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COMPARATIVE STUDY OF HONEY COLLECTED FROM DIFFERENT FLORA OF ALGERIA

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ABSTRACT

The aim of the present study was to evaluate the physical and chemical properties of five Algerian unifloral types of honey. Several physical parameters of honey, such as pH, moisture content, electrical conductivity, total dissolved solids, color intensity and total sugar content, were measured. The mean pH, moisture content, EC and water insoluble solids of Algerian honey were 4.41± 0.58, 15.3 ± 1.5%, 0.324± 0.116 mS/cm and 0.141± 0.065%, respectively. The mean color was 81 ± 72 mm Pfund. The majority of honey samples test results (moisture content, electric conductivity and acidity) levels were within the acceptable range of world honey standards.

Keywords: Apis *mellifera*, biochemical characters, unifloral honey, physical characteristics

1. INTRODUCTION

Honey is a natural sweet viscous fluid produced by honeybees from the nectar of flowering plants, which they collect and transform by combining with their salivary secretions, and deposit, dehydrate and store in the honey comb to ripen [1]. Honey is a complex mixture of 82.0% carbohydrates (sucrose, fructose, and maltose), 0.3% protein, 17.0% water and 0.7% minerals, vitamins and antioxidants [2].

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Honey contains a variety of photochemical and other substances, such as organic acids, vitamins and enzymes, which may serve as a source for dietary antioxidants [3]. The composition of honey and other bee products (pollen, propolis) depends highly on the type of flowers utilized by bees, climatic conditions in which the plants grow and maturation [4-6].

Many investigators have suggested the use the physicochemical criteria (water content, sugar content, pH, ash, etc.) analysis for characterization of honey [7].

The potential honey production is very high in Algeria; this is related to the botanical wealth and the biodiversity of this region. Therefore, this study was carried out to evaluate the physicochemical quality of some Algerian honey samples.

2. MATERIALS AND METHODS

2.1. CHEMICALS

Sodium hydroxide (NaOH), and sodium carbonate (Na_2CO_3) were purchased from Prolabo (Etats-Unis). High purity water, which was used in all experiments. All other reagents used were of analytical grade.

2.2. INSTRUMENTATION.

Spectrophotometric measurements were performed on an UV-1800 Schimadzu Spectrophotometer (double-beam) equipped with 1 cm quartz cuvettes (JAPAN). pH meter PHM 210 (Radiometry, FRANCE), Electrical conductivity meter CDM 210 (Radiometry, FRANCE), Digital abbe refractometer WAY-2S (Only Laboratory Inc, China).

2.3. HONEY SAMPLES

Typical Apis *mellifera* honey samples of unifloral types were collected from the 2012 harvest directly from 5 provinces located in Algeria, namely Laghouat, Blida, Mostaganem, El Oued and El Bayadh (**Fig 1)**. The samples were stored in a refrigerator in airtight plastic containers until analysis. The regions from which the samples of honey were collected are indicated in **Table 1**.

Table 1. Algerian honey samples used in this study on the basis of date of harvest, geographical origin.

Sample code	Date of harvest	Floral source	Place of production	Geographical origin
H01	2012	Ziziphus	Laghouat	Mountain
H02	2012	Eucalyptus	Blida	Field
H03	2012	Helianthemum lippii	Mostaganem	Mountain
H04	2012	Zygophyllum album	El Oued	Field
H05	2012	Euphorbia dendroides	El Bayadh	Field

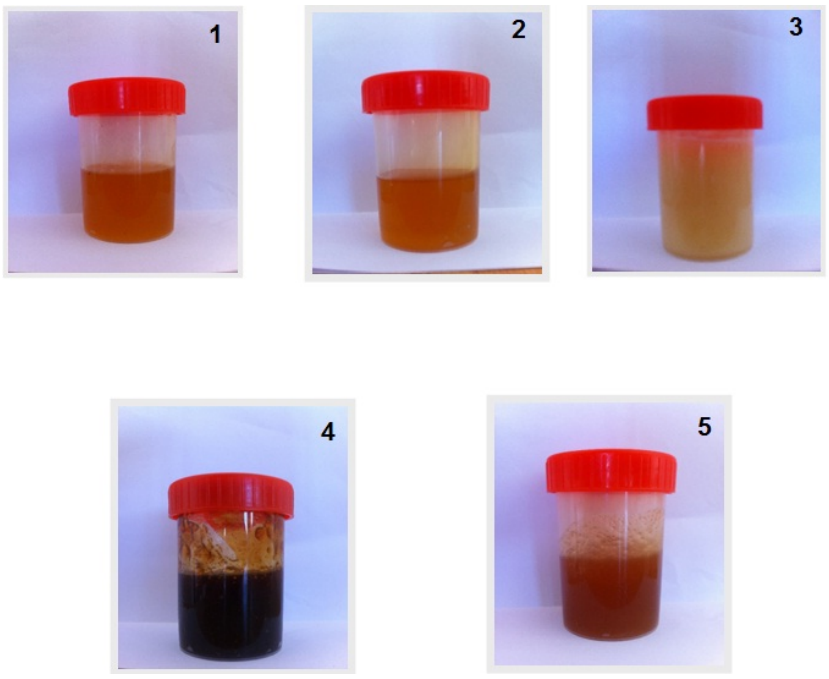

Fig. 1. The samples of honey

2.4. METHODS

The determination of physical and chemical parameters such as content of water, conductivity and pH and was carried out in accordance with the methods described in Harmonized methods of the European Honey Commission [8].

- **Specific gravity.** The specific gravity of honey (density) was determined by dividing the weight of specific gravity bottle (50 ml) filled with honey by the weight of the same bottle, filled with water [8].
- **Determination of moisture content.** The moisture content was determined using a refractometric method. In general, the refractive index increases with increases in the solid content of a sample. The refractive indices of honey samples were measured at ambient temperature using a refractometer, and measurements were further corrected for the standard temperature of 20 °C by the addition of the 0.00023/°C correction factor. The moisture content was measured in triplicate, and the percentage of moisture content, which corresponds to the corrected refractive index, was calculated using Wedmore's table [8].
- **Determination of total soluble solids.** Total soluble solids were determined as described by ISO 2173:2003 [9]. Hand refractometer with ranges of 50°Brix - 85°Brix, was first standardized. The prism was then washed with distilled water and dried off with a soft tissue. A drop of honey sample was placed on the refractometer prism and the reading was noted. The Brix of the sample was then calculated and temperature correction applied.
- **Water insoluble solids**. Water insoluble solids were measured according to the instructions of the Harmonized Methods of the International Honey Commission [10].
- **Determination of pH.** A pH meter was used to measure the pH of a 10% (w/v) solution of honey prepared in ultrapure water [11].
- **The free acidity** was determined as follows, by the titrimetric method: the addition of 0.05 N NaOH is stopped at pH 8.50 (free acidity). Results were expressed as meq/kg [8].
- **Determination of electrical conductivity.** Electrical conductivity EC was measured using a conductivity meter for a 20% (w/v) solution of honey suspended in milli-Q water [8].

- **Honey color analysis.** Honey samples were heated to 50 °C to dissolve sugar crystals, and the color was determined by spectrophotometric measurement of the absorbance of a 50% honey solution (w/v) at 635 nm. The honeys were classified according to the Pfund scale after conversion of the absorbance values:

$$mm\ Pfund = -38.70 + 371.39 \times Abs \quad [12]$$

Where mm Pfund is the intensity of honey color in the Pfund scale; Abs is the absorption of honey solution.

- **Statistical analysis:** Data were calculated as mean± standard deviation (SD).

3. RESULTS AND DISCUSSION

Several quality variables for 5 Algerian honey samples were analyzed and recorded viz. Density, moisture, total solids, total sugar, water insoluble solids content, pH, free acidity, electrical conductivity and color (Pfund index) (Table 2, Table 3).

Table 2. Physicochemical characteristic of Algerian honey

Samples code	Density	Moisture content (%)	Total soluble solids (°Brix)	Water insoluble solids content (%)
H01	1.328	15	83	0.092
H02	1.413	14	84.5	0.114
H03	1.290	15	83.5	0.084
H04	1.316	18	80.5	0.179
H05	1.301	14.5	83.5	0.237
Mean	1.329	15.3	83	0.141
SD	0.048	1.5	1.5	0.065
Limits of international standards	/	not more than 20 g/100g	/	not more than 0.5 g/100g

Moisture is a parameter related to the maturity degree of honey and temperature. In the present study, moisture values are between 14.0 and 18 % (mean value ± standard deviation = 15.3± 1.5 %) Table 2. The moisture content of honey depends on various factors such as harvesting season, degree of maturity reached in the hive and climatic factors Finola et al [13]. Also, the moisture content of honey is highly important factor contributing to its stability against fermentation and granulation during storage [14].

Sugars comprise about 95-99% of honey dry weight and are the main constituents of honey. Glucose and fructose are the main sugar constituents of honey and they are produced by sucrose hydrolysis and represent 85-95% of the total sugars.

The classification of unifloral honeys is related to sugar content. The measured sugar values are summarized in Table 2. Total sugar content ranged from 80.5 to 84.5 g/100g with the highest attributed to sample H02 and the lowest to H04.

Table 3. Physicochemical characteristic of Algerian honey

Samples code	pH	Free acidity (meq/kg)	Electrical conductivity (mS/cm)	Color (Pfund index)
H01	5.24	34.033	0.364	48
H02	4.78	58.823	0.338	31
H03	3.80	31.928	0.2	27
H04	4.11	17.988	0.491	198
H05	4.12	19.585	0.229	105
Mean	4.41	32.471	0.324	81
SD	0.58	16.378	0.116	72
Limits of international standards	/	not more than 50 meq/kg	not more than 0.8 mS/cm	/

All the Algerian honeys analyzed were found to be acidic in character. Honey pH values varied from 3.8 to 5.24 (mean value ± standard deviation = 4.41± 0.58) Table 3. Published reports indicate that pH should be between 3.2 and 4.5 (Bogdanov 1995). According to these values, Laghouat and Blida honey were outside this range. The mean values, however, indicated that the Laghouat and Blida honey were outside this range (5.24, 4.78). The low pH of honey inhibits the presence and growth of microorganisms and makes honey compatible with many food products in terms of pH and acidity. This parameter is of great importance during the extraction and storage of honey as it influences its texture, stability and shelf life [15].The values of pH in honey help to determine its origin: flower or forest; the latter show higher values [16].

The free acidity varied from 17.988 to 58.823 meq·kg^{-1} (mean value ± standard deviation = 32.471± 16.378 meq·kg^{-1}) Table 3. When considering the new limit for free acidity permitted by the Codex (2001) and the European Community Directive (The Council of the European Union 2002), only the eucalyptus honey sample from Blida was outside the legislation limits. The free acidity of honey may be explained by taking into account the presence of organic acids in equilibrium with their corresponding lactones, or internal esters, and some inorganic ions, such as phosphate [13].

The electrical conductivity values of the honeys analyzed ranged from 0.2 to 0.364 mS/cm (mean value ± standard deviation = 0.324± 0.116 mS/cm) Table 3. The electrical conductivity of honey may be explained by taking into account the ash and acid content of honey, which reflects the presence of ions and organic acids; the higher their content, the higher the resulting conductivity.
The color of honey varies from clear to dark amber or black, depending on its origin (floral source) and constituents (mineral content). It also depends on its chemical composition especially pigments like chlorophylls, carotenoids, flavonoids, tannin derivatives and polyphenols.
Sample H03 had the lowest lightness and sample H04 had the greatest (Table 3). It can be seen from the values that the honey samples had brown and yellow color components. The lightness values were lower, as the samples were darker in color. The importance of honey color is that it is one of the parameters that determine its industrial use.

4. CONCLUSIONS

Generally the majority of honey samples test results (moisture content, electric conductivity and acidity) levels were within the acceptable range of world honey standards, which indicate the presence of good opportunities for exporting of honey.

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