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Physicochemical characteristics of honey from different origins

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Abstract Honey is a natural sweet substance produced by honey bees, from the nectars of plant flowers and honey dew. The present study aimed to evaluate physicochemical characteristics and quality of honey from different origins. Melissopalynological analysis of honey samples showed a wide variability, with samples from different honey sources being collected from different geographical origins. The colour ranged from light amber for Egyptian and Yemeni samples to amber for Saudi and Kashmiri samples. Egyptian and Yemeni samples recorded the higher acidity than Saudi and Kashmiri honey, but all samples are still within the standard limit (pH 3.40 ± 0.002–6.10 ± 0.003). The electrical conductivity (EC) ranged from 0.53 ± 0.03 to 4.18 ± 0.05 ms/cm. The moisture content of honey samples was ranged from 14.73 ± 0.36% to 18.32 ± 0.67%. Ash content ranged from 0.23 ± 0.02% to 2.33 ± 0.02%. Kashmiri honey showed the highest protein content (4.67 ± 0.171 mg/g) while the lowest value of protein content was registered in Egyptian honey (1.69 ± 0.015 mg/g). Samples of Saudi honey showed the highest value of reducing sugars (72.36 ± 0.32 g/100 g), while Kashmiri honey showed the lowest value (15.11 ± 0.25 g/100 g). The estimated fructose/glucose ratio for all investigated samples was ranged from 0.42 ± 0.02 to 2.35 ± 0.02 and estimated glucose/water ratio was ranged from 0.72 ± 0.025 to 1.56 ± 0.025. It is noteworthy that, the crystallization of Kashmiri honey was faster than other types of studied honey samples. The quality of honey was varied based on the botanical origins, handling, transportation and storage conditions.

Introduction

Bee honey is the most well-known and economically important honey bee (*Apis mellifera*) colony product. It is defined as the natural sweet substance produced by honey bees, from the nectars of plant flowers and honey dew (Codex Alimentations,

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2001). Properties and compositions of bee honey depend on its geographical floral origin, season, environmental factors and treatment of beekeepers (Da Costa Leite et al. (2000), Kaškonienė et al. (2010) and El-Metwally 2015). Bee honey is one of the few virtually totally non-allergic foods that body easily assimilates. It contains nutrients especially as energy provider Rahman et al. (2010), it is a high-energy carbohydrate food (80–85%) and the honey sugars are easily digestible as those in many fruits (White and Doner, 1980). Bogdanov et al. (2004) found more than 22 sugars in honey; however, fructose and glucose are the major sugar content. Primary sugars existed in honey are fructose and glucose, and in nectar honey the fructose content should exceed that of glucose Zafar et al. (2008). Furthermore, the sum of fructose, glucose, fructose/glucose ratio and glucose/water ratio are other important factors related to honey quality. Fructose/glucose ratio indicates the ability of honey to crystallize (White and Doner (1980), Manikis and Thrasivoulou (2001), Kaškonienė et al. (2010) and Buba et al. 2013). Honey contains more than 180 substances, including amino acids, enzymes, protein, vitamins, minerals, ash, organic acids and phenol compounds Ouchemoukh et al. (2007). Moisture content of bee honey represents a major importance to its stability against fermentation and granulation. The low moisture content protects honey from microbiological activity and thus it can be preserved for longer periods (AL-Naji and Hujazy, 1982; Cantarelli et al., 2008; Bogdanov, 2009; Buba et al., 2013; Akhtar et al., 2014 and El-Metwally, 2015). Melissopalynology is the most frequently used method for the determination of honey botanical and geographical origin (Vorwhol, 1981; Cotte et al., 2004 and Ponnuchamy et al., 2014). Melissopalynological analysis remains nowadays as the only technique, which allows a direct botanical origin characterization, while physicochemical parameters afford quantitative results and allow an approximate estimation of the presence of honey blends Soria et al. (2004). This study aimed to evaluate physicochemical characteristics of local and imported honey in Egypt to assess the different types of honey quality.

Materials and methods

Honey samples

Honey samples were collected from different markets in Alexandria, Egypt, representing Yemeni, Saudi and Kashmiri honey. While, one honey sample was collected from *Rhamnus* sp. (Sidr trees) farm at El-Nobareya city, El-Beheira governorate represented Egyptian honey sample. All samples were stored at (−28 ± 2 °C) till further analysis to avoid the effect of laboratory conditions on the chemical composition and physical properties of honey samples (El-Metwally, 2015).

Determination of sediment content

Based on the method of Louveaux et al. (1978) ten grams of honey was dissolved in 20 ml of warm distilled water (40 °C). The solution was centrifuged for 10 min at 2500*g*. The solution was poured into a small tube and centrifuged again for 10 min. The entire sediment was putted on a slid and spread out over an area about 20 × 20 mm, after drying by slight heating at 40 °C. The sediment was mounted with glycerine gelatine, liquefied by heating in water bath at 40 °C. Melissopalynology was used as a reference. However, terms used in estimates of pollen grain Frequencies are as follows: "Very frequent" for grains constituting more than 45%, "Frequent" for grains constituting 16–45%, "Rare" for grains constituting 3–15% and "Sporadic" for grains constituting less than 3% of the total grains Maurizio (1975).

Moisture content

Moisture content was determined from the refractive index of the honey. A digital refractometer (NR 101 Spain), that can be thermostated at 20 °C, regularly calibrated with distilled water or with another certified reference material (Bogdanov, 2009).

pH

A pH metre (HI 98127, Hanna instruments, Mauritius) was used to measure the pH of a 10% (w/v) solution of honey prepared in milli-Q water (Millipore Corporation, Billerica, Massachusetts, USA) Bogdanov, 2009.

Electrical conductivity (EC)

EC was measured using an HI 98311 conductivity meter (Hanna Instruments, Mauritius) and a 20% (w/v) solution of honey was suspended in milli-Q water Bogdanov et al. (1999). The electrical conductivity of the milli-Q water was determined to be less than 10 μS/cm.

Colour analysis

The colour intensity of honey samples was measured according to the Pfund classifier. Briefly, homogeneous honey samples devoid of air bubbles were transferred into a cuvette with a 10 mm light path until the cuvette was approximately half full. The cuvette was inserted into a colour photometer (HI 96785, Hanna Instruments, Cluj County, Romania). Colour grades were expressed in millimeter (mm) Pfund grades when compared to an analytical-grade glycerol standard. Measurements were performed in triplicate for each sample using the approved colour standards of the United States Department of Agriculture USDA (1985).

Colour intensity

The mean absorbance of honey samples was determined using the method of Beretta et al. (2005). Briefly, honey samples were diluted to 50% (w/v) with warm (45–50 °C) milli-Q water, and the resulting solution was filtered using a 0.45 μm filter to remove large particles. The absorbance was measured at 450 and 720 nm using a spectrophotometer (T80 UV/VIS England), and the difference in absorbance was expressed as mAU.

Optical density (OD)

One gram of honey was diluted with 9 ml of distilled water and centrifuged for 10 min at 3000*g*. The absorbance of the filtrate supernatant was measured at 530 nm against distilled water as