STUDY ON THE QUALITY OF BEE HONEY COMMERCIALIZED IN AGRI-FOOD MARKETS FROM IAŞI CITY

STUDIU CU PRIVIRE LA CALITATEA MIERII DE ALBINE COMERCIALIZATĂ ÎN PIEȚE AGROALIMENTARE DIN MUNICIPIUL IAȘI

USTUROI Al.[1], RAȚU Roxana Nicoleta[1], USTUROI M.G.[1], NISTOR C.E.[1], DAVIDESCU Mădălina[1], AVARVAREI B.V.[1*]
[*]Corresponding author e-mail: bvavarvarei@uaiasi.ro

Abstract: *The purpose of the current paper was to establish the properties of bee honey sold in some agro-food markets within the radius of Iași City. To achieve this goal, we researched a series of essential parameters for this food product, namely: the sensorial and physical-chemical properties (expressed by refractive index, percentage in water, density, mineral substances, impurities and colour).*
Keywords: bee honey, agro-food markets, physical-chemical properties, sensorial properties.

Rezumat: *Scopul prezentei lucrări a fost acela de a stabili proprietățile mierii de albine comercializată în unele piețe agroalimentare de pe raza municipiului Iași. Pentru îndeplinirea acestui obiectiv am cercetat o serie de parametri esențiali pentru acest produs alimentar și anume: proprietățile senzoriale respectiv cele fizico-chimice (exprimate prin indice de refracție, procent în apă, densitate, substanțe minerale, impurități și culoare).*
Cuvinte cheie: miere de albine, piețe agroalimentare, proprietăți fizico-chimice, proprietăți senzoriale.

INTRODUCTION

Beekeeping plays a particularly important role in the creation of extremely valuable products, such as honey, wax, pollen or propolis. This branch of agriculture is essential because it ensures the pollination of crops and influences the considerable increase in the quantity and quality of some products, especially of seeds and fruits (Albu *et al*., 2021).

Because bee honey was at one time the only sweetener available, it has been an important food for *Homo Sapiens* since its inception, with the relationship between bees and humans apparently dating back to the Stone Age. Bees have a known history of around 10-20 million years and are one of the oldest life forms in the animal kingdom so far. According to the studies of some scientists, bees have been producing honey for almost 40 million years. Ancient civilizations

[1]Iași University of Life Sciences, Iași, Romania

valued this product primarily for its sweetness, using it as a commercial product (Živkov Baloš *et al.*, 2018).

At the moment, bee honey is the one of the most consumed and purchased beekeeping product. Codex Alimentarius (CODEX STAN 12-1981) defines honey as a "sweet substance, produced by bees (*Apis mellifera*) from the nectar of flowers or from the secretions of living plants, which the bees collect, transform by combining with their specific substances and store in honeycombs for ripening and maturing" (Belay *et al*., 2017).

It is undeniably a very complex and healthy food because it includes in its composition a multitude of useful substances for the human body, namely: proteins, vitamins, sugars, minerals, amino acids as well as antioxidants what gives honey a high therapeutic value (Chirsanova *et al*., 2021).

This bee product, which does not have harmful effects like sugar, offers the human body a better tonus and an increase in energy conferred by means of the vitamins and enzymes present in its composition (Majewska *et al*., 2019). In the food industry, bee honey is used to obtain a wide range of food products (biscuits, cakes, etc.) (Pauliuc and Oroian, 2020a).

MATERIAL AND METHOD

Sensorial examination: appearance, crystallization and consistency. Before being examined, the samples were homogenized using a glass rod. The appearance of bee honey samples was examined in natural light, establishing the degree of transparency (Pauliuc and Oroian, 2020b).

Because the fluid state transition of a composed in consistent state constitutes the process of crystallization. Under the influence of temperature of 40°C, the crystallized samples were liquefied.

Initially, the presence/absence of foam was followed, after which we noted the category of crystallization (initial, partial or total), as well as their particularities (fine, suitable or coarse).

The consistency of the samples was determined by observing the flow of the biological material on a glass rod. After the examination was completed, the types of consistency specific to the bee honey variety were noted: fine, thin or viscous (Pauliuc and Oroian, 2020b).

Smell and taste. The aroma examination was carried out by tasting the honey samples, thus establishing the taste and smell. Later, the characteristics of the aroma were centralized: discreet, moderate, highlighted.

The taste of the samples was expressed using (taking into account the amount of fructose of each honey type) the following characteristics: sweetish, sweet, bitter (Popescu, 2017).

Determination of impurities to determine the content in impurities, with the help of the technical balance it was weighed a quantity of 10 g produced in a Berzelius glass. 40 mL of distilled water was added over the sample and the mixture was homogenized with a glass rod and then filtered (Sakač *et al*., 2019).

The impurity content was expressed in g/100 g product by using the following

formula, namely:

$$Impurities = (m_2/m_1) * 100 \quad (g/100\ g\ product)$$

where:

m_1 = sample mass used for determination (g);

m_2 = residue mass obtained after filtration and drying (g).

Determination of colour. To establish this parameter, 5 g of honey from each assortment were weighed and then resorted to solubilizing the samples by heating (Sakač *et al.*, 2019).

Solubilized honey samples were introduced into the 10 mm long spectrophotometer cuvettes; the sample cuvettes were inserted into the spectrophotometer Shimadzu Uvmini 124, where they were analysed at a wavelength of 560 nm (Popescu, 2017).

After reading the absorbance for each sample in the spectrophotometer, the obtained values were plotted on the Pfund scale. According to table 1 we checked the colour (fig. 1, tab. 1).

Fig. 1 Pfund scale

Table 1

Classification of bee honey samples function of absorbance

Colour	Pfund scale (nm)	Absorbance
Water White	8 or <8	0.0945
Extra White	9–17	0.189
White	18–34	0.378
Extra Light Amber	35–50	0.595
Light Amber	51–85	1.389
Amber	86–114	1.390–3.008
Dark Amber	114-140	>3.100

Determination of refraction index. The evaluation was carried out by means of the Carl Zeiss Abbé refractometer. The percentage of water along with the specific gravity and total solids content of the honey is indicated by the refractive index.

For accuracy, the reading according to SR 784:3/2009 is carried out at a sample temperature of 20°C. Temperature correction was achieved by applying a correction factor of 0.00023 for each °C plus or minus from the standard (SR 784:3/2009, Zhelyazkova and Lazarov, 2017).

Determination of content in water. The determination of the content in water was based on the use of the correlation table corresponding to the index relation of refraction-humidity, and the expression was made in % (Zhelyazkova and Lazarov, 2017; Directive 2001/110/EC, SR 784:3/2009).

Determination of specific weight. After reading the refractive index and making the correction by means of the correction factor, we extracted the specific weight values from the refractive index-specific weight correlation table. The specific weight was expressed in g/cm^3 (Pauliuc and Oroian, 2020b).

Determination of mineral substances content. After bringing the crucibles to constant weight, 5 g of honey were weighed using the analytical balance (Živkov Baloš *et al*., 2018). Ash determination was carried out in 2 stages:

- burning of honey samples on the sand bath;
- calcination of honey samples from crucibles at a temperature of 550°C in the calcination oven.

Total mineral content represents the residue obtained from the calcination process, which we weighed after cooling in the desiccator.

Ash content was calculated with the following formula (Živkov Baloš *et al*., 2018):

$$Ash = (m_1/m_2) * 100 \quad (\%)$$

in which:

m_1 = mass of crucible with ash (g);

m_2 = mass of crucible (g).

RESULTS AND DISCUSSIONS

Crystallization, appearance, impurities and consistency

For sunflower honey (SfH), the lack of crystallization, impurities and foam was observed. The samples presented a liquid consistency, having a uniform and constant flow (tab. 2).

Analysing the sample of rapeseed honey (RH), revealed total crystallization, the presence of some small impurities and lack of foam. It was also observed that this category had a viscous consistency with an inconstant flow (tab. 2).

Analysing acacia honey (AH), an uncrystallised, uniform appearance and liquid consistency was observed; the sample showed no impurities and foam at the surface (tab. 2).

Linden honey (LH), had uncrystallised, uniform and transparent appearance and the consistency was liquid; the sample was free of impurities and foam (tab. 2).

Table 2

Crystallization, appearance, consistency and impurities of analysed honey

Sort	Crystallization, appearance, consistency and impurities
SfH	Uncrystallised, uniform, without foam, liquid consistency, constant and uniform flow, without traces of impurities
RH	Totality crystallised, buttery, uniform, small and fine crystals, doesn't present foam, viscous consistency, uneven flow, presents small impurities
AH	Uncrystallised, uniform and transparent, without foam, liquid consistency, quick and uniform flow, without traces of impurities
LH	Uncrystallised, transparent and uniform, without foam, liquid consistency, fast and constant flow, impurities missing

Smell and taste

Following the appreciation of the smell and taste, highlight the intensity of the aromas and the main or secondary nuances perceived during the tasting (tab. 3).

In general, we can state that the samples SfH, RH and LH presented a pleasant, intense smell, specific to sunflower, rapeseed and linden honey varieties. The acacia honey sample presented a pleasant, specific smell.

Regarding the taste, all the honey samples were sweet, aromatic and well highlighted, except for the RH sample in which a slightly bitter taste was found.

Table 3

Smell and taste

Sort	Characteristics	
	Smell	Taste
SfH	Pleasant, intensive	Sweet, pleasant
RH	Pleasant, intensive	Sweet, with a slightly bitter shade
AH	Pleasant, specific	Sweet, aromatic
LH	Pleasant, intensive	Sweet, well highlighted

Impurities content

The analysis of the obtained results highlighted a variation in the content of impurities depending on the assortment taken into study. The minimum average

value of 2.28±0.06 g/100 g product was highlighted in the case of the rapeseed honey sample (RH), and the maximum value of 2.68±0.05 g/100 g product for linden honey (LH) (tab. 4). The calculation of the coefficients of variation allowed us to characterize the analysed character as very homogeneous (V%=0.9-2.80) (tab. 4).

The maximum value of the impurity content provided for in SR 784:2/2009 is 0.1% for honey that is sold. The results obtained on the basis of the analysed samples were far above the admissible value, from which it emerged that the honey was subjected to poor processing, especially at the level of the filtering operation.

Table 4

Impurities content in the analysed honey (g/100 g)

Sort	No. readings	$\overline{X} \pm s_{\overline{X}}$	V%	Min.	Max.
SfH	5	2.39 ± 0.02	0.9	2.32	2.48
RH	5	2.28 ± 0.06	2.80	2.16	2.46
AH	5	2.48 ± 0.04	2.60	2.43	2.55
LH	5	2.68 ± 0.05	1.30	2.62	2.74

Colour of analysed honey

For colour determination was used the spectrophotometric method. The obtained values were compared with the Pfund colorimetric scale. Thus, colours were obtained that varied from white-yellow (Water White) to light yellow (Extra white) (tab. 5).

The maximum value was recorded in the case of acacia honey sample (AH) being 0.187 nm, and the minimum obtained value was for sunflower honey sample (SfH) and was of 0.089 nm (tab. 5).

The analysed samples of sunflower (SfH), rapeseed (RH) and linden (LH) honey showed a light yellow colour (Extra White).

Table 5

Colour of analysed bee honey (nm Pfund)

Sort	Absorbance	Colour
SfH	0.187	Light Yellow (Extra white)
RH	0.159	Light Yellow (Extra white)
AH	0.089	White to Yellow (Water white)
LH	0.171	Light Yellow (Extra white)

Refraction index

Analysing the results for the mentioned indicator indicated that the minimum average value of the refractive index 1.4812±0.01 was determined in the SfH sample, and the maximum value in the rapeseed sample (RH) with the value of 1.5016±0.01 (tab. 6).

Although there were differences, the coefficients of variation highlighted a very good homogeneity of the analysed batches. In general, the refraction index correlates in an inversely proportional ratio with the percentage in water.

Table 6

Refraction index of analysed honeys

Sort	n	$\overline{X} \pm s_{\overline{X}}$	V%	Min.	Max.
SfH	5	1.4812 ± 0.01	0.04	1.4712	1.4916
RH	5	1.5016 ± 0.01	0.03	1.4964	1.5179
AH	5	1.4868 ± 0.01	0.05	1.4750	1.4910
LH	5	1.4724 ± 0.01	0.02	1.4600	1.4886

Water content

The highest water content was identified in the SfH sample, the average value identified being 18.22±0.06%, while at the opposite pole was the RH sample with an average value of 13.89±0.05%; in all studied cases the character was very homogeneous. The results from the literature indicate approximate moisture values for rapeseed honey of 18.35% (tab. 7).

The growth content of the water leads to the risk of bee honey degradation. In accordance with the legislation in force Directives EC 110-2001 and SR 784:2/2009, honey must meet a series of quality standards, the maximum admissible for this parameter being 20%.

Table 7

Water content of the analysed honey

Sort	n	$\overline{X} \pm s_{\overline{X}}$	V%	Min.	Max.
SfH	5	18.22 ± 0.06	0.21	17.62	18.82
RH	5	13.89 ± 0.05	0.32	13.37	14.22
AH	5	16.16 ± 0.02	0.28	15.98	16.36
LH	5	17.36 ± 0.05	0.34	16.92	17.85

Specific weight – density

After determining its density was noticed the fact that the minimum average value was of 1.4324±0.01 g/cm^3 for sunflower honey (SfH), and the maximum of 1.4562±0.02 g/cm^3 in the case of rapeseed honey (RH). Between the two sorts there were tiny differences of approximately 0.0238 g/cm^3.

The other two types of honey have close values and namely: acacia honey (AH) recorded a value of 1.4548±0.02 g/cm^3, and linden variety (LH) a value of 1.4436±0.03 g/cm^3. The value difference observed between SH and LH samples was only 0.0112 g/cm^3 (tab. 8).

Table 8

Specific weight for the analysed honey (g/cm^3)

Sort	n	$\overline{X} \pm s_{\overline{X}}$	V%	Min.	Max.
SfH	5	1.4324 ± 0.01	0.19	1.4122	1.4680
RH	5	1.4562 ± 0.02	1.26	1.4030	1.4896
AH	5	1.4548 ± 0.02	0.68	1.4298	1.4684
LH	5	1.4436 ± 0.03	0.48	1.4236	1.4636

Mineral substances content

The data obtained as a result of the research showed the lowest average value of mineral substances content in the case of the AH sample was of 0.08±0.01%. Linden honey (LH) showed the highest average value of 0.23±0.01%. Intermediate, the sunflower honey sample (SfH) had an average value of 0.14± 0.01%, and that of RH of 0.09± 0.01% (tab. 9).

The legislation in force (SR 784-2/2009) states that the maximum admissible value of ash is 0.5%; all samples are in accordance with the standard.

Table 9

Content of mineral substances in the analysed honey (%)

Sort	n	$\overline{X} \pm s_{\overline{X}}$	V%	Min.	Max.
SfH	5	0.14 ± 0.01	2.26	0.13	0.15
RH	5	0.09 ± 0.01	3.16	0.08	0.10
AH	5	0.08 ± 0.01	4.55	0.07	0.09
LH	5	0.23 ± 0.01	3.82	0.22	0.24

CONCLUSIONS

Following the study, a series of general conclusions were drawn as follows:

1. Within the sensorial analysis, the types of analysed honey showed consistent results in terms of appearance, smell and taste;

2. In relation to the degree of crystallization, it was observed that only in the RH sample the crystallization was total. The linden, sunflower and acacia samples did not show crystallization;

3. The impurity content values ranged from 2.28% in the case of RH sample up to 2.68% for LH sample;

4. The colour of the 4 studied varieties showed a variation from Water White (white to yellow), for the AH sample, to Extra White (light yellow) (SfH, RH, LH);

5. The existence of a link between the colour and aroma of the honey varieties was noted, namely: the sample with a lighter colour (AH) had a light aroma, and those with a darker colour (SfH, RH, LH) a pronounced aroma;

6. Regarding the water content, all honey samples (SfH, AH, RH, LH) recorded values below the maximum admissible limit of 20%, limit provided in Directive 2001/110/EC and SR 784-2/2009;

7. Specific weight of honey samples showed a very small variation, the limits being between 1.4324±0.01 g/cm^3 and 1.4562±0.02 g/cm^3;

8. The values obtained for mineral substances fell within the admissible limits according to SR 784-2/2009.

REFERENCES

1. **Albu Aida, Radu-Rusu Cristina, Pop I.M., Frunză Gabriela, Nacu Gh., 2021 -** *Quality assessment of raw honey issued from Eastern Romania.* Agriculture, 11(3), 3-17.
2. **Belay A., Haki G.D., Birringer M., Borck Hannelore, Lee Y.C., Cho C.W., Kim K.T., Bayissa B., Baye K., Melaku S., 2017 -** *Sugar profile and physicochemical properties of Ethiopian monofloral honey*. International Journal of Food Properties, 20(11), 2855-2866.
3. **Chirsanova Aurica, Capcanari Tatiana, Boiștean Alina, Kanchel El Mehdi I., 2021 -** *Bee honey: history, characteristics, properties, benefits and adulteration in the beekeeping sector.* Journal of Social Sciences, 4(3), 98-114.
4. **Majewska Eva, Drużyńska Beata, Wołosiak R., 2019 -** *Determination of the botanical origin of honeybee honeys based on the analysis of their selected physicochemical parameters coupled with chemometric assays*. Food Sci. Biotechnol., 28(5), 1307-1314.
5. **Pauliuc Daniela, Oroian M., 2020a -** *Physicochemical parameters of Romanian sunflower honey*. Food and Environment Safety, 19(2), 148-155.
6. **Pauliuc Daniela, Oroian M., 2020b -** *Sugars content and physicochemical parameters of Romanian rape honey*. Scientific Bulletin. Series F. Biotechnologies, 24(2), 69-76.
7. **Popescu Agatha, 2017 -** *Bee honey production in Romania, 2007-2015 and 2016-2020*

forecast. Scientific Papers. Series Management, Economic Engineering in Agriculture and Rural Development, 17(1), 339-348.

8. **Sakač Marijana, Jovanov P.T., Marić A.Z., Pezo L.L., Kevrešan Ž.S., Novaković Aleksandra, Nedeljković Natasa, 2019 -** *Physicochemical properties and mineral content of honey samples from Vojvodina (Republic of Serbia)*. Food Chemistry, 276, 15-21.
9. **Zhelyazkova Ivanka, Lazarov S., 2017 -** *Comparative study of rapeseed, monofloral types and multifloral honey by some physicochemical parameters*. Agricultural Science and Technology, 9(4), 277-281.
10. **Živkov Baloš Milica, Popov N., Vidaković Suzana, Ljubojević Pelić Dragana, Pelić M., Mihaljev Ž., Jakšić Sandra, 2018 -** *Electrical conductivity and acidity of honey*. Archives of Veterinary Medicine, 11(1), 91-101.
11. *****Council Directive 2001/110/EC concerning honey**. Offic. J. Eur. Commu., L10:47-L10:52.
12. *****CODEX STAN** 12-1981.
13. *****SR 784-1:2009**: Miere de albine. Partea 1: Cerinţe de calitate la preluarea de la producători.
14. *****SR 784-2:2009**: Miere de albine. Partea 2: Cerințe de calitate de comercializare.
15. *****SR 784-3:2009**: Miere de albine. Partea 3: Metode de analiză.