JAP&T
TPA-Timişoara

Available online at http://journal-of-agroalimentary.ro

Journal of Agroalimentary Processes and Technologies 2019, *25* (1), 31-35

Journal of Agroalimentary Processes and Technologies

Effect of honey types on physico-chemical properties, electrical conductivity and mineral contents of honeys

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Abstract

This study was performed to compare the physico-chemical properties of flower, sunflower, cotton and pine honeys The pH, moisture, electrical conductivity, ash, free acidity and total phenolic content of honey samples varied from 3.788 to 4.870, 24.812% to 26.875%, 0.351 mS/cm to 1.447 mS/cm, 0.095% to 0.876%, 22.040 meq/kg to 42.700 meq/kg and 64.792 mg GAE/100g to 131.528 mg GAE/100g, respectively. The highest potassium (K) content was found in pine honey (3191.955 ppm), while calcium (Ca) contents of honey samples change between 22.056 (flower) and 92.715 ppm (cotton); phosphorus (P) contents of samples ranged from 31.705 ppm (sunflower) to 171.378 ppm (pine honey). In addition, sodium (Na) contents of honey samples were found between 101.680 ppm (flower) and 169.709 ppm (pine honey. It was determined that the most predominant mineral was potassium and pine honey is a good source of K.

Keywords: proximate analysis, electrical conductivity, mineral contents, ICP-AES

1. Introduction

Honey products should be accepted as an significant part of agricultural production due to nutritional and economic values as well as the benefits of pollinating the crops. Turkey acts as a natural bridge between three continents and is one of the important gene centers of the world. The fact that our country has a wide geographical area, ecological conditions, favorable climate characteristics and rich plant flora constitutes a very important potential for diversification in agricultural production [1,2]. There is also great potential for colony existence and adequate labor force in addition to ecological conditions in order to improve beekeeping in our country and to increase the production of bee products [3]. The moisture contents of flower and honeydew honeys are generally 17.2% and 16.3%, respectively.

If maturation is not complete in the harvested honey, the moisture content is high which caused early crystallization and fermentation. The amount of moisture is higher in non-pure honey. The amount of moisture in honey is the most important factor in honey protection and granulation [4,5]. A wide variety of honeys are produced depending on the rich flora in our country. The most important of these are; highland, pine, chestnut, citrus, alfalfa, sunflower, cotton, corn, acacia and lime honeys [6]. Production season, plant origin and climatic conditions affect honey structure. The most important factor among these is the plant variety [6-8].

The objective of the study was to determine the physicochemical properties of polyfloral, sunflower, cotton and pine honeys.

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2. Materials and method

Honey samples (Flower, Sunflower, Cotton and Pine honeys) were directly obtained from the beekeepers (Hadim-Konya, Karapınar-Konya, Kırkhan-Hatay and Köyceğiz-Muğla) in 2013. The honeys were kept in glass jar at room temperature in the dark until analysed.

The pH, electrical conductivity, free acidity, moisture and ash contents were determined according to Harmonised Methods of the European Honey Commission [9]. For pH, a solution was prepared with 10 g of honey in 75 mL of distilled water, and measured with a pH meter. The electrical conductivity of a solution of 10 g of honey in 75 mL of deionised water was measured at 25°C using a portable conductivity metre (WTW inoLab Cond/720, Germany), and results were expressed as µs/cm. Acidity was determined by dissolving honey sample (10 g/75 mL distilled water) and titration with 0.1 N NaOH until pH value reached 8.30 and results were given as meq/kg. The moisture content was determined using an Abbe refractometer. The ash content was determined by the gravimetric methodology, and the samples were placed in the furnace, heated at 550 °C for 6 h.

Total phenol contents of honey solutions (5%, w/v) were determined by using the Folin-Ciacueltau (FC) reagent according to Yoo et al. [10]. After 1 ml of Folin–Ciacueltau was added into sample, it was mixed for five minutes. Then 10 mL of Na_2CO_3 solution was added and was mixed. The final volume was completed to 25 ml with distilled water. At the end of 1 hours, total phenolic content was determined at 750 nm by a spectrophotometer. Gallic acid was used (0-200 mg/ml) as the standard for calibration curve. The results were evaluated as mg gallic acid equivalent (GAE)/100 g.

About 0.5 g of honey sample was put into burning cup with 15 ml of pure NHO_3 and 2 ml H_2O_2 (% 30 w/v). The sample was incinerated in a microwave oven at 210 ˚C. After digestion treatment, sample was filtrated through whatman paper filter (No 42). The filtrate was collected in 50 ml flasks and analysed by Inductively coupled plasma atomic emission spectroscopy (ICP-AES). The mineral contents of the samples were quantified against standard solutions of known concentrations which were analysed concurrently [11].

Instrument	: ICP-AES (Varian-Vista)
RF Power	: 0.7-1.5 kw (1.2-1.3kw for Axial)
Plasma gas flow rate (Ar)	:10.5-15L/min. (radial) 15“(axial)
Auxilary gas flow rate (Ar)	: 1.5“
Viewing height	: 5-12 mm
Copy and reading time	: 1-5 s (max. 60 s)
Copy time	: 3 s (max. 100 s)

3. Results and Discussion

Physicochemical properties of sunflower, flower, pine and cotton honeys are illustrated in Table 1.

The pH values ranged from 3.788 (in cotton honey) to 4.870 (in pine honey). Serem and Bester [12] informed that honey samples from southern Africa were found to be acidic in character, with pH values varying from 3.87 to 5.12. The pH value of Harenna Forest honey was reported in the range of 3.45-4.18 [13]. In the experiments found by Özcan and Ölmez [14], pH values of honeys collected in 2006 and 2007 were determined as 4.66 and 4.67 for pine honey; 4.24 and 3.86 for cotton honey, respectively. The reported pH values for Indian, Algerian and Spanish honeys varied from 3.7 to 4.4, 3.49 to 4.53 and 3.63 to 5.01, respectively [15,16]. pH values effect texture, stability and shelf life of honeys during storage [17]. The moisture content of honey samples ranged from 24.812% to 26.875%. These values were higher than the maximum moisture content (20g /100g) set by the International Honey Commission [13]. Harvesting season, maturity degree, climatic conditions may cause to high moisture content [18] and high moisture may cause sour taste because of yeast fermentation during storage. Additionally, high storage humidity can also raise the moisture content due to the hygroscopic property of honey [14]. Moisture contents of honey samples collected from Romania were found between 15.40% and 20.00% [19]. The moisture contents of honeys harvested from Malaysia and India were observed between 20.62% and 37.31%; 17.2% and 21.6%, respectively [15,17]. Pine honey had the minimum moisture content (16.20%), while the maximum moisture value was determined in cotton honey with value of 20.00% [14]. The electrical conductivity values of honeys varied from 0.351 mS/cm to 1.447 mS/cm. The highest electrical conductivity (1.447 mS/cm) was observed in pine honey, followed by cotton honey (0.672 mS/cm). Accordingly, electrical conductivity of honeydew honeys are higher than floral honeys. In addition, ash, organic acids, proteins, mineral salts and some complex sugars effect the electrical conductivity [13].

Ouchemoukh et al. [16] informed that the electrical conductivities of some Algerian honeys were between 0.23-1.61 mS/cm. Manzanares et al. [20] reported that the electrical conductivities of honeydew honey and blossom honey were determined as 1.21 mS/cm and 0.47 mS/cm, respectively. In another study, electrical conductivity of honeys ranged between 0.30 mS/cm and 1.50 mS/cm [21]. The total phenolic contents of honey samples varied from 64.792 (in sunflower honey) to 131.528 (in pine honey). The total phenolic contents of pine and cotton honeys were 508.55 mg GAE/100g and 272.24 mg GAE/100g, respectively [14]. Kowalski [22] determined the total phenolic content of honeydew (109.22 mg GAE/100g), lime (69.11 mg GAE/100g), acacia (38.29 mg GAE/100g) and buckwheat (121.06 mg GAE/100g) honeys. Pulcini et al. [23] found that the total phenolic content of sunflower honey was 169.02 mg GAE/100g. In an other study, total phenolic contents of honeydew honeys produced in Romania were found between 73 and 127 mg GAE/100g [24]. According to Can et al. [21], total phenolic contents of honeys varied between 16.02 mg GAE/100g (in acacia honey) and 120.04 mg GAE/100g (in oak honey) and total phenolic content of pine honey was also determined as 61.42 mg GAE/100g.

Table 1. Physicochemical properties of honey samples

Honeys	**pH**	**Moisture (%)**	**Electrical conductivity (25°C) (mS/cm)**
Sunflower	3.875±0.042*	25.562±2.040	0.272±0.000
Flower	4.088±0.004	25.000±2.270	0.272±0.020
Pine	4.870±0.014	24.812±1.240	0.186±0.100
Cotton	3.788±0.004	26.875±1.700	0.629±0.050
Honeys	**Total phenolic content (mg GAE/100g)**	**Ash (%)**	**Free acidity (meq/kg)**
Sunflower	64.792±0.069	0.095±0.004	22.040±0.272
Flower	109.306±2.083	0.177±0.002	29.270±0.272
Pine	131.528±4.722	0.876±0.015	28.240±0.186
Cotton	111.667±5.139	0.206±0.002	42.700±0.629

*mean±standard deviation

Table 2. Mineral contents (ppm) of raw honey samples

Honeys	**Mo**	**Ca**	**B**
Sunflower	0.106±0.060*	25.800±0.800	6.497±0.227
Flower	0.115±0.015	22.056±0.999	4.752±0.422
Pine	0.032±0.002	0.000±0.000	4.125±0.369
Cotton	0.107±0.026	92.715±0.383	9.170±1.928
Honeys	**Cu**	**Fe**	**K**
Sunflower	1.159±0.223	33.167±1.038	78.282±11.477
Flower	2.052±0.025	16.184±0.142	556.535±3.478
Pine	2.902±0.310	28.230±2.140	3191.955±137.847
Cotton	2.252±0.025	22.773±1.525	701.232±72.051
Honeys	**Mg**	**Mn**	**Na**
Sunflower	0.885±0.055	0.021±0.001	147.473±6.201
Flower	25.013±0.006	0.348±0.057	101.680±2.375
Pine	39.073±0.145	0.013±0.008	169.709±8.735
Cotton	55.689±5.624	0.006±0.001	168.109±4.073
Honeys	**P**	**S**	**Zn**
Sunflower	31.705±0.957	84.228±3.242	0.842±0.084
Flower	85.683±0.389	67.084±2.978	1.666±0.344
Pine	171.378±7.603	211.318±8.501	1.629±0.389
Cotton	82.144±7.044	134.608±7.447	2.368±0.654

*mean±standard deviation

The highest ash value was observed in pine honey with value of 0.876%, followed by cotton honey (0.206%) and upland honey (0.177%). In several studies, the ash contents of honey samples ranged from 0.03% to 1.23% reported for Romanian honeys; from 0.07% to 0.43% reported for Indian honeys; from 0.01% to 0.65% reported for Southern African honeys and from 0.05% to 0.35% reported for Harenna forest honeys [5,12,13,19]. The acidity values of honey samples are given in Table 1. The highest acidity (meq/kg) was determined in cotton honey (42.700), followed by flower honey (29.270) and pine honey (28.240). According to the study of Kowalski [22], free acidity of honeydew honey was determined as 38.98 mM/kg. The free acid content of the Harenna forest honeys ranged from 25.49 to 48.81 meq/kg [13]. In other study, acidity of cotton and pine honeys was measured as 31.00 meq/kg and 36.00 meq/kg in 2006; 37.50 meq/kg and 36.00 meq/kg, respectively [14].

The major minerals in the honeys were potassium (K), sulfur (S), sodium (Na), phosphorus (P), magnesium (Mg), and calcium (Ca). Other minerals such as Mo, B, Cu, Mn and Zn were observed at lower levels than 10 ppm, while Al, Co, Cd, Cr, Pb and Se minerals were not detected in all honeys (Table 2).

Potassium content was the highest level in pine honey with value of 3191.955 ppm, followed by cotton honey (701.232 ppm). Additionally, pine honey showed higher amounts of phosphorus (171.378 ppm) and sulfur (211.318 ppm) than floral honeys. The sodium contents of pine (169.709 ppm) and cotton honeys (168.109 ppm) were comparable. The amount of iron (Fe) in honey samples ranged from 16.184 ppm (in flower honey) to 33.167 ppm (in sunflower honey). Although the magnesium contents were between 25.013 ppm and 55.689 ppm in honeys, sunflower honey has the lowest magnesium content, with ranging of 0.855 ppm. Besides, calcium was not detected in pine honey, while the maximum level of Ca was found in cotton honey (92.715 ppm). Alves et al.[25] studied with Portuguese monofloral honeys and the contents of sodium (4.63-200.60 mg/kg), calcium (0.43- 72.30 mg/kg), magnesium (3.05 - 82.20 mg/kg) and iron (below 7.06 mg/kg) were lower than potassium concentration (30.90–449.66 mg/kg) in honey samples. Gonzalez-Miret et al. [26] determined that the mineral content was higher (between 1340 and 1879 mg/kg) in darker honeys (avocado, chestnut, honeydew, and heather).

Compliance with Ethics Requirements. Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human / or animal subjects (if exist) respect the specific regulation and standards.

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