| Impact Factor: | | | | | |
|---|---|---|---|---|---|
| | ISRA (India) = 4.971 | SIS (USA) = 0.912 | ICV (Poland) = 6.630 |
| | ISI (Dubai, UAE) = 0.829 | РИНЦ (Russia) = 0.126 | PIF (India) = 1.940 |
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| | JIF = 1.500 | SJIF (Morocco) = 5.667 | OAJI (USA) = 0.350 |

SOI: 1.1/TAS DOI: 10.15863/TAS

International Scientific Journal

**Theoretical & Applied Science**

**p-ISSN:** 2308-4944 (print) **e-ISSN:** 2409-0085 (online)

**Year:** 2020 **Issue:** 11 **Volume:** 91

**Published:** 30.11.2020 **http://T-Science.org**

QR – Issue QR – Article

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# RESEARCH OF NATURAL HONEY BY SENSOR AND PHYSICO-CHEMICAL METHODS

***Abstract***: *Nowadays, the requirements imposed by the consumer on the quality of goods have become more stringent. In this regard, the effectiveness of organizations is possible only with the constant provision of a high level of quality of products sold. This is achieved through compliance with the requirements of regulatory documents. The purpose of this study is to determine the organoleptic and physicochemical characteristics of natural honey in order to determine its naturalness, quality and safety by sensory, chromatographic and refractometric methods. The data obtained made it possible to determine competitive and high-quality honey samples.*

***Key words***: *natural honey, safety, physicochemical properties, diastase number, pesticides.*

***Language***: *English*

***Citation***: Khamrokulov, G. H., Khasanova, D., Djumaniyozova, M., & Sayfullayeva, Z. (2020). Research of natural honey by sensor and physico-chemical methods. *ISJ Theoretical & Applied Science, 11 (91),* 571-576.

***Soi***: http://s-o-i.org/1.1/TAS-11-91-90 ***Doi***: https://dx.doi.org/10.15863/TAS.2020.11.91.90

***Scopus ASCC***: *2200.*

## Introduction

Requirements for the quality of products that meet the needs of customers are established in standards, technical regulations, which constitute the regulatory framework for conducting a commodity examination [1].

Assessment of the quality of natural bee honey is carried out in accordance with the requirements of GOST (Interstate standard adopted by the Interstate Council for Standardization, Metrology and Certification of the Commonwealth of Independent States) 19792-2001, which applies to honey procured and sold in various trading enterprises of all forms of ownership.

In the commodity examination of honey, organoleptic and measuring methods are mainly used. The need for laboratory research of honey arises in the case of its identification (floral, honeydew, monofloral or polyfloral), determination of quality, establishment

of falsifications, or when certain indicators of the quality of honey cause controversy.

To identify and assess the quality of honey, an organoleptic researches are carried out (determine the appearance and consistency of honey, its color, aroma, taste, the presence of mechanical impurities and signs of fermentation) in combination with laboratory methods (determine the content of water, reducing sugars and sucrose, diastase number, total acidity, the amount of hydroxymethylfurfural, put reactions to various falsifications, etc.) [2]

The natural honey which has been researched is classified in heading 0409 TN [3].

## 2. OBJECTS AND METHODS OF RESEARCH

We have studied the chemical composition of six samples of bee honey, taken from a honey fair, of different harvest years. Sample No. 1- "Vasilokr", 2018 p. Sample No. 2- "Buckwheat", 2018g.s, Sample No. 3- "Vysokogorny", 2019g.s. Sample No. 4 - "Mountain Kyrgyzstan", 2019 p. Sample No. 5 - "Cotton plant", 2011 p. Sample No. 6 - "Cotton plant", 2017 p.

**Determination of organoleptic indicators**

Determination of color - the color of honey is determined by visual inspection in daylight.

Determination of aroma - put 30-40 gr of honey in a glass beaker, cover with a lid and heat in a water bath at 40-45 ° C for 10 minutes.

Determination of taste - honey is heated to a temperature of 30 ° C and then taste is determining.

Determination of consistency - take a spoonful of honey with a density (viscosity, juiciness) at a temperature of 20 ° C is taken and assessed by the flow from the spoon.[4]

**Determination of the mass fraction of water**

The method is based on the fact that the refractive index of honey depends on the water content.

Apparatus for analysis: refractometer with a refractive index scale division not more than 1x10-3.

Uncrystallized honey is used for testing. If the honey is crystallized, then about 1 cubic meter. cm of honey is placed into the test tube, tightly closed with a rubber stopper and heated in a water bath at 60 ° C until the crystals are completely dissolved. The tube is then cooled at the air temperature in the laboratory. Water, condensed on the inner surface of the walls of the test tube, and the mass of honey are thoroughly mixed with a glass rod.

One drop of honey is applied to a refractometer prism and the refractive index is measured.

Mass fraction of water in honey, depending onon the refractive index

**Table 1.**

| Coefficient refraction *n20D* | Mass share of water, % | Coefficient refraction *n20D* | Mass share of water, % | Coefficient refraction *n20D* | Mass share of water,% |
|---|---|---|---|---|---|
| 1,5044 | 13,0 | 1,4935 | 17,2 | 1,4830 | 21,4 |
| 1,5038 | 13,2 | 1,4930 | 17,4 | 1,4825 | 21,6 |
| 1,5033 | 13,4 | 1,4925 | 17,6 | 1,4820 | 21,8 |
| 1,5028 | 13,6 | 1,4920 | 17,8 | 1,4815 | 22,0 |
| 1,5023 | 13,8 | 1,4915 | 18,0 | 1,4810 | 22,2 |
| 1,5018 | 14,0 | 1,4910 | 18,2 | 1,4805 | 22,4 |
| 1,5012 | 14,2 | 1,4905 | 18,4 | 1,4800 | 22,6 |
| 1,5007 | 14,4 | 1,4900 | 18,6 | 1,4795 | 22,8 |
| 1,5002 | 14,6 | 1,4895 | 18,8 | 1,4790 | 23,0 |
| 1,4997 | 14,8 | 1,4890 | 19,0 | 1,4785 | 23,2 |
| 1,4992 | 15,0 | 1,4885 | 19,2 | 1,4780 | 23,4 |
| 1,4987 | 15,2 | 1,4880 | 19,4 | 1,4775 | 23,6 |
| 1,4982 | 15,4 | 1,4875 | 19,6 | 1,4770 | 23,8 |
| 1,4976 | 15,6 | 1,4870 | 19,8 | 1,4765 | 24,0 |
| 1,4971 | 15,8 | 1,4865 | 20,0 | 1,4760 | 24,2 |
| 1,4966 | 16,0 | 1,4860 | 20,2 | 1,4755 | 24,4 |
| 1,4961 | 16,2 | 1,4855 | 20,4 | 1,4750 | 24,6 |
| 1,4956 | 16,4 | 1,4850 | 20,6 | 1,4745 | 24,8 |
| 1,4950 | 16,6 | 1,4845 | 20,8 | 1,4740 | 25,0 |
| 1,4946 | 16,8 | 1,4840 | 21,0 | | |
| 1,4940 | 17,0 | 1,4835 | 21,2 | | |

**Determination of the diastasis number:**

A 10% solution is prepared with a sample of 30 g of honey, distilled water is added in accordance with the table. Firstly, a 1% solution of soluble starch is being prepared. 11 test tubes are taken, numbered and poured all solutions in accordance with the table

**Table 2.**

| Number of test tubes | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 10% honey solution, ml | 1 | 1,3 | 1,7 | 2,1 | 2,8 | 3,6 | 4,6 | 6,0 | 7,7 | 11,1 | 15 |
| Distilled water, ml | 9,0 | 8,7 | 8,3 | 7,9 | 7,2 | 6,4 | 5,4 | 4,0 | 2,3 | - | - |
| 0,58 % p-p salt,ml | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 |
| 1% p-p starch, ml | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 | 5,0 |
| Diastasis number | 50,0 | 38,0 | 29,4 | 23,8 | 17,9 | 13,9 | 10,9 | 8,0 | 6,5 | 4,4 | 3,3 |

After spilling all the solutions, the tubes are closed with stoppers, mixed thoroughly. The rack is put with the test tubes in a water bath at a temperature of 40ºC for one hour. When it is time the tubes are cooled under running tap water till the room temperature. Then of the Lugol solution is dripped into each tube, for a drop from the first tube to the last one. The diastase number of the tube that is the previous tube with a brown color is taken [5].

## 3. RESULTS OF THE STUDY AND THEIR DISCUSSION

The results of the organoleptic evaluation of honey samples are shown in the table 1. As it can be seen from the table 1 all honey samples met the requirements of GOST in terms of organoleptic indicators, no gross defects in organoleptic indicators were found. Honey samples with the numbers 1, 2, 3 and 4 are distinguished by an excellent aroma. This is due to the variety of melliferous plants with a bright, well-expressed aroma. The aroma of honey samples No. 5, 6 is very weak. This is due to the fact that the main melliferous plant is cotton, the honey aroma of which is practically absent. If the aroma of honey is poorly expressed, then by its organoleptic characteristics, consumers may undeservedly confuse it with sugar honey[6].

Color, as well as physicochemical indicators, helps to establish the botanical origin of monofloral honey, since it primarily depends on the plants from which the honey is collected and which may also contain pollen from melliferous plants.

**Table 3: Organoleptic characteristics of bee honey**

| Title of the indicator | Sample №1 | Sample №2 | Sample №3 | Sample №4 | Sample №5 | Sample №6 |
|---|---|---|---|---|---|---|
| Aroma | Pleasant, well-defined, floral, without stranger smell., | Nice, delicate and gentle, well-defined, without stranger smell | Pleasant, well-defined, floral, without stranger smell | Pleasant, well-defined, floral, without stranger smell | Pleasant but weak, without outsider smell | Very weak, without outsider smell |
| Taste | Sweet,pleasant,rather spicy , without stranger taste | | | | | |
| color | Dark amber | Dark amber | Light amber | amber | Light gold | Bright yellow |
| Consistency | Viscous, transparent | | | | | |
| Mechanical impurities | absent | | | | | |
| Fermentation signs | absent | | | | | |

From the physicochemical properties of honey followings are standardized: mass fraction of water - no more than 21%; mass fraction of reducing substances (for dry matter) for honey from white acacia - not less than 76%, from cotton - not less than 86%; for other types of honey - at least 82%.

The diastase number, characterizing the activity of enzymes, in honey from white acacia is at least 5 units. Gothe, for all other types of honey - at least 7 units. Gothe. The total acidity of all types of honey is standardized not more than 4.0 cm3. Physicochemical indicators of honey are given in table 2. As can be seen from the data given in table 2. Diastase number characterizes the amount of enzymes in the product. And as well, its medicinal properties [7].

**Table 4.**

| Title of the indicators | sample №1 | sample №2 | sample №3 | sample №4 | sample №5 | sample №6 |
|---|---|---|---|---|---|---|
| diastase number, unit gote | 13,9 | 10,9 | 17,9 | 23,8 | 6,5 | 8,0 |
| Mass share of the moisture, % | 18,6 | 17,8 | 16,2 | 18,2 | 19,0 | 16,6 |
| General acidity, $cm^3$ | 2,9 | 2,8 | 3,0 | 3,0 | 3,8 | 3,2 |

As for the indicator of the mass fraction of moisture, the results of the study which are given in Table 2, it can be seen that honey will ferment quickly, and the diastase number will then collapse. Increased water content is often observed in unripe honey that has been pumped out of the hives early. Sample No.5 had the highest moisture content. The overall acidity of honey when exceeded also indicates that honey may ferment very soon. In all samples, the total acidity was significantly lower than the standard established by GOST, which is consistent with the organoleptic characteristics of honey samples. In addition to sample No. 5, the value of which is close to the maximum permissible GOST [8].

Of the six samples which were submitted for examination, the tests have been successfully tested and samples No. 1,2,3,4,6 have been recognized as of high quality and sample No. 5 has a low diastase number. Thus, a comprehensive study of the quality of honey samples made it possible to roughly determine the quality and naturalness of honey [9].

For an even deeper study of honey, safety indicators were also investigated. Since now an environmental problem has arisen all over the world. Humanity is faced with such life-threatening phenomena as industrial pollution of air, soil and water, accumulation of toxic elements (heavy metals, pesticides, radionuclides, etc.). Environmental pollution suggests the possibility of its influence on bees and beekeeping products, which leads to the need to study toxic elements in them. Requirements for the quality of beekeeping products are becoming more stringent, namely for their ecological purity and safety. From the above samples, two samples of bee honey (Sample No. 4 - "Mountain Kyrgyzstan", collection year 2019, Sample No. 6 - "Cotton plant", collection year 2017) were selectively investigated for the content of chlorine-containing pesticides. The study was carried out on gas-liquid chromatography brand "Crystal-Lux 4000M".

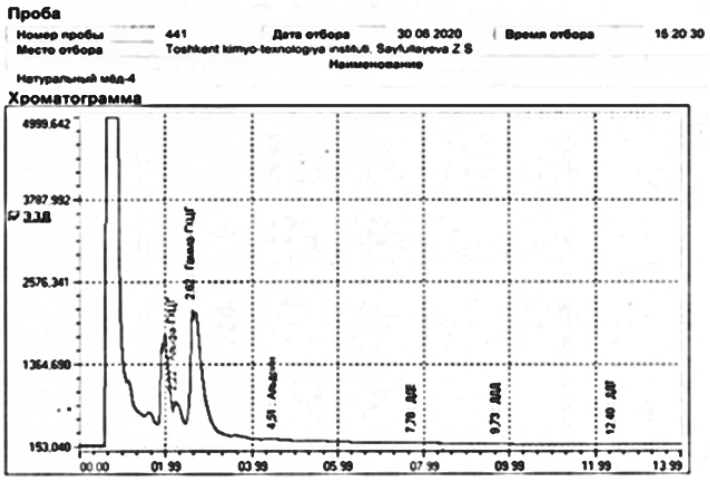


**Figure 1 - Chromatogram of sample No. 4**

This sample contains two different isomers of Hexachlorane[10].

**Table 5. Values of chromatogram peaks for sample No. 4**

| № | Component | Detector | time, minute | window, minute | Concentration, мgr/kg | MPC (not more than), mg/kg |
|---|---|---|---|---|---|---|
| 1 | Alpha HCH | ECD | 2,22 | 0,50 | 0,004 | 0,083 |
| 2 | Gamma HCH | ECD | 2,62 | 0,50 | 0,019 | 0,086 |
| 3 | Aldrin | ECD | 4,51 | 0,50 | 0,001 | 0,146 |
| 4 | DDE | ECD | 7,78 | 0,50 | 0,000 | 0,093 |
| 5 | DDD | ECD | 9,73 | 0,50 | 0,000 | 0,101 |
| 6 | DDT | ECD | 12,40 | 0,50 | 0,000 | 0,184 |

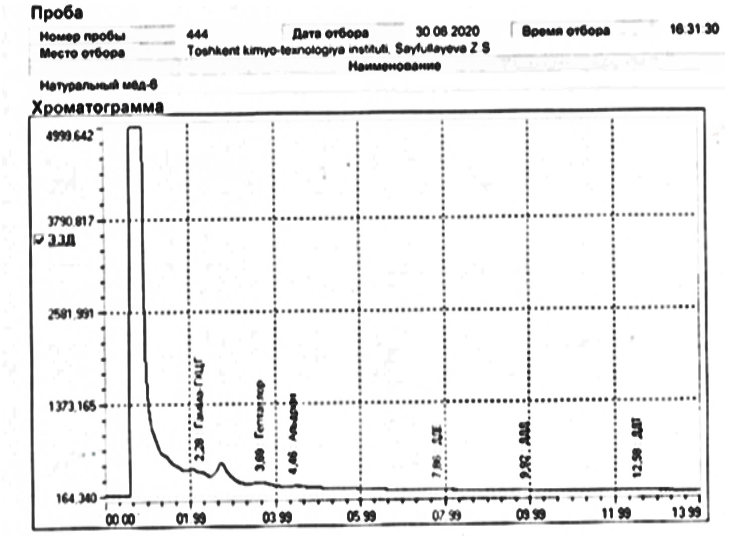


**Figure 2 - Chromatogram of sample No. 6**

Fig. 2. You can see the presence of the component Gamma HCH (Hexachloran), this type of insecticide is widely used in agriculture to combat animal parasites. Hexachloran enriched in the γ-isomer, which has higher insecticidal properties (is a strong contact, systemic, intestinal and fumigant poison.[11]

**Table 6. Peak values of the chromatogram of sample No.6**

| № | Component | Detector | time, minute | Окно, min | Concentration, mgr/kg | norm (not more than), mgr/kg |
|---|---|---|---|---|---|---|
| 1 | Alpha HCH | ECD | 2,28 | 0,50 | 0,005 | 0,083 |
| 2 | Gamma HCH | ECD | 2,28 | 0,50 | 0,008 | 0,086 |
| 3 | Heptachlor | ECD | 3,70 | 0,50 | 0,008 | 0,092 |
| 4 | Aldrin | ECD | 4,46 | 0,50 | 0,003 | 0,146 |
| 5 | DDE | ECD | 7,87 | 0,50 | 0,000 | 0,093 |
| 6 | DDD | ECD | 9,92 | 0,50 | 0,000 | 0,101 |
| 7 | DDT | ECD | 12,58 | 0,50 | 0,000 | 0,184 |

## 4. CONCLUSIONS

1. The examined samples of natural honey, except for sample No. 5, meet the requirements of GOST 19792-2001, which indicates the quality and naturalness of honey.

2. The investigated two samples contain insecticides, but their concentration is significantly low compared to the maximum permissible concentration. This means that the test samples are safe for consumption.

3. Thus, natural honey has different characteristics in terms of botanical origin and in terms of physicochemical indicators. In this regard, the question arises of the classification of natural honey according to the Commodity Nomenclature of Foreign Economic Activity of the Republic of Uzbekistan (CN FEA RUz). In CN FEA RUz "Natural honey" is assigned the classification code 0409000000, which is located in Section 1, in Group 04 "Dairy products; bird eggs; natural honey; foodstuffs of animal origin, not elsewhere specified or included. " This code is indicated in column 33 of the Cargo Customs Declaration. It should be noted that "Natural honey" has only one product code, which does not take into account its consumer value. There was a task about detailing this commodity code by examining its properties and consumer characteristics.

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