMC 30: Amoxiclav (Amoxicillin /Clavulanic acid) 30 mcg; CZ 30: Cefazolin 30 mcg; CIP 5: Ciprofloxacin 5 mcg; MXF 5: Moxifloxacin 5 mcg; LEV 5: Levofloxacin 5 mcg were used as the controls. After 24 h incubation at 35 °C, diameter of inhibition zones was measured for each microorganism under assay.

2.5. Statistical Analysis: All assays were carried out as triplicate. The data analysis was employed using one-way analysis of variance (ANOVA). Means difference was analyzed using the Duncan test ($p<0.05$). Data was processed using SPSS for Windows 18.0.0 (SPSS Inc., Chicago, USA).

3. RESULTS SECTION

3.1. Pollen analyses assays. Honey samples (n=8) were purchased from the counties of Anamur, Gülnar, Tarsus, Erdemli, Çamlıyayla, Toroslar I and Toroslar II in the region of İçel (Figure 1). Multifloral type of pollen grains were recorded in the samples. The pollen diversity as well as the image of the pollen grains were indicated in Table 1 and Figure 2.

Table 1. Pollen composition of honey from İçel region. *dominant pollen (>45%), ** secondary pollen (16–44%), ***minor pollen (3–15%), ****rare pollen (<3%)

Location		Taxa spectrum
Anamur	**	*Astragalus 32*
	***	*Hedysarum 9, Euphorbia 9, Centaurea 7, Quercus 7, Salix 6, Onobrychis 4*
	****	*Conium, Cupressus, Sinapis, Plantago, Citrus, Melilotus, Cistus, Zea mays,Mercurialis, Echium, Carduus, Taraxacum,Calycotome villosa, Olea, Paliurus, Ferula, Cichorium, Carthamus, Asphodelus, Castanea, Malva, Geranium, Melissa*
Gülnar	**	*Castanea 29, Salix 20,*
	***	*Heliotropium 7, Citrus 6, Vitex 6, Euphorbia 4,Cistus 3, Hedysarum 3*
	****	*Vicia, Erica, Centaurea, Salvia, Plantago, Laurus nobilis, Melilotus, Onobrychis, Pimpinella, Quercus, Ferula, Sinapis, Trifolium, Bellis, Mercurialis, Crataegus, Olea, Echium, Carduus, Carthamus, Taraxacum, Helianthus, Rubus, Zeamays, Tanacetum, , Myrtus communis*
Tarsus	**	
	***	*Helianthus 15, Astragalus 9, Olea 9, Centaurea 9, Sinapis 6, Trifolium 6, Euphorbia 5, Salix 5, Onobrychis 5, Hedysarum 4, Medicago 3*
	****	*Conium, Cistus, Rubus, Geranium, Quercus, Gossypium, Vicia, Sesamum, Chenopodium, Echium, Paliurus, Scorzonera, Citrus, Vitex, Stachys, Myrtus communis, Dipsacus, Malva, Rosmarinus, Carthamus, Erica, Ceratonia*
Erdemli	**	*Hedysarum 27, Salix 25*
	***	*Astragalus 13, Onobrychis 5, Melilotus 5*
	****	*Cistus, Anchusa, Vitex, Sophora, Cotoneaster, Conium, Medicago, Echinophora, Cupressus, Phlomis, Prunus, Centaurea, Quercus, Salvia, Convolvulus, Raphanus, Crataegus, Euphorbia, Castanea, Thymus, Ornithogalum, Pimpinella, Papaver, Ferula, Pelargonium, Lilium, Mentha, Paliurus, Taraxacum, Teucrium, Carex, Geranium, Zea mays, Dianthus, Melissa, Cousinia, Rubus, Rosmarinus*
Çamlıyayla	**	*Salix 27, Styrax officinalis 26*
	***	*Salvia 5, Onobrychis 5, Taraxacum 3, Astragalus 3, Conium 3, Cistus 3, Rosmarinus 3*
	****	*Eucalyptus, Mercurialis, Gossypium, Centaurea, Pinus, Geranium, Vicia, Echium, Poterium, Plantago, Olea, Eriobotyra, Campanula, Anchusa, Paliurus, Chenopodium, Carduus, Rubus, Trifolium, Zea mays, Anthemis, Chondrilla, Crataegus, Stachys, Raphanus*
Toroslar I	**	*Astragalus 16*
	***	*Quercus 12, Trifolium 9, Ligustrum 8, Conium 7,Salix 7, Mercurialis 6, Bellis 3, Coriandrum 3*
	****	*Citrus, Onobrychis, Cistus, Salvia, Rubus, Carduus, Narcissus, Silene, Euphorbia, Scorzonera, Thymus, Taraxacum, Papaver, Pimpinella, Geranium, Ferula, Rosmarinus, Hedysarum, Melilotus, Crataegus, Echium, Potentilla, Eucalyptus, Populus, Pelargonium, Paliurus, Teucrium, Vitex, Melissa*
Toroslar II	**	*Trifolium 23*
	***	*Echium 12, Salix 9, Astragalus 9, Paliurus 7 Hedysarum 4*
	****	*Melilotus, Eucalyptus, Centaurea, Quercus, Euphorbia, Medicago, Rubus, Teucrium, Populus, Dianthus, , Vitex,, Citrus, Crataegus, Vicia, Raphanus, Conium, Prunus, Rosmarinus, Pimpinella,, Erica, Sinapis, Ferula, , Convolvulus, Ceratonia, Robinia, Laurus, Salvia*

The present results indicated that *Astragalus* sp., *Hedysarum* sp., *Euphorbia* sp., *Quercus* sp., *Salix* sp., *Conium* sp., *Cistus* sp., *Echium* sp., *Paliurus* sp., *Citrus* sp., *Ferula* sp., *Geranium* sp., *Vitex* sp., *Melilotus* sp., *Trifolium* sp., were the

most common taxon in all specimens. The secondary pollen taxa were *Trifolium* sp., *Astragalus sp*., *Hedysarum sp.* (Fabaceae), *Castanea* sp. (Fagaceae), *Salix* sp (Salicaceae), and *Styrax officinalis* (Styracaceae) respectively (Table 1). The pollen belonging to *Styrax officinalis* as a secondary taxon in honey sample could be considered as the first report.

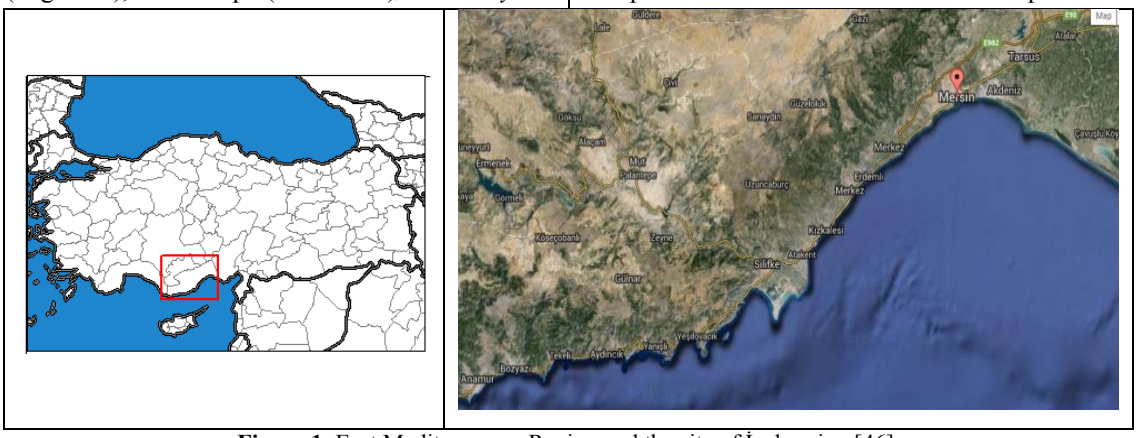


Figure 1. East Mediterranean Region and the site of İçel region [46].

3.2. Physicochemical assays. Total acidity (TA), pH, moisture, brix, refractive index, electrical conductivity and colour values of honey samples are presented in Table 2. TA of honey samples ranged from 27 to 40 meq kg^{-1}. which were within the allowed limits (50 meq kg^{-1}) of the European Union' recommendation (2002), and samples had no indication of fermentation [19]. Low TA values (meq/kg) were reported from honey samples obtained from different regions of the World [20, 21, 22]. There are also reports for high TA values in multiflower honey samples [23, 24, 25, 26]. The differences of TA value could be related to the season and the species of the plant where honeybee collect the nectar [21].

The extraction and storage of honey are significantly affected by pH value. In addition, pH influences on texture, stability and shelf life of honey [26, 27].

As in Table 2, pH levels varied from 3.69 to 4.48 in honey samples. Statistically significant differences ($p<0.05$) were present in pH of the samples due to locations. Similar values were reported in multifloral honey by other authors from different regions of Turkey [20, 28]. Also, either low and/or high values of pH in honey were reported from different regions of many countries [23, 24, 25, 26, 29, 30, 31, 32, 33, 34, 35].

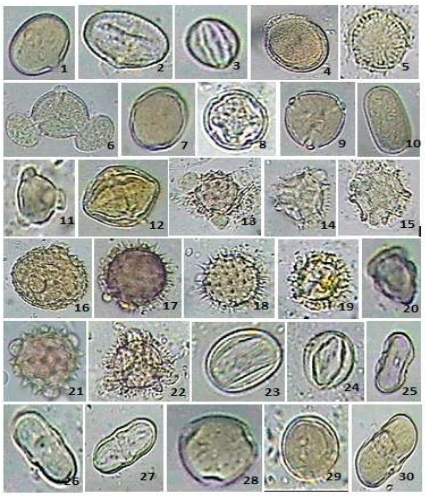
Total soluble solids content (Brix) and refractive index varied from 77.8 to 84.3 % and from 1.4845 to 1.4985 respectively. The significant differences were observed due to locations ($p<0.05$). The present results, are similar to those previous reports of total soluble solids content (Brix) of honey samples [26, 28, 35, 36, 37].

It has been pointed out that state of honey handling as well as environmental parameters have considerable effects on the moisture content of honey samples [38]. The moisture in honey is also responsible for its stability against fermentation and granulation [25]. As in Table 2, the significant differences ($p<0.05$) were found in the moisture content of honey specimens due to locations. The moisture levels ranged from 15.26 to 20.80 %. It appeared that most samples had moisture content less than 20%, except one sample from Toroslar II (20.80 %). The results of the present findings were also comparable with those of previous reports [21, 22, 24, 25, 26, 28, 29, 30, 31, 33, 34, 39].

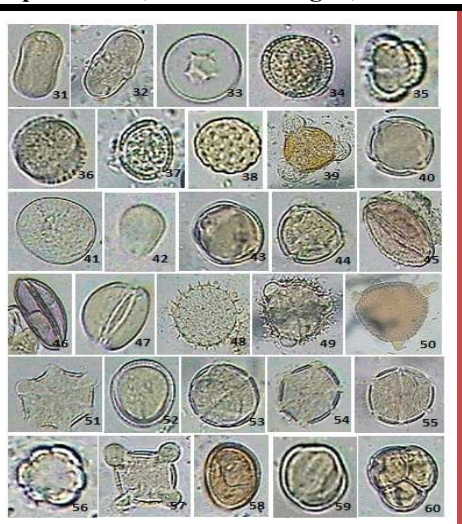
Table 2. Physicochemical properties, phenolic, flavonoid and antioxidant values of honeys from İçel region.

	Anamur	Gülnar	Tarsus	Erdemli	Çamlıyayla	Toroslar I	Toroslar II
pH	3.97^{b}±0.03	4.48^{a}±0.03	3.76^{cd}±0.06	3.69^{d}±0.04	3.92^{bc}±0.02	4.04^{b}±0.06	3.78^{cd}±0.05
Total acidity (meq/kg)	36^{ab}±2.82	35^{ab}±0.0	30^{cd}±2.80	27^{c}±2.70	30^{cd}±2.79	31^{cd}±1.41	40^{a}±1.30
°Brix (%mass)	81.6^{c}±0.28	81.5^{c}±0.29	83.2^{b}±0.30	84.3^{a}±0.0	81.4^{c}±0.14	82^{c}±0.0	77.8^{d}±0.0
Refractive index	1.4943^{a}±0.0	1.4943^{a}±0.0	1.4976^{a}±0.0	1.4985^{a}±0.0	1.4928^{a}±0.0	1.4956^{a}±0.0	1.4845^{b}±0.0
Moisture (H_2O) % mass	16.92^{c}±0.11	16.92^{c}±0.0	15.61^{d}±0.11	15.26^{d}±0.01	17.51^{b}±0.10	16.40^{c}±0.01	20.80^{a}±0.11
Conductivity (mS/cm)	0.10^{e}±0.0	0.10^{e}±0.0	0.20^{d}±0.01	0.10^{e}±0.0	0.90^{a}±0.02	0.45^{b}±0.02	0.29^{c}±0.01
L	47.16^{a}±1.25	30.59^{b}±0.37	45.57^{a}±2.33	55.03^{a}±0.70	47^{a}±1.60	51.70^{a}±2.15	54.32^{a}±5.23
a	1.95^{c}±0.12	10.57^{a}±0.12	6.99^{b}±0.47	-0.44^{e}±0.03	1.26^{d}±0.22	1.63^{cd}±0.13	-0.77^{e}±0.25
b	26.64^{a}±2.53	7.83^{c}±0.40	27.41^{a}±5.30	13.75^{bc}±0.57	22.24^{ab}±2.13	29.32^{a}±3.54	20.96^{ab}±1.62
Total phenolics	37.87^{d}±1.23	79.90^{a}±0.57	49.93^{c}±1.31	24.69^{f}±1.25	57.21^{b}±1.40	31.52^{e}±1.44	30.55^{e}±0.0
Total flavonoid	9.0^{c}±0.0	22.0^{a}±1.41	15.71^{b}±1.28	22.0^{a}±0.0	7.26^{c}±0.0	8.51^{c}±0.70	7.63^{c}±0.2
Total antioxidant (%)	27.80^{d}±0.84	54.18^{a}±1.50	48.56^{b}±1.07	36.60^{c}±0.10	27.80^{d}±0.42	19.2^{e}±0.98	22.44^{e}±0.6

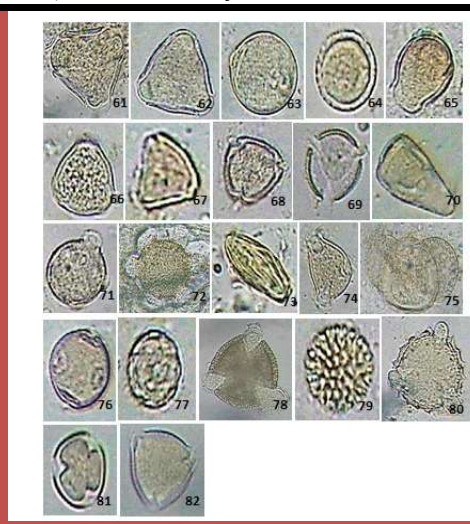
The letters represents in the means are different by Duncan test with significance ($p<0.05$)



1) Astragalus 2) Hedysarum 3) Castanea sativa 4) Calicotome villosa 5) Tanacetum 6) Trifolium 7) Medicago 8) Ceratonia siliqua 9) Euphorbia 10) Onobrychis 11) Mercurialis 12) Centaurea 13) Carduus 14) Taraxacum 15) Cichorium 16) Carthamus 17) Bellis 18) Helianthus 19) Chondrilla 20) Cousinia 21) Anthemis 22) Scorzonera 23) Quercus 24) Melilotus 25) Pimpinella 26) Conium 27) Ferula 28) Salix 29) Populus 30) Vicia



31) Echinophora 32) Coriandrum 33) Cupressus 34) Sinapis 35) Olea 36) Raphanus 37) Ligustrum 38) Plantago 39) Cistus 40) Citrus 41) Zea mays 42) Echium 43) Heliotropium 44) Paliurus 45) Asphodelus 46) Ornithogalum 47) Lilium 48) Malva 49) Gossypium 50) Geranium 51) Salvia 52) Phlomis 53) Thymus 54) Mentha 55) Rosmarinus officinalis 56) Melissa 57) Stachys 58) Teucrium 59) Vitex agnus castus 60) Erica



61) Crataegus 62) Prunus 63) Poterium 64) Laurus nobilis 65) Rubus 66) Eriobotyra 67) Myrtus communis 68) Eucalyptus 69) Papaver 70) Carex 71) Dianthus 72) Silene 73) Narcissus 74) Styrax officinalis 75) Pinus 76) Campanula 77) Chenopodium 78) Convolvulus 79) Sesamum 80) Dipsacus 81) Sophora 82) Cotoneaster

Figure 2. Photomicrographs of pollen grains in honey samples obtained from İçel region.

A close relationship in a honey sample has been confirmed between the electrical conductivity and those of ash content, organic acids and protein composition [19, 27]. As in Table 2, electrical conductivity varied from 0.10 to 0.90 mS cm^{-1}. The significant difference in moisture content was observed in honey samples due to locations ($p<0.05$). The electrical conductivity was the lowest in three honey samples collected from Erdemli, Anamur and Gülnar (0.10 mS cm^{-1}), whereas this value was the highest in a honey sample obtained from Çamlıyayla (0.9 mS cm^{-1}), which is also higher than that of the recomended limit of European Union (≤ 0.80 mS cm^{-1}) (EU, 2002). Compared to the present data, lower and or higher EC values of honey samples were reported in multifloral honey from various countries [8, 26, 28, 30, 32, 33, 37, 40, 41, 42, 43].

3.3. Total phenolic plus flavonoid content and antioxidant assays. Honey colour is closely linked to the phenolics compounds, HMF, pollen composition and minerals [44]. L, a, b values varied significantly due to locations ($p<0.05$). L (lightness), a (red) and b (yellow) of honeys samples ranged from 30.59 to 55.03, -0.77-10.57 and 7.83-29.32 respectively (Table 2). It was observed that honey specimen from Gülnar was the darkest one (lower L) among the samples in concern. Compared to this study, high and low L, a and b values in multifloral honey had similarities and dissimilarities in honey from different countries [4, 8, 11, 36, 37].

Total phenolic index of honey samples varied from 24.69 to 79.90 (mg/100ml) in Gülnar and Erdemli honey samples, respectively (Table 2). Low values for phenolic contents in multiflower honey were reported in other previous studies such as 0.323-0.149 (mg/100ml) [8] and 8.36-14.693 (11.207) (mg/100ml) [45]. On the other hand, high phenolic content were reported in honey samples taken from different countries such as 32.59-93.66 (mg/100ml) [17], 198 (mg/100ml) [2], 87.5-107.3 (mg/100ml) [33], 51-60 (mg/100ml) [35], and 99.75 (mg/100ml) [7], 35.3-1961 (mg/100ml) [11].

Total flavonoid index changed from 7.26 to 22.0 mg/100 ml which sampled from Çamlıyayla and Gülnar locations, respectively (Table 2). The present study showed that TFI values were similar to Tornuk et al. [11] and Isla et al. [33], who reported TFI values varying from 5.38 to 26.75, and 4.0 to 20, respectively. Meda et al. [17] found low TFI values (0.41-8.37) but Serem et al. [7] obtained higher TFI values (30.77).

Total Antioxidant Content (2,2-Dipenyl-1-picrylhydrazyl-DPPH) value ranged from 19.2 % to 54.18 %. According to Table 2, the highest values of total antioxidant content were found in Gülnar honey samples, while the lowest values were found in Toroslar I honey samples. The result of present study indicated the similar DPPH values with Isla et al. [33], and lower DPPH values than Tornuk et al. [11]. The differences could be attributed to the floral composition of the honey samples.

3.4. Antimicrobial assays. As in Table 3, samples from different regions of İçel in the the Mediterranean region had no inhibitory effects on the growth of *E. coli*, *C. albicans* and *C. parapsilosis*. Only one sample collected from Toroslar II revealed inhibitory activities on *S.aureus* BAA and *K. pneumoniae.* Furthermore, the same sample gave the highest inhibitory activities on both *S. aureus* 29213 and *E. hormaechei*. Honey sample from Çamlıyayla and Erdemli revealed only inhibitory effects on *B. cereus* and *P. aeruginosa*, repsectively. Honey sample obtained from the regions of Toroslar and Gülnar in İçel showed the highest inhibitory effect on *E. caseliflavus* and *E. faecalis*, respectively.

Table 3. Antimicrobial activities of the honey samples from İçel region.

Location	Con	B.c	S.a BAA	S.a	E.cs	E.f	E.h	K.p	P.a
Anamur	15	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$0^{k}\pm0$	$0^{e}\pm0$	$0^{e}\pm0$
	35	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$12.3^{ij}\pm1.2$	$0^{e}\pm0$	$0^{e}\pm0$
	55	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$16.3^{defg}\pm1.2$	$0^{e}\pm0$	$0^{e}\pm0$
	75	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$12.3^{e}\pm0.6$	$0^{g}\pm0$	$17^{cdef}\pm1.7$	$0^{e}\pm0$	$0^{e}\pm0$
Gülnar	15	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$0^{k}\pm0$	$0^{e}\pm0$	$0^{e}\pm0$
	35	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$11.3^{def}\pm1.2$	$0^{k}\pm0$	$0^{e}\pm0$	$0^{e}\pm0$
	55	$0^{g}\pm0$	$0^{g}\pm0$	10.6±0.6f	$0^{f}\pm0$	$12^{de}\pm1$	$13.3^{ghij}\pm0.6$	$0^{e}\pm0$	$0^{e}\pm0$
	75	$0^{g}\pm0$	$0^{g}\pm0$	11.6±0.6f	$0^{f}\pm0$	$15.3^{bc}\pm0.6$	$16^{defgh}\pm1$	$0^{e}\pm0$	$0^{e}\pm0$
Tarsus	15	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$0^{k}\pm0$	$0^{e}\pm0$	$0^{e}\pm0$
	35	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$12^{ij}\pm1$	$0^{e}\pm0$	$0^{e}\pm0$
	55	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$9.3^{f}\pm0.6$	$15.3^{defgh}\pm1.5$	$0^{e}\pm0$	$0^{e}\pm0$
	75	$0^{g}\pm0$	$0^{g}\pm0$	$12^{f}\pm0$	$14.3^{d}\pm0.6$	$10.3^{ef}\pm0.6$	$19.3^{bcd}\pm1.5$	$0^{e}\pm0$	$0^{e}\pm0$
Erdemli	15	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$0^{k}\pm0$	$0^{e}\pm0$	$0^{e}\pm0$
	35	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$0^{k}\pm0$	$0^{e}\pm0$	$0^{e}\pm0$
	55	$0^{g}\pm0$	$0^{g}\pm0$	$10.6^{f}\pm0.6$	$0^{f}\pm0$	$0^{g}\pm0$	$12^{ij}\pm0$	$0^{e}\pm0$	$0^{e}\pm0$
	75	$0^{g}\pm0$	$0^{g}\pm0$	$11.6^{f}\pm0.6$	$0^{f}\pm0$	$13^{cd}\pm1$	$17^{cdef}\pm1$	$0^{e}\pm0$	$13.6^{d}\pm1.5$
Çamlıyayla	15	$10.6^{f}\pm0.6$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$0^{k}\pm0$	$0^{e}\pm0$	$0^{e}\pm0$
	35	$12.3^{e}\pm0.6$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$10.6^{j}\pm0.6$	$0^{e}\pm0$	$0^{e}\pm0$
	55	$13.6^{d}\pm0.6$	$0^{g}\pm0$	$13.6^{e}\pm0.6$	$11.3^{e}\pm0.6$	$0^{g}\pm0$	$16^{defgh}\pm2.6$	$0^{e}\pm0$	$0^{e}\pm0$
	75	$16.3^{c}\pm0.6$	$0^{g}\pm0$	$14.6^{e}\pm0.6$	$12.3^{e}\pm0.6$	$0^{g}\pm0$	$21.6^{b}\pm1$	$0^{e}\pm0$	$0^{e}\pm0$
Toroslar 1	15	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	0±0 k	$0^{e}\pm0$	$0^{e}\pm0$
	35	$0^{g}\pm0$	$0^{g}\pm0$	$9^{g}\pm1$	$0^{f}\pm0$	$0^{g}\pm0$	$12.6^{hij}\pm0.6$	$0^{e}\pm0$	$0^{e}\pm0$
	55	$0^{g}\pm0$	$0^{g}\pm0$	$11.6^{f}\pm0.6$	$0^{f}\pm0$	$0^{g}\pm0$	$13.3^{ghij}\pm0.6$	$0^{e}\pm0$	$0^{e}\pm0$
	75	$0^{g}\pm0$	$0^{g}\pm0$	$14.3^{e}\pm0.6$	$21.3^{b}\pm1.2$	$0^{g}\pm0$	$14.3^{fghi}\pm1.5$	$0^{e}\pm0$	$0^{e}\pm0$
Toroslar II	15	$0^{g}\pm0$	$0^{g}\pm0$	$0^{h}\pm0$	$0^{f}\pm0$	$0^{g}\pm0$	$12.3^{ij}\pm0.6$	$0^{e}\pm0$	$0^{e}\pm0$
	35	$0^{g}\pm0$	$11^{f}\pm1$	$10.6^{f}\pm0.6$	$0^{f}\pm0$	$0^{g}\pm0$	$17.6^{cdef}\pm0.6$	$0^{e}\pm0$	$0^{e}\pm0$
	55	$0^{g}\pm0$	$13.6^{e}\pm0.6$	$15^{e}\pm1$	$0^{f}\pm0$	$0^{g}\pm0$	$20^{bc}\pm1$	$0^{e}\pm0$	$0^{e}\pm0$
	75	$0^{g}\pm0$	$16^{d}\pm1$	$17.3^{d}\pm0.6$	$0^{f}\pm0$	$0^{g}\pm0$	$21.3^{b}\pm1.2$	$10.3^{c}\pm0.6$	$0^{e}\pm0$
Standart Antibiotics									
AMC 30		$11.6^{ef}\pm0.6$	$21^{c}\pm1$	$23.3^{c}\pm0.6$	$23.6^{b}\pm1.5$	$23.6^{a}\pm0.6$	$16.6^{cdefg}\pm1.5$	$9^{d}\pm1$	$0^{e}\pm0$
CZ 30		$14.6^{d}\pm1.2$	$31^{b}\pm2$	$30.3^{b}\pm1.2$	$21^{b}\pm2$	$17.3^{b}\pm2.1$	$18.3^{bcde}\pm1.2$	$10.6^{c}\pm1.2$	$0^{e}\pm0$
CIP 5		$24.66^{b}\pm0.6$	$30.6^{b}\pm0.6$	$29.6^{b}\pm0.6$	$19^{c}\pm1$	$21.3^{a}\pm1.5$	$30^{a}\pm1$	$21.3^{a}\pm1.5$	$37.3^{a}\pm0.6$
MXF 5		$27.66^{a}\pm1.2$	$34.3^{a}\pm1.5$	$33^{a}\pm1$	$25^{a}\pm1$	$23.6^{a}\pm2.5$	$28.3^{a}\pm0.6$	$17.6^{b}\pm0.6$	$26.6^{c}\pm1.2$
LEV 5		$27.6^{a}\pm0.6$	$33.3^{a}\pm1.2$	$29^{b}\pm1$	$20^{bc}\pm0$	$20^{b}\pm1$	$30.6^{a}\pm1.5$	$21.6^{a}\pm1.2$	$33^{b}\pm0$

Abbreviations: B.c: *B.cereus*; S.a. BAA: *S.aureus* BAA*;* S.a: *S.aureus* 29213; E.cs: *E.casse;* E.f: *E.faecalis*; E.c: *E.coli*; E.h: *E. hormaechei*; K.p: *K. pneumoniae; P.a: P. aeruginosa;* AMC 30: Amoxiclav (Amoxicillin /Clavulanic acid) 30 mcg; CZ 30: Cefazolin 30 mcg; CIP 5: Ciprofloxacin 5 mcg; MXF 5: Moxifloxacin 5 mcg; LEV 5: Levofloxacin 5 mcg; Different letters in the same column are significantly different according to Duncan test ($p< 0.05$).

4. CONCLUSIONS

Honey samples from İçel region of the East Mediterranean part of Turkey had multifloral origin. The determination of the pollen of *Styrax officinalis* as a secondary taxon in honey could be considered as the first report. The flora of East Mediterranean Part of Turkey is very rich in terms of plant diversity. The diversity of plant families as well as their important phytoconstituents in honey contributed the significant antioxidant and antimicrobial activities.

5. REFERENCES

[1] Mendes E., Proença E.B., Ferreira M.A., Quality evaluation of Portuguese honey, *Carbonhydrate Polymers*, 37, 219-223, **1998**.

[2] Küçük K. M., Kolaylı S., Karaoğlu S., Ulusoy E., Baltacı C., Candan F., Biological activities and chemical composition of three honeys of different types from Anatolia, *Food Chemistry*, 100, 526-534, **2007**.

[3] Escuredo O., Silva L.R., Valentão P., Seijo M.C, Andrade P.B., Assessing Rubus honey value: Pollen and phenolic compounds content and antibacterial capacity, *Food Chem.*, 130, 3, 671–678, **2012.**

[4] Ahmed J., Prabhu G. S. V., Ngadi R. M., Physico-chemical, rheological properties and dielectric behaviour of selected Indian honey, *Journal of Food Engineering*, 79, 1207-1213, **2007**.

[5] Mercan N., Guvensen A., Çelik A., Katırcıoğlu H., Antimicrobial activity and pollen composition of honey samples collected from different provinces in Turkey, *Natural Product Research*, 21, 3, 187–195, **2007**.

[6] Ouchemoukh S., Louaileche H., Schweitzer P., Physicochemical characteristics and pollen spectrum of some Algerian honeys, *Food Control*, 18, 52–58, **2007**.

[7] Serem, J. C., Bester, M. J., Physicochemical properties, antioxidant activity and cellular protective effects of honeys from southern Africa, *Food Chemistry*, 133, 1544-1550, **2012**.

[8] Soria A.C., Gonzalez M., de Lorenzo C., Martinez-Castro I., Sanz I., Characterization of artisanal honeys from Madrid (Central Spain) on the basis of their melissopalynological, physicochemical and volatile composition data, *Food Chemistry*, 85, 121-130, **2004**.

[9] Gomes S., Dias L.G., Moreira L.L., Rodrigues P., Estevinho, L., Physicochemical, microbiological and antimicrobial properties

of commercial honeys from Portugal, Food and Chemical Toxicology, 48, 544-548, **2010**.

[10] Moniruzzaman M., Khalil M. I., Sulaiman S. A., Gan, S. H., Physico-chemical and antioxidant properties of Malaysian honeys produced by *Apis cerana*, *Apis dorsata* and *Apis mellifera*, BMC Complementary and Alternative Medicine, 13, 43, **2013**.

[11] Tornuk F., Karaman S., Ozturk I., Toker, O. S., Tastemur, B., Sagdıc O., Dogan M., Kayacier A., Quality characterization of artisanal and retail Turkish blossom honeys: Determination of physicochemical, microbiological, bioactive properties and aroma profile, *Industrial Crops and Products*, 46, 124-131, **2013**.

[12] Çenet M., Toroğlu S., Keskin D., Bozok F., Pollen Analysis and Antimicrobial Properties of Honey Samples Sold in Western Turkey. *Pakistan J. Zool.,* 47, 1 269-273, **2015**.

[13] Louveaux J., Maurızıo A., VorwohL G., 1978. Methods of melissopalynology, *Bee World*, **59**, 139–157.

[14] AOAC (1994). In K. Helrich (Ed.), Official methods of analysis (15th edn). Arlington, VA: Association of Official Analytical Chemists., **1994**.

[15] AOAC. In K. Helrich (Ed.), VA: *Association of Official Analytical Chemists*; 1990; 15th edn, **1990.**

[16] Bertoncelj J., Dobers U., Jamnik M., Golob T., Evaluation of the phenolic content, antioxidant activity and colour of Slovenian honey, *Food Chemistry*, 105, 822–828, **2007**.

[17] Meda A., Lamien C. E., Romito M., Millogo J., Nacoulma O.G., Determination of the total phenolic, flavanoid and proline contents in Burkina Fasan honey, as well as their radical scavenging activity, *Food Chemistry*, 91, 571-577, **2005**.

[18] Alves A., Ramos R., Gonçalves M., Bernardo M., Mendes B., Antioxidant activity, quality parameters and mineral content of Portuguese monofloral honeys, *Journal of Food Composition and Analysis*, 30, 130-138, **2013**.

[19] Belay A., Solomon W. K., Bultossa G., Adgaba N., Melaku S., Botanical origin, colour, granulation, and sensory properties of the Harenna forest honey, Bale, Ethiopia, *Food Chemistry*, 167, 213-219, **2015**.

[20] Akyüz N., Bakırcı İ., Ayar A., Tunçtürk Y., A study on some physical and chemical characteristics of honey samples collected from Van city market and their comparison with the related Standard, *Gıda*, 20 (5), 321-326, **1995**.

[21] Nanda V., Sarkar B. C., Sharma H. K., Bawa A. S., Physico-chemical properties and estimation of mineral content in honey produced from different plants in Nothern India, *Journal of Food Composition and Analysis*, 16, 613-619, **2003**.

[22] Ünal C., Küplülü Ö., Chemical quality of strained honey consumed in Ankara, *Ankara Üniversitesi Veteriner Fakültesi Dergisi*, 53, 1-4, **2006**.

[23] Terrab A., Diez M. J., Heredia F. J., Characterisation of Moroccon unifloral honeys by their physicochemical characterisctics, *Food Chemistry*, 79, 373-379, **2002**.

[24] De Rodriguez G.,O., Ferrer B. S., Ferrer A., Rodrigues B., Characterization of honey produced in Venezula, *Food Chemistry*, 84, 499-502, **2004**.

[25] Malika N., Mohammed F., Chakib E. A. Microbiological and physicochemical properties of Moroccan honey*, International Journal of Agriculture and Biology*, 7, 5, 773-776, **2005**.

[26] Silva L. R., Videira R., Monteiro A. P., Valentao, P., Andrade, P. B., Honey from Luso region (Portugal): Physicochemical characteristics and mineral contents, *Microchemical Journal*, 93, 73-77, **2009**.

[27] Terrab A., Recamales A. F., Hernanz D., Heredia F., Characterisation of Spanish Thyme honeys by their physicochemical characteristics and mineral contents, *Food Chemistry*, 88, 537-542, **2004**.

[28] Batu A., Küçük E., Çimen M., Doğu Anadolu ve Doğu Karadeniz bölgeleri çiçek ballarının fizikokimyasal ve biyokimyasal değerlerinin belirlenmesi, *Gıda Teknolojileri Elektronik Dergisi*, 8, 1, 52-65, **2013**.

[29] Yılmaz H., Küfrevioğlu İ., Composition of honeys collected from eastern and southeastern Anatolia and effect of storage on hydroxymethylfurfurate content and diastase activity, *Turkish Journal of Agricultural Forestry*, 25, 347-349, **2001**.

[30] Corbella E., Cozzolino D., Classification of the floral origin of Uruguayan honeys by chemical and physical characteristics combined with chemometrics, *LWT-Food Science andTechnology*, 39, 534-539, **2006**.

[31] Aydın B. D.., Sezer Ç. O., Kars'ta satışa sunulan süzme balların kalite niteliklerinin araştırılması, *Kafkas Üniversitesi Veterinerlik Fakültesi Dergisi*, 14, 1, 89-94, **2008**.

[32] Manzanares A., Garcia Z. H., Galdon B. R., Rodriguez E. R., Romero C. D., Differentiation of blossom and hoeydew honeys using multivariate analysis on the physicochemical parameters and sugar composition, *Food Chemistry*, 126, 664-672, **2011**.

[33] Isla M. I., Craig A., Ordonez R., Zampini C., Sayago J., Bedascarrasbure E., Alvarez A., Solomon V., Maldonado L., Physicochemical and bioactive properties of honeys from Northwestern Argentina, *LWT-Food Science and Technology*, 44, 1922-1930, **2011**.

[34] Sahinler N., Sahinler S., Gül A., Hatay yöresi ballarının bileşimi ve biyokimyasal analizi, *MKU Ziraat Fakültesi Dergisi*, 6, 1-2, 93-108, **2001**.

[35] Alqarni A. S., Owayss A. O, Mahmooud A. A., Physico-chemical characteristics, total phenols and pigments of national and international honeys in Saudi Arabia, *Arabian Journal of Chemistry*, **2012**

[36] Anupama D., Bhat K. K., Sapna V. K., Sensory and physico-chemical properties of commercial samples of honey, *Food Research International*, 36, 183-191, **2003**.

[37] Habib H. M., Al Meqbali F. T., Kamal H., Souka U. D., Ibrahim W. H., Physicochemical and biochemical properties of honeys from arid regions, *Food Chemistry*, 153, 35-43, **2014**.

[38] Acquarone C., Buera P., Elizalde B., Pattern of pH and electrical conductivity upon honey dilution as a complementary tool for discriminating geographical origin of honeys, *Food Chemistry*, 101, 695-703, **2007**.

[39] Finola M. S., Lasagno M. C., Marioli J. M., Microbiological and chemical characterization of honey from central Argentina, *Food Chemistry*, 100, 1649-1653, **2007**.

[40] Kaskoniene V., Venskutonis P. R., Ceksteryte, V., Carbohydrate composition and electrical conductivity of different origin honeys from Lithuania, *LWT-Food Science and Technology*, 43, 801-80, **2010**.

[41] Çetin K., Alkın E., Uçurum M. H., Ö 2011 Piyasada satılan çiçek ballarının kalite kriterlerinin belirlenmesi Gıda ve Yem Bilimi - Teknolojisi Dergisi, *Journal of Food and Feed Science – Technology,* 11, 49-56, **2011.**

[42] Rahman K., Hussain A., Ullah S., Zai I. U. M., Phytochemical analysis and chemical composition of different branded and unbranded honey samples, *International Journal of Microbiological Research*, 4, 2, 132-137, **2013**.

[43] Yücel Y., Sultanoğlu P., Characterisation of honeys from Hatay Region by their physicochemical properties combined with chemometrics, *Food Bioscience*, 1, 16-25, **2013**.

[44] Perez-Arquille C., Conchello P., Arino A., Juan T., Herresa A., Quality evaluation of spanish rosemary (Rosmarius officinalis) honey, *Food Chemistry*, 51, 207–210, **1994**.

[45] Lachman J., Orsak M., Hejtmankova A., Kovarova E., Evaluation of antioxidant activity and total phenolics of selected Czech honeys, *LWT-Food Science and Technology*, 43, 52-58., **2010**.

[46] http://www.uzaydanbak.com/, Google Earth, **2016**.