International Journal of Food Science and Nutrition
ISSN: 2455-4898; Impact Factor: RJIF 5.14
Received: 17-01-2019; Accepted: 19-02-2019
www.foodsciencejournal.com
Volume 4; Issue 2; March 2019; Page No. 62-66

Evaluation of physicochemical quality of bees honey commercialized in Côte d'Ivoire

André Philippe S Kpaibé[1*], Nicaise Bony[2], Franck D Djonwan[3], Gildas K Gbassi[4], Michèle Aké[5]
[1-5] Department of Analytical chemistry and Food Sciences, Pharmaceutical and Biological Sciences College, Félix Houphouët-Boigny University, Abidjan, Côte d'Ivoire
[2, 4] Laboratoire Nationale de Santé Publique (LNSP), Côte d'Ivoire

Abstract
Honeys and Derivatives are Consumer Products in Côte d'Ivoire. Several products are available. The authenticity of honey is of great importance for commercial and health reasons. This work was to carry out a physic-chemical and microscopy study of the quality of honey commercialized and search adulerations, which are prohibited in Codex Alimentarius. pH, density, electrical conductivity, water and sugar contents, as well as microscopic were study. The microscopic analysis of honey was intended to identify honeys pollen content. Non-compliant honey were detected. Analyzes showed that some products commercialized as honey were adulteration products.

Keywords: honey, bees, physico-chemical, pollen, aduleration, quality

1. Introduction

Honey is a product of great consummation in the world. For a long time in human history, honey has been an important carbohydrate source, and the only largely available sweetener, until industrial sugar production began to replace it after 1800 [1]. Honey has, during a long time, been used as nutrient and as medicine. An alternative medicine branch, called "apitherapy", has been developed in recent years, offering treatments based on honey and other bee products against many diseases [1]. Honey is the natural sweet substance produced by bees from the nectar of plants, or secretions of living parts of plants, or excretions of plant sucking insects on the living parts of plants, which they collect. Bees, then, transform it by combining it with specific substances of their own, and deposit, dehydrate, store and leave it in the honey comb to ripen and mature [2]. Honey is composed mainly of sugar and water represent honey (generally 80% of carbohydrates and 17% of water), and also of proteins, aromas, pigments, vitamins, of free amino acids and many volatile compounds in the minority [5,3].

Honey products are increasingly commercialized in the world. The annual world honey production is over 1.2 million tons [1]. It can be used for direct consumption or as an ingredient in various food and products [1] Due to its popularity and economic profitability, honey has become a common adulteration substance. Adulteration of bees honey with sweetening materials were reported in the literature [1]. The authenticity of honey is of great importance for commercial and health reasons [4]. In Côte d'Ivoire, several industrial and artisanal products from local and foreign producers are available. The quality of these products remains unknown because there is no regulation for their control. This research consists in evaluating the physicochemical quality of honeys commercialized in Côte d'Ivoire according to the Codex Alimentarius.

2. Material and Methods

2.1 Samples

A total of 17 different honeys were purchased. 9 samples of locally produced honey and 8 samples of imported honey were obtained (Table 1). Samples were coded (1 to 9 for local production, and 10 to 17 for the imported ones) for the study. Organoleptic characteristics were appreciated during the study.

Table 1: Honey samples studied

Sample	Manufacturer's indication			Sample	Manufacturer's indication		
	Harvest year	Harvest area	Floral origin		Harvest year	Harvest area	Floral origin
1	2017	Bouaflé (Cote d'Ivoire)	Coffee tree	10	2016	Algeria	Date palm
2		Agboville (Cote 'Ivoire)	Acacia tree	11	2017	Senegal	All flowers
3		Katiola (Cote d'Ivoire)	Cashew tree	12		France	Acacia tree
4		Korhogo (Cote d'Ivoire)	All flowers	13		Spain	Orange tree
5				14	2016		All flowers
6				15	2017	Europe /Latin America	
7		Djekanou (Coted'Ivoire)		16		Europe/ America	
8		Katiola (Cote d'Ivoire)		17	2016	Central America	
9		Korhogo (Cote d'Ivoire)					

2.2 Physicochemical analysis

a) Density

To determine density, 5 mL of sample and 5 mL of distilled water were successively weighed. The density was expressed by the ratio of the masses obtained.

Density = M / M'

M: Mass of honey weighed

M': Mass of the distilled water weighed

b) pH

pH has been measured with pH-meter previously calibrated with buffer solutions (pH7 and pH4).

c) Conductivity

To determine conductivity, 10 g of honey was weighed and diluted with distilled water in a 50 ml beaker. The resulting solution was placed in a water bath set at 20 ℃. The conductivity was measured by introducing the electrode of the conductivity meter into the honey solution.

d) Water content

Water content was determined by means of a refractometer. A drop of perfectly liquid honey was deposited on the plate of the prism of an Abbe refractometer with thermometer incorporated and distributed in a thin layer. Reading was done through the eyepiece at the level of the horizontal dividing line between a light area and a dark area. This line cuts a vertical scale graduated directly in refractive index. The water content is obtained by referring to Chataway table (Table 2) which links the obtained refractive index to the water content.

Table 2: Chataway Table (1935)

Refractive index (20°C)	Water content (%)	Refractive index (20°C)	Water content (%)	Refractive index (20°C)	Water content (%)
1,5044	13,0	1,4935	17,2	1,4835	21,2
1,5038	13,2	1,4930	17,4	1,4830	21,4
1,5033	13,4	1,4925	17,6	1,4825	21,6
1,5028	13,6	1,4920	17,8	1,4820	21,8
1,5023	13,8	1,4915	18,0	1,4815	22,0
1,5018	14,0	1,4910	18,2	1,4810	22,2
1,5012	14,2	1,4905	18,4	1,4805	22,4
1,5007	14,4	1,4900	18,6	1,4800	22,6
1,5002	14,6	1,4895	18,8	1,4795	22,8
1,4997	14,8	1,4890	19,0	1,4790	23,0
1,4992	15,0	1,4885	19,2	1,4785	23,2
1,4987	15,2	1,4880	19,4	1,4780	23,4
1,4982	15,4	1,4875	19,6	1,4775	23,6
1,4976	15,6	1,4870	19,8	1,4770	23,8
1,4971	15,8	1,4865	20,0	1,4765	24,0
1,4966	16,0	1,4860	20,2	1,4760	24,2
1,4961	16,2	1,4855	20,4	1,4755	24,4
1,4956	16,4	1,4850	20,6	1,4750	24,6
1,4951	16,6	1,4845	20,8	1,4745	24,8
1,4946	16,8	1,4840	21,0	1,4740	25,0
1,4940	17,0				

e) Sugar level

Sugar content was determined with Abbe refractometer, which indicated the Brix degree scale, which is parallel with the refractive index scale. The measurements were made at 20°C.

2.3 Microscopic analysis

The microscopic analysis of honey is intended to identify and determine honeys pollen content. 10 g of honey were weighed and dissolved in 20 ml of water in 5% of sulfuric acid, then centrifuged at 3000 rpm for 15 minutes. The supernatant was removed and the pellet was recovered in 2 mL of distilled water. A drop of the pellet was spread on slide and dried at 40 ℃ in the oven for 30 minutes. The prepared slide, with a coverslip, was then observed with microscope. Pollen identification was performed using reference documents [5, 6, 7].

2.4 Statistical analysis

ANOVA and NEWMAN-KEULS statistical tests were performed.

3. Results and Discussion

Honey samples analyzed had colors ranging from yellow to brown with sweet taste. Honey can have varying colors ranging from yellow to dark brown color. The clearer is the honey, the less it is rich in minerals [8,]. Harvest areas and floral origins were mentioned on the label in accordance to referential [9, 10].

Regarding physicochemical study, honeys analyzed had a density between 1.28 and 1.45 (Table 3). Density of a good quality honey dependent on water content varies between 1.40 and 1.45 at 20 °C. Some sample densities (2, 7, 10, 11, 13) were less than 1.40.

pH values of honeys studied were ranged from 3.9 to 4.7 (Table 3). These honeys were more acidic than good quality honeys. Their pH was between 3.5 and 4.5 These honeys were more acidic than good quality honeys, (pH between 3.5 and 4.5 for nectar honeys and between 5 and 5.5 for honeydews). These pH values are in accordance with the recommendations of Codex Alimentarius. Donadieu and Gonnet reported the acidic pH of honeys between 3.5 and 6 [11]. According Gonnet, pH is a measure to determine the floral origin of honey [12]. Honeys, with pH around 3.5 will require special storage precautions, while honeys with pH around 5 will be better and last longer [12].

Electrical conductivities of honeys analyzed have been between 1.39 and 39.70 × 10^{-4} S/cm (Table 3). According to Codex Alimentarius, electrical conductivity of nectar honeys is below 8×10^{-4} S/cm, and that of honeydew honeys does not fall above 8×10^{-4} S/cm. Electrical conductivity expresses the ability of the aqueous solution to conduct electricity. It is positively correlated with the content of soluble salts which is proportional to conductivity [8]. It is a good criterion linked to botanical origin of honey, and very often used in routine controls. Electrical conductivity of sample 10 (39.7×10-4 S/cm), which is nectar honey according to floral origin, is far superior to the norm, suggesting an adulteration contrary to the regulation of Codex Alimentarius [9, 13].

Table 3: Physical parameter values of milk samples

Sample number	Density	pH	Conductivity (10^{-4} S/cm)
1	1,40	3,92	6,80
2	1,38	3,95	6,04
3	1,41	4,70	9,54
4	1,40	4,36	6,11
5	1,40	4,33	6,65
6	1,41	4,04	4,57
7	1,39	4,18	4,83
8	1,44	4,49	5,91
9	1,43	3,95	3,37
10	1,28	4,33	39,7
11	1,37	4,07	6,80
12	1,40	4,03	1,39
13	1,39	3,92	1,67
14	1,43	4,42	7,37
15	1,43	4,17	3,57
16	1,45	4,05	2,73
17	1,43	3,90	3,40

Water content is a parameter determining the quality of honey. Water content of honey samples analyzed ranged from 16.2% to over 25% (Table 4). Codex Alimentarius recommends less than 21% of moisture content for honeys (less than 25% for industrial production). Sample number 10 had the highest water content that is 34.2%. This water content, above standard, associated with the high conductivity for this sample confirms the adulteration that is prohibited by Codex Alimentairus. In addition, honeys with moisture content of less than 18% are better preserved [10]. Thus, some samples (1, 6, 7, 9, 10, 11) would be difficult to preserve.

Sugar content of honey samples analyzed is between 70% and 82%. These rates are approximately in line with developed guidelines which recommend a sugar content less than 80% [14, 15].

Table 4: Water and sugar levels values of milk sample.

Sample number	Water content (%)	Sugar level (°B)
1	19	79
2	18,2	80
3	18,2	80
4	17	81,5
5	17,4	81
6	19	79
7	20,2	78
8	16,6	81,5
9	19,4	79
10	34,2 %	70
11	19,4	79
12	17,8	80,5
13	17,4	81
14	17,8	80,5
15	17,8	80,5
16	16,2	82
17	17,8	80,5

Microscopic study [5] of the samples allowed to divide them into 3 classes, according to their amount of pollen grains, (Table 5) based on Maurizio classification [16]:

Table 5: Pollen analysis of honey samples

Samples	Floral origin by the manufacturer	Pollen density obtained	Families or species of Pollens determined
1	Coffee tree	++	Coffea arabica (Rubiaceae)
2	Acacia tree	++	Coffee arabica (Rubiaceae) ; Acacia sp (Mimosaceae)
3	Cashew tree	+++	Anacardium occidentale Linn(Anarcadiaceae) ; Acacia sp (Mimosaceae) ; Lannea acida A. Rich ; Vicia sp (Fabaceae)
4	All flowers	++	Acacia sp(Mimosaceae) ; Vicia sp (Fabaceae), pollen d'Astéraceae
5	All flowers	+++	Acacia sp(Mimosaceae) ; Anacardium occidentale Linn ; Pollen de rubiaceae
6	All flowers	++	Vicia sp (Fabaceae) ; Acacia sp(Mimosaceae)
7	All flowers	++	Coffee arabica (Rubiaceae) ; Vicia sp (Fabaceae)
8	All flowers	++	Anacardium occidentale Linn(Anarcadiaceae ; Autres pollen non identifiés
9	All flowers	+++	Acacia sp(Mimosaceae) ; pollen d'Astéraceae ; Anacardium occidentale Linn(Anarcadiaceae)
10	Date palm	--	Aucun grain de pollen
11	All flowers	+++	Acacia sp(Mimosaceae) ; Acacia sp (Mimosaceae) ; autres pollens non identifiés
12	Acacia tree	+	robinia pseudoacacia (Fabacées); Acacia longifolia(Mimosaceae) ; Cirsium arvense (Asteraceae) ; Pollen de Malvaceae.
13	Orange tree	+	Citrus sinensis. L (Rutaceae) ; Achillea sp (Asteraceae) Rhododendron groenlandidicum (Ericaceae)
14	All flowers	+	Rhododendron groenlandidicum (Éricacées) ; pollen d'Astéraceae
15	All flowers	+	Citrus sinensis. L (Rutaceae) ; Coriandrum sativum L. (Apiaceae) ; autres pollens non identifiés
16	All flowers	++	Melissa officinalis L (Lamiaceae) ; pollen d'Astéraceae ; Pollen de Malvaceae
17	All flowers	+	Acacia sp (Mimosaceae) ; Melissa officinalis L (Lamiaceae) ; pollen d'Astéraceae ; Citrus sinensis. L (Rutaceae)

Class I: Large number of pollen (+++): more than 80 grains of pollen per field (Gx10).
Class II: few pollens (++): between 40 and 80 grains of pollen per field (Gx10).
Class III: Very little pollen (+): less than 40 grains of pollen (Gx10).

A large number of pollen (class 1) has been found in samples 3, 5, 9 and 11, which are locally produced honeys (Table 5). Sample number 3 (cashew honey) is dominated by pollen grains from Anarcardiacea confirming its mono-floral designation and its geographical origin (Katiola, Côte d'Ivoire), where cashew cultivation is widely practiced. Samples numbers 5 and 9 are mono floral honeys of Acacia because they contain mostly Mimosaceae pollens of the genus Acacia. Sample number 11 showed different forms of pollen (polyfloral) which after comparison with reference pollen belong to the family Mimosaceae, Anacardiaceae, Caryophylaceae, Fabaceae (Fig. 1).

Few pollen (class 2) were found in the samples numbers 1, 2, 4, 6, 7, 8 and 16 (Table 5). Samples numbers 4, 6, 7, 8 and 16 contain several forms of pollen. Regarding sample number 1, pollen grains observed do not correspond to the indicated botanical origin (Coffee), but they resemble the pollens of Theobroma cacao. In sample number 2 (acacia honey), two types of pollen grains (Acacia pollen and a pollen similar to Theobroma cacao) were observed. This sample is not a unifloral honey as indicated by the producer but a mixture of two unifloral honeys (Fig. 1).

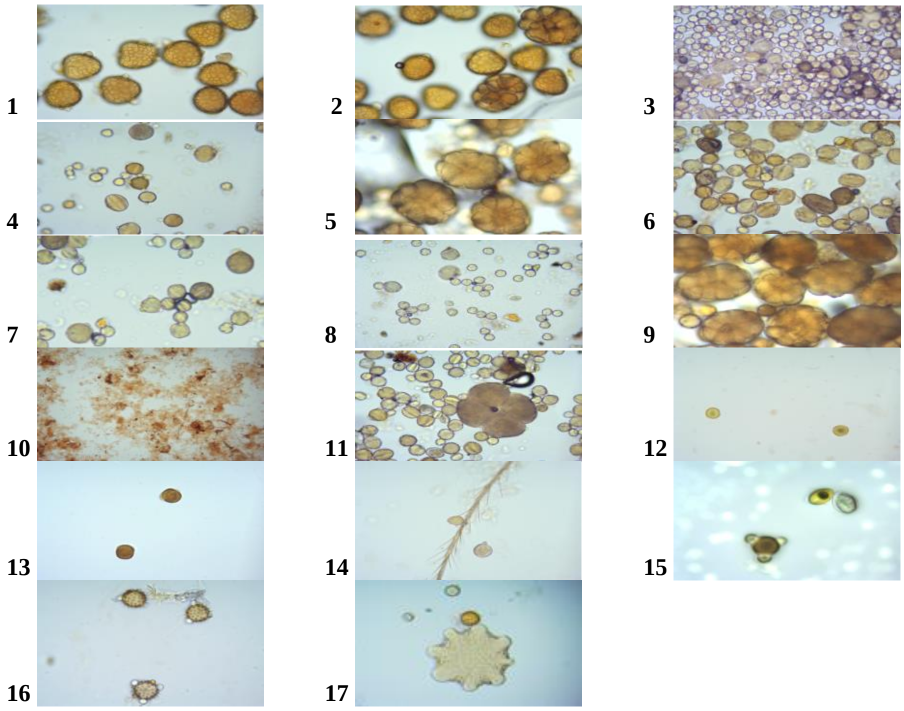

Fig 1: Microscopic images of pollen grains of the 17 honey samples (1 to 17).

Samples numbers 12, 13, 14, 15 and 17 reported a very small amount of pollen grains (Table 5). Samples numbers 14, 15 and 17 contain different forms of pollen in small quantities, confirming their multifloral honey names. Samples numbers 12 (acacia honey) and 13 (orange honey) show that they are monofloral honeys (Fig. 1). Sample number 10 did not contain pollen grain (Fig. 1). and therefore would not be honey bee. This sample would be date syrup, which are improperly called honeys [17]. Pollen microscopic analysis is a very important parameter which gives precise information on botanical and geographical origins, making it possible to detect the possible falsifications.

4. Conclusion

The work carried out allowed the evaluation of the quality of honeys commercialized in Côte d'Ivoire through various physicochemical and microscopic analyzes. pH, density, electrical conductivity, water and sugar contents, as well as microscopic study of pollens made it possible to detect among the 17 samples analyzed, a sample which was corrupted, and was not really honey. Establishment of national regulations on honey products, as well as their systematic control are become essential to ensure the quality of honeys consumed by populations.

5. References

1. Bogdanov S, Jurendic T, Sieber R, Gallmann P. Honey for Nutrition and Health: A Review. J. Am. Coll. Nutr. 2008; 27:677-689.
2. Belhaj O, Oumato J, Zrira S. Étude physico-chimique de quelques types de miels marocains. Rev. Mar. Sci. Agron. Vét. 2015; 3(3):71-75.
3. García-Alvarez M, Huidobro JF, Hermida M, Rodríguez-Otero JL. Major Components of Honey Analysis by Near-Infrared Transflectance Spectroscopy. J. Agric. Food Chem. 2000 ; 48:5154-5158.
4. Sivakesava S, Irudayaraj J. A Rapid Spectroscopic Technique for Determining Honey Adulteration with Corn Syrup. J. Food Sci. 2001; 66:787-791.
5. Puusepp L, Koff T. Pollen analysis of honey from the Baltic region, Estonia. Grana. 2014; 54:54-61.
6. Přidal A, Vorlová L. Honey and its physical parameters. Czech J Anim Sci. 2002 ; 47(10):439-444.
7. Ybert JP. Atlas de pollens de Côte d’Ivoire. IRD Editions, 1979, 69.
8. Bogdanov S, Ruoff K, Oddo L. Physico-chemical methods for the characterisation of unifloral honeys: a review. Apidologie. 2004; 35:4-17.
9. Alimentarius C. Draft revised for honey at step 6 of the Codex Procedure. CX 5/10.2, CL 1998/12-S 1998.
10. Conseil Européen. Directive relative au miel. Journal officiel des Communautés Européennes, 2001.
11. Donadieu Y, Marchiset C. La cire thérapeutique naturelles. Ed Maloine S.A. Paris, 1984, 69.
12. Gonnet M. L’analyse des miels. Description de quelques méthodes de contrôle de qualité. Bul. Tech. Apic. 1986; 13(1):17-36.
13. Bogdanov S, Martin P, Lullmann C. Harmonised methods of the international honey commission. Ed fInternational Honey Commission (ICH), 2002, 62.
14. Bogdanov S. Honey Composition. In: Book of Honey. Bee Product Science, 2011, 10.
15. Guler A, Kocaokutgen H, Garipoglu AV, Onder H, Ekinci D, Biyik S. Detection of adulterated honey produced by honeybee (*Apis mellifera L.*) colonies fed with different levels of commercial industrial sugar (C3 and C4 plants) syrups by the carbon isotope ratio analysis. Food Chem. 2014; 155:155-160.
16. Maurizio A. Microscopy of honey. crane e, Ed, honey, comprehensive survey. London. Heinemann, 1939, 240-257.
17. Zábrodská B, Vorlová L. Adulteration of honey and available methods for detection: a review. Acta Vet. Brno. 2014; 83:85-102.