Physicochemical Analysis Of Some Honey Samples From Konya And Karaman Regions

Konya ve Karaman İllerinden Bazı Bal Örneklerinin Fizikokimyasal Analizi

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There are many factors that affect quality and chemical composition of honey. The most important of these factors is pollen and nectar of blossoms or secretions of living parts of plants. Anatolian honey has various pollen types, because of rich plant diversity. Also physicochemical analysis is one of the procedure determining the quality of honey. These physicochemical parameters are electrical conductivity, free acidity, diastase activity, moisture, proline, pH, content of fructose, glucose, sucrose, colour of pollen and taste. The aim of this study was to determine the quality of 17 multifloral honey samples collected different locations from Konya and Karaman regions in the year 2015. The ranges of parameters in examined honey samples are 0.19-0.58mS/cm the electrical conductivity, 18-29 free acidity (meq/kg), 10.4-34.9 diastase activity, 3.63-4.72 pH, 15.40-18.80% moisture, 26.47-33.70% glucose, 35.51-40.19% fructose, 1.10-1.41 fructose/glucose or %349-908 mg/kg proline. The mean percentage of sucrose in honey samples is convenient with the standart value. The results of these parameters are in the normal ranges proposed by Turkish Food Codex (TFC), EU codex.
1. Introduction

Honey is a sweet natural product made by honeybees by using pollen and nectar of flowers or exudates from trees and with the addition of plant-sucking insects. Turkey has very favourable conditions for apiculture with its different climatic conditions, ecosystem diversity and more than 10,000 plant species. Therefore Anatolian honeys are rich in pollen types per sample and 85% of the world’s floral types can be found in Turkish honeys (Gök et al., 2015). Karaman-Konya region where the working samples are collected are located within the Irano-Turanian pytogeographical region. This phytogeographic region has very rich in terms of plant species. Özbey et al., (2015) also identified macrophytic vegetation type, halopytic vegetation type, ruderal vegetation type and step vegetation type in the region. These different source of pollen and nectar affects the chemical composition of the honey in terms of its organic acid, enzyme, protein, carbohydrate content.

Physicochemical analysis are used to determine the quality of honey. For the quality criteria of honey, certain constituents such as moisture content, electrical conductivity, reducing sugars, amount of fructose and glucose, sucrose content, individual sugars, mineral, free acidity, diastase activity, HMF content, invertase activity, proline content and specific rotation have been proposed by the international honey commission (IHC) (Bogdanov et al., 1999; Joshi et al., 2000). With increasing interest in honey composition, many studies have been carried out in relation to physicochemical parameters in the other countries (Anupama et al., 2003; Felsner et al., 2004; Dag et al., 2006; Finola et al., 2007; Qamer et al., 2008; Khalil et al., 2012; Aloisi, 2010; Shahnawaz et al., 2013; Akram et al., 2014; El-Shoimy et al., 2015). But there are limited studies on phsicochemical parameters although honey is widely consumed and used in ethnomedicine in Turkey (Yılmaz and Küfrevioğlu, 2001; Sorkun et al., 2002; Silici, 2004; Ünal and Küpürülü, 2006; Kıcık et al., 2007; Doğan, 2008; Günbey et al., 2010; Erez et al., 2015).

This study focused on the effect of plant diversity on the physicochemical characteristics of honey samples collected from Konya and Karaman regions in Turkey.

2. Material And Method

Honey Samples

17 multifloral honey samples were obtained from local producers in different localities of Konya and Karaman regions (Middle Anatolia) in November 2015 (Fig. 1). If the honey contains pollens of multiple taxa, it is called multifloral honey. All samples were collected in sterile glass bottles (labelled with numbers, collection locality and date) and stored at room temperature until chemical and physical analysis were done.

Figure 1. Konya (A) and Karaman (B) regions from Turkey

Physicochemical Analysis

In this survey free acidity, proline, sugar profiles, moisture, pH, diastase activity and electrical conductivity were examined according to methods proposed by TS13360 (Anonymous, 2008), TS13359 (Anonymous, 2008), AOAC (AOAC 1990) and Bogdanov et al. (1997) respectively. Electrical conductivity was determined on a 20% w/v honey: water solution on a dry matter basis and expressed in mS/cm (Shahnawaz et al., 2013). Free acidity was determined using the titrimetric method. Aqueous honey solution (10 g in 75 mL distilled water) was titrated with NaOH until pH 8.3, after adding
To classify examined honey samples based on ten physicochemical variables, multivariate analyses of hierarchical cluster analysis was applied (HCA) (IBM Corp. Released SPSS Statistics 21.0, 2012). In HCA, the Euclidean distance with complete linkage rule was used to group honey samples in clusters in terms of their nearness with linkage distance or similarity (Fig. 2) (Kek et al., 2016).

### 3. Results and Discussion

In this study, physicochemical characteristics of 17 honey samples from Turkey were analysed and compared to the values set by Turkish Food Codex (TFC) (Turkish Food Codex 2012), EU codex (European Union, 2001). The obtained results from analysed honey samples were given in Table 1.

It was observed that the range of the moisture contents were various from 15.40% to 18.80% which are within the limit (≤20%) recommended by TFC, EU codex (Table 1). The moisture content varies depending on specific composition of honey, the ratio of sugar content and amount of water. These results are in agreement with the findings of Kıcık et al. (2007) who reported that the average moisture content was recorded 17.0% in heterofloral honey, 19.7% in Chestnut honey, 19.0% in Rhododendron honey. Günbey et al. (2010), Ng’ang’a et al. (2013) and Derebaş et al. (2014) found that the range of moisture content in different honey samples was 16.12%, 16.87 and 19.13% respectively. Although Khalil et al. (2012) measured lower moisture content in Algerian honey samples (11.59 and 14.13%), Akram et al. (2014) measured higher moisture content in different honey samples of Apis dorsata in different locations of Pakistan (22.87-26.70%).

According to White (1979), honey contains about 200 substances. Honey is composed of approximately 80% sugar (mainly glucose and fructose), 17% water and organic acids, mineral salts, vitamins, proteins, phenolic compounds, lipids and free amino acids, pollen, beeswax and pigments. The mineral content and elements in trace amounts of honey can be used in determining the geographical origin.

<table>
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<th>Samples No</th>
<th>Proline (mg/kg)</th>
<th>Fructose %</th>
<th>Glucose %</th>
<th>Fructose/ Glucose</th>
<th>Sucrose %</th>
<th>Moisture %</th>
<th>pH</th>
<th>Electrical conductivity</th>
<th>Diastase number</th>
<th>Free Acidity</th>
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**Table 1.** The results of physicochemical analysis of honey samples from Konya and Karaman regions of T

1= Blossom honey, 2= Honeydew honey, nd=not detected
The carbohydrate content in honey is approximately 80%. Glucose and fructose in honey is about 75%. Maltose, melitositë and oligosacharites are other carbohydrates in honey. While the amount of fructose is high in many honey types, the amount of glucose comes second. The amount of sucrose is dependent on the amount of invertase enzyme (Anonymous, 2016). The result of analysis showed that the sucrose ratios were in normal range.

The results of analysis of all the seventeen (17) honey samples indicated that the ratio of fructose in the examined honey samples ranged from 35.51 to 40.19%, and the ratio of glucose ranged from 26.47 to 33.70%. The ratio F/G ranged from 1.10% to 1.41%. The pH of honey varies according to the presence of organic acids. Acidity contributes the taste of honey, which is found naturally in honey (Akram et al., 2014). Gluconic acid is produced from enzymatic breakdown of glucose by glucose oxidase which is found naturally in honey (Akrarn et al., 2014). The acidity of honey is based on mainly gluconic acid and other organic acids. Gluconic acid is produced from enzymatic breakdown of glucose by glucose oxidase which is found naturally in honey (Akrarn et al., 2014). The variation of free acidity in honey can be diverse according to harvest season and regional flora (Erez et al., 2015; Derebaş et al., 2014). Free acidity values of 17 honey samples studied range from 18.00 to 29.00 meq/kg (Table 1) and all honey samples analysed were below the limit proposed by TFC and EU (<50 meq acid/kg). Our results were closer to data of Sorkun et al. (2001) (24.34–32.81 meq/kg), Finola et al. (2007) (11.9–29.4 meq/kg), Derebaş et al. (2014) (17.00–34.00 meq acid/kg) and Erez et al. (2015) (16.41–26.20 meq/kg). However, the value of free acidity (15.51–64.68 meq/kg) in Trifolium honey from Turkey declared by Doğan (2008) were higher than our results.

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The source of protein and amino acids in honey is mainly pollen. Proline is the main amino acid in honey, added to honey by the bee in different unifloral honeys show various characteristic values that is correlated with enzymatic activity (Bogdanov et al., 2004). The proline content is used as a criterion of honey ripeness and, in some cases, sugar adulteration (Anonymous, 2009). The amino acid profile of the honey can be used in determining the botanical origin of honey. The amount of proline in quality honey should be higher than 350 mg/kg and at least 66% of the total amino acids (Anonymous, 2016). The results of honey samples examined showed that the proline content was found in the range of 439-908 mg/kg. While the amount of proline was found the lowest in sample 8, it was the highest in sample 10. It seems that our results are consistent with the standard (Table 1). Some authors determined that amount of proline was 324-673, 290-580, 430-734, 596-12.0, 305-650, 298-1199, 264-636, 329-931 mg/kg in Greek unifloral honey of different harvests. The results of proline concentration were consistent with the standard (Table 1). Some authors have indicated that the amount of proline was 324–673, 290–580, 430–734, 596–12.0, 305–650, 298–1199, 264–636, 329–931 mg/kg in Greek unifloral honey of different harvests.
botanical origins (Thrasyvoulou and Manikis, 1995), 68.85-116.10 mg/100 gr in Eucalyptus camaldulensis honey (Sorkun et al. 2001), 1692–2712 mg/kg in Algerian honey (Khalil et al., 2012) and 220±5.8, 192±6.4, 234±5.9 in multifloral honey (Erez et al., 2015).

Figure 2. The dendrogram of cluster analysis for 17 honey samples based on physicochemical parameters

Enzymes are among the most important and interesting components that make up the content of the honey. There are small amounts of various enzymes in honey. Diastase is added to honey by bees and catalyses the transformation of starch to maltose. Honey diastase activity is a quality factor, influenced by honey storage and heating and thus an indicator of honey freshness and overheating (Bogdanov et al., 2000). The diastase activities in this study were ranging from 10.4 to 34.90 (Table 1). This value was significantly higher than the recommended quality criteria (>8) by FAO/WHO Codex, TFC and EU. Küçük et al. (2007) suggests that a high quality honey is expected to have high diastase activity. Higher diastase number was found in Christ’s thorn honey (25.39-50.51DN) by Daniela et al. (2008); in Burkina Fasan honey (6.5-62.3DN) by Meda et al. (2005); in Trifolium honey from Turkey (13.90-50.00) by Doğan (2008); in Eucalyptus camaldulensis honey from Turkey (10.90-38.50) by Sorkun et al. (2001).

Lower diastase number was detected as 22.68 by Sorkun et al. (2002), as 10.48 by Silici (2004) as 17.9 (heterofloral honey), 17.7 (chestnut honey) and 23.0 (Rhododendron honey) by Küçük et al.(2007) as 4.53-11.23 by Ng’ang’a et al. (2013) as 5.00-23.00 by Derebaşi et al. (2014).

The results of HCA showed that 17 honey samples could be classified big large groups. As can be seen in the dendrogram, subgroups in the large cluster have similar pyhsicochemical characteristics (Fig. 2).

The physicochemical analysis of honey samples obtained from Konya and Karaman regions indicated that honey samples had a good level of quality and all parameters were within the quality criteria according to TFC and EU Codex. We can conclude that the bees fed from natural plant resources and beekeepers in the regions carry out a conscious production.
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