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Physicochemical and biochemical properties of honeys from arid regions

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ABSTRACT

This study was conducted to evaluate the quality of 11 honeys from arid regions for first time, and compare it with 5 different honeys from non-arid regions. Mean values obtained for physicochemical parameters were: pH 4.76 ± 0.55; 17.32 ± 1.8% moisture; 80.95 ± 1.60 °Brix sugar; 69.05 ± 4.41% total sugar; 413.81 ± 178.48 μS cm^{-1} electrical conductivity; 17.58 ± 7.68 meq/kg free acidity; 11.05 ± 3.18 meq/kg lactonic acidity; 28.63 ± 9.6 meq/kg total acidity; 12.66 ± 20.39 mg/kg HMF; 0.58 ± 0.03 water activity; and 0.98 ± 0.62 colour intensity. Potassium was the major mineral (1760.54 ± 685.24 mg/kg). All the samples showed considerable significant variations with reference to their physicochemical and biochemical properties, moreover, the total free amino acids and total carotenoids were 61.13 ± 63.16 mg/100 g and 4.07 ± 10.05 μg/100 g respectively. Acrylamide was detected only in one sample at 2.39 ± 0.22 μg/kg.

1. Introduction

Honey is the natural sweet product produced by *Apis mellifera* bees from nectar of plants (nectar honey), from secretions of livings parts of plants or excretions of plant-sucking insects of the living part of plants (honeydew honey) (Silva, Videira, Monteiro, Valentão, & Andrade, 2009). This natural complex foodstuff is produced in almost every country and largely used as food source. Honey cannot be considered a complete food by human nutritional standards, but it offers potential as a dietary supplement (Silva et al., 2009). Honey mainly contains simple sugars or monosaccharides [of which fructose and glucose are the main components (65%)] and approximately 18% water, (Silva et al., 2009). Proteins, flavour and aroma, phenolic compounds (phenolic acids and flavonoids), free amino acids, organics acids, vitamins and minerals constitute minor components of honeys (Silva et al., 2009). Honey commercially available varies greatly in quality all over the world. This is largely assessed on the basis of colour, flavour and density. Honey composition is influenced by the plant species, climate, environmental conditions and the contribution of the beekeeper. In general, honey is either monofloral or multifloral depending on the source of the plant (Andrade et al., 1999; Anklam, 1998; Azeredo, Azeredo, Souza, & Dutra, 2003; Gonzalez-Miret, Terrab, Hernanz, Fernandez-Recamales, & Heredia, 2005).

Several types of honeys are produced in arid regions. However, the information available on their chemical and physical properties is limited. Also there has been no particular research to determine their essential physical, chemical and biological properties such as, mineral, free amino acids, sugar and carotenoid profiles in different varieties of honey produced in arid regions. Therefore, the current study was conducted to assess the physicochemical properties composition and biochemical properties of honey samples from arid regions for the first time, as well as comparing it with different non-arid regions honey samples.

2. Materials and methods

2.1. Materials

All of the chemicals and reagents used were of analytical grade, sucrose, fructose, glucose, maltose, formic acid, acrylamide, methanol, phosphoric acid, acetonitrile, bovine serum albumin, hexane, acetone, lutein, cryptoxanthine, zeaxanthine, lycopene, α-carotene, β-carotene, γ-carotene and ethyl acetate were purchased from Sigma (St. Louis, MO, USA). Folin–Ciocalteu's phenol reagent, HCl, $FeSO_4$_$7H_2O$, HMF, and standard solutions (1000 mg/l): [aluminum (Al), arsenic (As), sulphur (S), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), iron (Fe), manganese (Mn), molybdenum (Mo), nickel (Ni), phosphorus (P), lead (Pb), vanadium (V), zinc (Zn), calcium (Ca), potassium (K), sodium (Na), magnesium (Mg), and strontium (Sr)], were obtained from Merck (Darmstadt, Germany). AccQ_Tag kit was purchased from (Waters, Miliford, MA, USA).

2.1.1. Honey samples

The present study was performed on eleven reputed commercial honey brands from arid regions (8 monofloral and 3 heterofloral) and five from non-arid regions (3 monofloral and 2

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heterofloral) (Table 1). Fresh honey samples weighing 250–1 kg, packed and sealed in glass bottles, were purchased from a local market, and some samples provided directly by local UAE beekeepers, and stored at 4 °C. The samples were diluted 10 time using deionized water and were kept at −80 °C and analysed at the earliest in such a way that none of the samples exceeded the storage period beyond 6 months. The honey samples were thawed at ambient temperature before the analyses were performed.

2.2. Methods

2.2.1. Physicochemical analysis

2.2.1.1. Water content, RI, Brix. Water content was determined by refractometry, measuring the refractive index (RI) according to AOAC Methods (AOAC 969.38B, 2003), using a standard model Abbe type refractometer at 20 °C. Water content (%) was then obtained from the Chataway table.

2.2.1.2. Water activity. Water activity of liquid honey samples was measured using an Rotronic Hygrolab (Rotronic Instrument Corp. Hauppauge NY, USA) at 20 °C. (Acquarone, Buera, & Elizalde, 2007).

2.2.1.3. Acidity (free, lactone, and total). Free, lactone, and total acidity were determined as follows by the titrimetric method (AOAC 962.19, 2003): 10 g honey samples were dissolved in 75 ml, CO_2-free water in a 250 ml beaker. The electrode of the pH meter (Mettler Toledo Delta 320) was immersed in the solution, stirred with a magnetic stirrer and titrated with 0.05 N NaOH to pH 8.5 (free acidity). Then the addition was stopped; immediately 10 ml of 0.05 N NaOH were added and without delay back-titrated with 0.05 N HCl to pH 8.30 (lactone acidity). Total acidity resulted from adding free plus lactone acidities. The results were expressed as milliequivalents/kg (meq/kg).

2.2.1.4. pH determination. pH measurements were performed potentiometricaly a 20 °C using a pH-meter Sartorius Professional Meter PP-15 (Sartorius Ag, Goettingen, Germany) in Honey samples diluted with freshly deionized water, ranging from 10% to 100% (w/v) (Silva et al., 2009).

2.2.1.5. Redox potential (Eh). Millivolt measurements were performed at 20 °C using a pH-meter cyber scan pH 6000 (Eutech instruments, Nijkerk, Netherlands). Honey samples were diluted with freshly deionized water, ranging from 10% to 100% (w/v) (Dimiņs, Kuka, Kuka, & Cakste, 2006).

2.2.1.6. Ash. Ash was indirectly determined using the measured electrical conductivity and applying the following equation: X1 = (X2 − 0.143)/1.743, were: X1 = ash value; X2 = electrical conductivity in μS/cm at 20 °C (Piazza, Accorti, & Persano Oddo, 1991).

2.2.1.7. Electrical conductivity. Electrical conductivity was measured at 20 °C in solutions of honey samples in deionized water with specific electrical conductivity $\mu S/cm^{-1}$ using a conductivity meter WTW 1970i (Werkstätten, GmbH, Germany), (Silva et al., 2009).

2.2.1.8. Colour intensity. The net absorbance of the honey samples was determined by the method of Beretta, Granata, Ferrero, Orioli, & Facino, 2005. The honey samples were diluted to 50% (w/v) with warm (45–50 °C) milli Q water and the solution was filtered through a 0.45 μm filter. There was a complete absence of coarse particles in the honey solutions as all the commercial samples were non-crystalline liquid honeys. The absorbance was measured using a spectrophotometer at 450 and 720 nm and the difference in absorbance was expressed as mAU.

2.2.1.9. Colour. Visual colour was measured using Hunter colorimeter model ColorFlex (Hunter Associates Laboratory, Reston, VA, USA) in terms of *L* (lightness), *a* (redness and greenness) and *b* (yellowness and blueness). The instrument (45°/0° geometry, 10°observer) was calibrated with a standard black and white tile followed by measurement of each honey samples (Beretta et al., 2005).

2.2.2. Biochemical analysis

2.2.2.1. Sugar profile analysis. Honey (1 g) was dissolved in 10 ml acetonitrile: water (1:1) solution. The mixture was homogenised with constant shaking for at least 30 min. Then the samples were

Table 1
Classification of honey types and regional sources.

Sample	Type of honey	Family	Botanical name	Common name	Local name	Region	Sensory characteristics (colour, consistency)
Arid regions							
H1	Monofloral	Fabaceae	*Prosopis juliflora*	Ghaf	Ghaf honey	UAE	Light amber, less viscous
H2	Monofloral	Rhamnaccae	*Ziziphus spina-csisti*	Wild jujube	Alain sider	UAE	Slightly dark amber, very less viscous
H3	Monofloral	Fabaceae	*Acacia tortilis*	Wild mountain	Ras ul Khaima Samar	UAE	Light amber, less viscous
H4	Monofloral	Rhamnaccae	*Ziziphus spina-csisti*	Wild jujube	Oman sider	Oman	Light amber, less viscous
H5	Monofloral	Fabaceae	*Acacia tortilis*	Wild mountain	Oman samer	Oman	Slightly dark amber, viscous
H6	Monofloral	Rhamnaccae	*Ziziphus spina-csisti*	Wild jujube	Garden sider	Yemen	Dark amber, very viscous
H7	Monofloral	Fabaceae	*Acacia tortilis*	Wild mountain	Doany samer	Yemen	Light amber, viscous
H8	Monofloral	Fabaceae	*Acacia tortilis*	Marya herbal	Ashab marya samer	Yemen	Dark amber, viscous
H9	Heterofloral	–	–	Wild mountain	Ashab gablaya	UAE	Light amber, viscous
H10	Heterofloral	–	–	Herbs	Ashab	Omani	Slightly dark amber, less viscous
H11	Heterofloral	–	–	Mountain herbal	Ashab gbalya	Yemen	Light amber, viscous
Non arid regions							
H12	Monofloral	Rhamnaccae	*Ziziphus spina-csisti*	Wild jujube	Pakistan sider	Pakistan	Light amber, viscous
H13	Monofloral	Rhamnaccae	*Ziziphus spina-csisti*	Wild jujube	Kashmir sider	Kashmir	Light amber, less viscous
H14	Monofloral	Myrtaceae	*Leptospermum scoparium*	Manuka	Manuka	New Zealand	Light amber, very fine granulated, medium solid
H15	Heterofloral	–	–	Black forest	El ghabat el sawda	KSA(Imported)	Dark amber, less viscous
H16	Heterofloral	–	–	Black forest	El ghaba el sawda	Germany	Dark amber, less viscous