Influence of Some Physicochemical Properties on the Quality of Honey

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ABSTRACT

One of the most important agricultural activities is certainly beekeeping, which significantly contributes to the preservation of biodiversity and the improvement of agricultural and, above all, fruit production.

In its approach to the European Union, Bosnia and Herzegovina follows the trends and harmonizes its legal legislation in many segments that relate to agriculture and beekeeping as its very important segment.

According to the available land per capita, Bosnia and Herzegovina does not lag behind European countries, because it has a great potential for agricultural production that has not been used.

The application of legal norms in beekeeping production is the basis for success in production, as well as health and food quality.

The primary goal of this study was to determine the influence of physicochemical properties on honey quality. Data collection was performed on the basis of honey analysis of four producers from the area of Tuzla, Lukavac, Živinice and Bihać. The analysis was performed on February 18, 2020, to 25.02.2020, years.

The analysis of samples and their physico-chemical parameters proved that there are statistically significant differences between the examined types of honey. The analysis of the main components was performed with the aim of detecting the difference in quality.

The analysis of the processed data was performed in the statistical program IBM SPSS.

Keywords- Honey Quality, Analysis, Physical and Chemical Properties, Beekeeping.

I. INTRODUCTION

With the modernization of society, we have reached a turning point in agricultural production. Modern society is increasingly striving for "healthy food" that is tested and safe and wants to have an insight into every part of production "from the field to the table". With these customer requests, we can only respond to the established traceability of food in each part of the chain and good agricultural practice. Honey is one of the most endangered agricultural products because it is susceptible to pathogens, which can have a negative impact on consumer confidence, and in beekeeping it is most necessary to establish good beekeeping practice. This type of production will ensure quality, continuity, consumer confidence and competitiveness in the global market.¹

Honey produced according to the rules of dpp must guarantee that all factors that affect the health and quality of honey are under control and within the legally prescribed limits. One of the ways of guarantee is proper and regular record keeping. "By keeping their own documentation (it must be available to everyone), beekeepers prove that they performed honey production according to the prescribed procedures and instructions, and that the health quality of the product corresponds to the expected standard. Any deviation from the set standards of health safety should be recorded, investigated and their causes eliminated, and preventive measures should be taken so that deviations do not recur."²

The hygiene of beehives is one of the most important factors in beekeeping production, and accordingly the HACCP system has established a system of self-control consisting of 7 principles, as follows:

- Conducting a hazard analysis,
- Determination of critical control points,
- Establishing critical boundaries,
- Establishment of supervisory procedures,
- Establishment of corrective measures,
- Establishing verification procedures,
- Establishing records and documents.

In order for the beekeeper to ensure the safety of his products, it is necessary to opt for the guidelines of the "Code of Good Beekeeping Practice according to the principles of the HACCP system" or his own HACCP system for the safety of bee products. When deviations from the prescribed guidelines are determined, the beekeeper decides for himself the appropriate correction procedure, which he must document. For professional

1The role of bees in the ecosystem, final thesis, Polytechnic of Šibenik
2Guidelines for "good beekeeping practice" according to the principles of the HACCP system, https://pdfslide.net/documents/1-smjernice-za-dobru-pecelarsku-praku-prema-.html
assistance, you can contact the competent services. It is important to emphasize that the quality of honey cannot be determined visually and that it is necessary to perform appropriate analyzes.

Analogous data on the storage and heating of honey is given by the amount of HMF. Natural honey should contain less than 2 mg% HMF, but in most cases that amount is below 1 mg%. During long-term storage of honey, the amount of HMF reaches 2-3 mg%. Heating honey at high temperatures also leads to an increase in HMF.

In some cases, a higher amount of HMF indicates that the honey is adulterated with glucose, especially invert sugar, obtained by acid hydrolysis of sucrose.

Depending on the hydrolysis conditions, invert sugar contains over 50-100 mg% HMF and if honey is added, it increases its amount. Even when bees are fed with invert sugar, HMF turns into the obtained sugar honey. If they are fed regular sugar, the amount of HMF is negligible.

The amount of HMF has been used for many years as an indicator of honey adulteration, in a way that the concentration of HMF also increased with increasing temperature. However, it was concluded that HMF is present in small amounts and in natural honey and its concentration depends on a number of factors such as pH value, acid content, moisture and light exposure. Pursuant to the aforementioned Ordinance, it is prescribed that the permitted amount in honey can range up to 40 mg / kg. All concentrations exceeding 100 mg / kg are indications that it is a forgery.

The presence of HMF is an extremely important indicator of quality because it serves as an indicator of freshness and overheating of honey.

II. METHODOLOGY

Honey samples were collected directly from honey producers (beehive) in the period of February 2020. The collected samples were produced in the spring / summer 2019 season.

Samples were delivered to the laboratory in glass containers, in the amount of 450 g, with information on the regional and botanical origin of honey. A total of 4 honey samples were collected, of which: three samples of acacia honey and one sample of chestnut honey.

Electrical Conductivity

Electrical conductivity is a physical property that depends on the presence of minerals and acids in honey. The higher it is, the higher the electrical conductivity of honey. Today, more and more in the routine control of honey quality due to simplicity and speed, instead of the proportion of ash, the measurement of electrical conductivity is carried out. It serves as a good criterion for determining the botanical origin of honey, i.e., for distinguishing nectar honey from honeydew.

The electrical conductivity in honey is defined by a 20% volume aqueous solution of honey at 20°C, where 20% refers to the dry matter of honey. The method is valid for determining the electrical conductivity in honey in the range of 01 to 3 milliSiemens / cm-1 (mS / cm-1).

Determination of water in honey

Water is the second most abundant ingredient in honey. The legal content of water in honey depends on the species and ranges from 15% to 20%. The amount of water present in honey has a significant impact on the physical properties of honey, such as crystallization, viscosity and specific gravity. The proportion of water depends on climatic conditions, the breed of bees, the strength of the bee community, the humidity and temperature of the air in the hive, the conditions during processing and storage and the botanical origin of honey. The method of determining water by drying is based on drying the sample to a constant mass in various types of dryers.

Determination of ash by standard incineration method

Every food, even honey, contains minerals, whether processed or unprocessed. The total mineral residue of a food can be determined as the proportion of ash that is actually the inorganic part remaining after all organic matter has been burned.

The principle of this method is based on the process of burning the sample at 600°C to constant mass.

Determination of acidity volumetrically

The prepared sample is titrated, in addition to phenolphthalein, with 0.1 mol / L sodium hydroxide solution until a light pink color appears.

Determination of HMF (hydroxymethylfurfural) at two wavelengths (White method)

The determination of HMF content is based on the absorption of HMF in the UV part of the 284 nm spectrum. In order to prevent the interference of other components at this wavelength, the differences between the absorption of pure honey solution after the addition of disulfite are determined.

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3Guidelines for “good beekeeping practice” according to the principles of the HACCP system, https://pdfslide.net/documents/1-smjernice-za-dobru-peclarsku-praksu-prema-.html, visited.

4Organic control, OK Standards for organic production and processing, http://www.organskakontrola.ba/site/OK_Standard.pdf

5Bogdanov, S., Lullmann, C., Martin, P. (1999) Honey quality, methods of analysis and international regulatory standards: Review of the work of the International Commission.

6Škenderov, S., Ivanov, C. (1986) Bee products and their use, Nolit, Belgrade

7Vahčić, N., Hruškar M., Marković, K. Analytical methods for determining basic ingredients food (internal script). Faculty of Food Technology and Biotechnology, University of Zagreb, Zagreb (2008)

8 International Honey Commission (2009) Harmonised methods of the International Honey Commission, www.ihc-platform.net
III. RESULTS AND DISCUSSION

Analysis of honey samples is usually a very complex process. The reason for this is the discrepancy between the studied variables, "analysis of honey from an area can provide important information about its geographical origin, i.e. the environment of that area."9

Therefore, for a qualitative analysis, it is necessary to take a larger number of samples, which will eventually be combined in order to be able to explain the obtained results. The analysis of samples and their physico-chemical parameters proved that there are statistically significant differences between the examined types of honey. The analysis of the main components was performed with the aim of detecting the difference in quality.

The analysis of the obtained research results included a descriptive analysis of the research results. Descriptive analysis included mean (arithmetic mean) and standard deviation. The arithmetic mean gives us a number that is often considered the closest in theoretical terms. On the other hand, the standard deviation tells us how far it deviates from the mean. The smaller the standard deviation, the closer the arithmetic mean is to the data. If the standard deviation is equal to 0, all values are the same, and the arithmetic mean is equal to all values.10

Electrical conductivity

Based on the analysis, the following data were obtained:

Table 1: Electrical Conductivity Analysis

| Sample number | Sample result | Regulation for BiH | Regulation for EU |
|---------------|---------------|--------------------|------------------|
| 1             | 0.104 ms/cm   | To 0.8 ms/cm       | To 0.8 ms/cm     |
| 2             | 0.135 ms/cm   | To 0.8 ms/cm       | To 0.8 ms/cm     |
| 3             | 0.190 ms/cm   | To 0.8 ms/cm       | To 0.8 ms/cm     |
| 4             | 0.280 ms/cm   | To 0.8 ms/cm       | To 0.8 ms/cm     |

Analyzing the electrical conductivity, on a sample of 4 honey producers, we can notice that by observing all samples we have a small deviation, ie a standard deviation of 0.077181, from the mean value. This tells us that in our sample, although we have obtained values in the interval 0.104 ms / cm - 0.280 ms / cm, in total, the results do not deviate greatly from the basic set. The obtained mean value is 0.17725 ms / cm, which is below the limit according to the norms in BiH and the EU (0.800).

Table 2: Descriptive statistics - Electrical conductivity

|                      | N  | Mean    | Std. Deviation |
|----------------------|----|---------|----------------|
| Electrical conductivity | 4  | 0.17725 | 0.077181       |
| BiH                  | 4  | 0.8000  | 0.00000        |
| EU                   | 4  | 0.8000  | 0.00000        |
| Valid N (listwise)   | 4  |         |                |

The electrical conductivity of honey is a property that depends primarily on the amount of mineral salts, organic acids and proteins present. The higher the content of mineral salts, the higher the electrical conductivity of honey. This parameter is important for determining the botanical origin of honey. Some varieties of honey have a much higher electrical conductivity than others due to itself mineral content in it, so that the expected highest electrical conductivity will be in honeydew and chestnut honey compared to other types of honey.11

Sucrose Based on the analysis

The following data were obtained:

Table 3: Sucrose analysis

| Sample number | Sample result | Regulation for BiH | Regulation for EU |
|---------------|---------------|--------------------|------------------|
| 1             | 2.05 g        | To 5 g             | To 10 g          |
| 2             | 2.29 g        | To 5 g             | To 10 g          |
| 3             | 3.78 g        | To 5 g             | To 10 g          |
| 4             | 1.36 g        | To 5 g             | To 10 g          |

When it comes to sucrose (or the amount of sucrose), the obtained mean value is 2.37, which is below the norm in BiH and the EU. However, as can be observed here, the standard deviation is extremely large, relative to the mean, which means that the analyzed samples deviate greatly from the mean. (Table 3).

Table 4: Descriptive statistics - Sucrose analysis

|               | N  | Mean     | Std. Deviation |
|---------------|----|----------|----------------|
| Sucrose analysis | 4  | 2.37000  | 1.019313       |
| Regulation for BiH | 4  | 5.00000  | 0.00000        |
| Regulation for EU | 4  | 10.00000 | 0.00000        |
| Valid N (listwise) | 4  |          |                |

9Vahčić, N., Hruškar M., Marković, K. Analytical methods for determining basic ingredients food (internal script). Faculty of Food Technology and Biotechnology, University of Zagreb, Zagreb (2008)
10Tadić T., Arithmetic mean and standard deviation; available at www.hrcak.srce.hr
11Guidelines for the interpretation of honey quality test results, Food Safety Agency of Bosnia and Herzegovina
The proportion of sucrose disaccharides in honey ranges from 5 g to 15 g per 100 g of honey depending on the type of honey. The content of sucrose is an important indicator of honey forgery by feeding bees with sugar, i.e., sucrose or by directly adding sugar to honey.12

**Ash Content**

Based on the analysis, the following data were obtained:

| Sample number | Sample result | Regulation for BiH | Regulation for EU |
|---------------|---------------|--------------------|-------------------|
| 1             | 0.0844 g      | 0.6-1.2g           | 0.1-1g            |
| 2             | 0.1220 g      | 0.6-1.2g           | 0.1-1g            |
| 3             | 0.187 g       | 0.6-1.2g           | 0.1-1g            |
| 4             | 0.032 g       | 0.6-1.2g           | 0.1-1g            |

Analyzing the amount of ash in the observed sample, we can notice the approximate values of all analyzed producers. Thus, our mean value is 0.10635, and the standard deviation is 0.0652152, which confirms the above statement.

| Sample number | Sample result | Regulation for BiH | Regulation for EU |
|---------------|---------------|--------------------|-------------------|
| 1             | 0.0844 g      | 0.6-1.2g           | 0.1-1g            |
| 2             | 0.1220 g      | 0.6-1.2g           | 0.1-1g            |
| 3             | 0.187 g       | 0.6-1.2g           | 0.1-1g            |
| 4             | 0.032 g       | 0.6-1.2g           | 0.1-1g            |

The share of mineral substances in honey primarily depends on the botanical origin of honey, but also on the climatic conditions and the composition of the soil on which the honey plant grew. Therefore, the content and composition of minerals in honey is often used in determining the botanical and geographical origin of honey, but also the adulteration of honey with sugar molasses.13

**HMF**

Based on the analysis, the following data were obtained:

| Sample number | Sample result | Regulation for BiH | Regulation for EU |
|---------------|---------------|--------------------|-------------------|
| 1             | 2.56 mg/kg    | To 40 mg/kg        | To 40 mg/kg       |
| 2             | 13.75 mg/kg   | To 40 mg/kg        | To 40 mg/kg       |
| 3             | 0.316 mg/kg   | To 40 mg/kg        | To 40 mg/kg       |
| 4             | 0.129 mg/kg   | To 40 mg/kg        | To 40 mg/kg       |

As presented in Table 7, an extremely large difference can be observed between the analyzed samples. Sample No. 2 deviates extremely from sample No. 1, and especially from samples 3 and 4. This is confirmed in Table No. 12, so that the calculated mean value is 4.14375, with an extremely large standard deviation of 6.3805.

| N | Mean | Std. Deviation |
|---|------|---------------|
| HMF | 4 | 4.14375 | 6.380500 |
| Regulation for BiH | 4 | 40,00000 | 0.000000 |
| Regulation for EU | 4 | 40,00000 | 0.000000 |
| Valid N (listwise) | 4 | | |

The share of HMF is used as an indicator of freshness and heating of honey, but extremely high values above 100 mg/kg can certainly be a good indicator of possible adulteration of honey. The ordinance stipulates that the content of HMF in honey must not exceed 40 mg/kg.14

**Moisture**

Based on the analysis, the following data were obtained:

| Sample number | Sample result | Regulation for BiH | Regulation for EU |
|---------------|---------------|--------------------|-------------------|
| 1             | 15.16 %       | To 20%             | 15-19%            |
| 2             | 15.61 %       | To 20%             | 15-19%            |
| 3             | 15.25 %       | To 20%             | 15-19%            |
| 4             | 15.80 %       | To 20%             | 15-19%            |

Table No. 9, which presents the analyzed values, shows that all 4 samples have approximately the same values. The mean value of the analyzed samples is 15.455 (Table 9). Having in mind the above, the calculated mean value is 15.455, which confirms the above statement.

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12 Guidelines for the interpretation of honey quality test results, Food Safety Agency of Bosnia and Herzegovina
13 Guidelines for the interpretation of honey quality test results, Food Safety Agency of Bosnia and Herzegovina
14 Guidelines for the interpretation of honey quality test results, Food Safety Agency of Bosnia and Herzegovina
deviation from the mean value is small, and amounts to 0.301164.

Table 10: Descriptive Statistics Moisture

|                | N | Mean     | Std. Deviation |
|----------------|---|----------|----------------|
| Moisture       | 4 | 15.45500 | .301164        |
| Regulation for BiH | 4 | 20.00000 | .000000        |
| Regulation for EU min | 4 | 15.00000 | .000000        |
| Regulation for EU max | 4 | 19.00000 | .000000        |
| Valid N (listwise) | 4 |          |                |

The moisture content in honey, above all, depends on the maturity of the honey, but also on the season and climatic conditions, as well as storage and storage conditions. The high moisture content in honey contributes to faster fermentation of honey, its spoilage and loss of organoleptic properties. The moisture content can also be an important piece of evidence for proving honey counterfeiting, given that some beekeepers can also intentionally add water to honey to make a higher profit.

A high percentage of moisture can also cause fermentation by the action of yeast, so this parameter is one of the main criteria for determining the shelf life of honey.15

**pH value**

Based on the analysis, the following data were obtained:

Table 11: Analysis of pH values

| Sample number | Sample result | Regulation for BiH | Regulation for EU |
|---------------|---------------|--------------------|-------------------|
| 1             | 6.01          | 3.2-5.4            | 3.5-5.5           |
| 2             | 5.90          | 3.2-5.4            | 3.5-5.5           |
| 3             | 5.30          | 3.2-5.4            | 3.5-5.5           |
| 4             | 4.80          | 3.2-5.4            | 3.5-5.5           |

Analyzing the acidity of honey on 4 samples, the obtained results show that the pH value ranges from 4.80 to 6.01. If these indicators are compared to BiH and EU norms, it can be noticed that the pH value of samples 1 and 2 exceeds the maximum allowed amount, both in BiH and in the EU, while sample number 3 is at the border. Analyzing the mean value of 4 samples, which is 5.5025, it can be concluded that, on average, all analyzed samples are at the upper limit of permissible values in BiH and the EU. With a standard deviation of 0.56275, it can be seen that the samples do not deviate much from each other.

The pH content of honey significantly affects the fermentation processes, and due to the presence of many organic acids in the form of esters, there is an effect on smell and taste.

**IV. CONCLUSION**

Based on the analysis of the work, we can conclude that it is necessary to constantly educate beekeepers about respecting the principles of good beekeeping practice and keeping the necessary records in order to get a quality and safe product as a final result. The obtained results indicate good quality of honey, which is the result of respecting the standards in beekeeping. All samples meet the prescribed standards and can be competitive in both domestic and European markets.

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