Study of influence of agro-industrial production of Perm region on honey condition

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Abstract. Honey is a unique product of nectar and pollen processing by bees, which is a sweet, viscous substance rich in amino acids, macro- and microelements. Honey in the modern world is used in many directions: cosmetology, cooking, medicine, as well as in the home for eating, treating cold diseases, massage, etc. Honey has high taste and nutritional qualities, is easily absorbed by the body. It is also a dietary food for the human body. The object of the study is honey purchased from individual entrepreneurs of Solikamsk and Osinsky districts of Perm region of Russia. The purpose of the study: to study veterinary-sanitary indicators of the honey sold on the counter of the city of Solikamsk, which came both from local producers and from the Osinsky district of Perm region. The priority task of this work was to assess the veterinary and sanitary quality of honey produced by beekeepers of Solikamsk city and compare its quality with honey from ecologically clean Osinsky district of Perm region. Studies were carried out to determine the basic physical and chemical values of the selected honey samples by free acidity, diastase number; mass fraction of water; The weight fraction of water insoluble substances; Weight ratio of reducing sugars, weight ratio of sucrose and other indicators. Studies have shown that some honey samples had an increased percentage of sucrose – 7.87, with a maximum allowed value of 5%. No excess of heavy metal ions was detected, which meets the safety requirements of the Technical Regulation.

1. Introduction
Honey is a product of processing by honey bees nectar. Honey is a sweet aromatic syrup-like liquid or crystallized mass of different consistency. Honey has a high energy value of about 308 kCal per 100 g and also contains a number of biologically active substances. Honey contains a unique set of vitamins, trace elements, antibacterial substances, biogenic stimulants. It is a valuable food product containing a significant amount of carbohydrates, minerals. It has pronounced bactericidal properties, so it is often used in folk medicine. It does not stay long in the stomach, quickly enters the intestine and is absorbed into the lymphatic system, and from there into the blood and tissues, that is, the main components of honey – glucose and fructose, are easily absorbed in the human body [1–2].
2. Materials and methods of research

2.1. Samples of tests

The research work was carried out on the basis of the Perm Veterinary and Diagnostic Center.

Sample No. 1 - honey different herbs, Simankov I.V., Village “Figure” of Solikamsk district.

Sample No. 2 - honey different herbs, private owner Berendeev A.V., Village “Figure” of Solikamsk district.

Sample No. 3 - honey different herbs, Private owner Parshakov N.A., Village May Osinsky district.

Apiaries, from which samples No. 1 and No. 2 are taken, are located in the village “Figure” on the neighboring allotments of land. The village “Figure” is located north of Solikamsk, in Solikamsk district of Perm region, 8 km from the district center, Solikamsk city. Apiaries are located 1 km from the road in the forest area and 200 meters from the bank of the Borovaya River.

To the nearest industrial enterprise about 4 km on a straight line to the south, there is a logging plant LLC "Trading House" (production of plywood). From apiary to the south there are enterprises of heavy industry, such as: JSC "Solikamskboomprom" (paper production), OJSC "Solikamsk Plant Ural" – the largest military-industrial plant in Eastern Europe, the plant of metal products - ZMI. In addition, enterprises of mining chemical industry (extraction of potassium salts and production of mineral fertilizers) - PJSC "Uralkali," the enterprise of metallurgical industry - OJSC "Solikamsk Magnesium Plant" (magnesium production based on processing of potassium-magnesium salts) are located in the district center.

Apiary, with which sample No. 3 is taken, is located 15 km south-east from the town of Osa, south on the 8 from Gorsky settlement in the floodwaters of Kamenka River, to the river bank about 600 m. To the nearest settlement of the village “Staroe Gorodische” 5.5 km.

There are no heavy industry enterprises within a radius of 20 km. From the point of view of the environmental situation in general, the Osinsky district is considered to be prosperous.

2.2. Methods of examination of honey samples

In order to determine honey quality organoleptic (color, aroma, consistency, taste), laboratory physicochemical studies and studies for toxic metals content: lead, cadmium, arsenic were carried out. Organoleptic examination of honey included determination of colour, aroma, taste, crystallization according to GOST 19792–2017 “Natural honey. Specifications”. Laboratory physicochemical studies included the following methods: determination of hydroxymethylfurfural; free acidity; diastazny number; mass fraction of water; The weight fraction of water insoluble substances; Weight fraction of reducing sugars and weight fraction of sucrose [3–7].

3. The results of the study and their discussion

3.1. Definition of falsification of honey

Honey, one of the most commonly falsified products, is more likely to add flour or starch to increase the volume of honey produced. The results showed that there were no traces of foreign matter in the samples examined.

3.1.1. Definition of organoleptic indexes. The nature and quality of the honey was determined by organoleptic examination, and the color, aroma, taste and consistency of the honey were determined.

Honey color was visually determined. As a result of the works carried out it was found that honey under the number 1 in color bright golden – yellow, sample No. 2 light golden. Sample No. 3 is golden amber. Honey color depends mainly on the nature of the dyes contained in the nectar. Honey color is also influenced by its origin, time of collection and place of honey production [8].

The aroma of honey was determined by smell, it was found that sample No. 1 by aroma gentle, pleasant, without foreign odors sample No. 2 was weak, without foreign odors, and sample No. 3 – tolerant, spicy, there is a floral aroma of Linden.
The taste of honey was determined by testing. All the honey samples studied had a sweet, pleasant taste, but were also with a tolerant, spicy taste. Thus, the sample of honey of sample No. 1 – sweet, gentle, without foreign tastes taste; Sample No. 2 – sweet, pleasant, without foreign tastes taste, sample No. 3 – pleasant, gentle taste.

The consistency of the honey was set by the nature of the honey flowing from the glass stick, after double lowering the stick into the honey. It turned out that the consistency of honey in Sample No. 1 was viscous, in Sample No. 2 it was very viscous, Sample No. 3 it was viscous.

Honey crystallization is a natural process that in no way reduces honey quality. Biologically active substances are well preserved in it. Honey at the order number is 1 fine-grained, and at No. 2 – coarse-grained, and Sample No. 3 has fine-grained crystallization. The results are shown in table 1.

### Table 1. Organoleptic indices of honey samples.

| Index         | Tests of honey                  | Sample 1               | Sample 2               | Sample 3               |
|---------------|--------------------------------|------------------------|------------------------|------------------------|
| Color         | Bright golden-yellow           | Light-golden           | Golden-amber           |
| Aroma         | Gentle, pleasant, without foreign smells | Weak, without foreign smells | Floral aroma of the lip, without foreign smells |
| Taste         | Sweet, gentle without foreign tastes | Sweet, pleasant, without foreign tastes | Pleasant, gentle taste, without foreign tastes |
| Consistence   | Viscid                         | Very viscid            | Viscid                 |
| Crystallization | Compact-grained               | Largely-grained        | Compact-grained        |

3.1.2. Definition of physical and chemical indicators. No traces of hydroxymethylfurfural were detected in determining the physical and chemical parameters of the samples presented. Free acidity, diastase number, mass fraction of water and mass fraction of water-insoluble impurities in tested samples are within normal limits.

However, when examining the above honey samples, a higher sucrose content was found in Sample No. 2 – 7.87% at a ratio of no more than 5%. Quality flower honey usually contains 1–5% sucrose. Its increased content indicates poor honey quality. For example, in fall honey there can be up to 10%. in honey falsified with artificially inverted sugar, sucrose reaches 45%, or simply immature honey. The results are shown in table 2.

### Table 2. Physical and chemical indicators of honey.

| Indexes                               | Sample No. 1 | Sample No. 2 | Sample No. 3 |
|---------------------------------------|---------------|---------------|---------------|
| Reaction to GMF                       | The negative  | The negative  | The negative  |
| Free acidity (M eq/kg)                | 12.6          | 10.9          | 14.2          |
| Diastazny number (unit. to Gotha)     | 39.37         | 37.37         | 37.38         |
| Mass fraction of water (%)            | 17.80         | 17.2          | 17.2          |
| Mass fraction of water insoluble substances (%) | 0.08        | 0.05          | 0.05          |
| Weight fraction of reducing sugars (%) | 89.47         | 87.00         | 88.86         |
| Mass fraction of sucrose (%)          | 4.02          | 7.87          | 4.00          |

3.1.3. Determination of heavy metal ion content. Heavy metals account for a significant proportion of environmental pollution, and are second to pesticides in toxicity. Analysis of samples of honey of Solikamsk and Osinsky district for content of heavy metals: lead, cadmium, lead was carried out. The results showed that the amount of cadmium, arsenic and lead was different in the samples studied. In the Solikamsk district honey samples, cadmium was 0.014 mg/kg with a test error of ± 0.002 in Sample No. 1 and 0.022 mg/kg in Sample No. 2 with a study error of ± 0.004. This result does not exceed the standard permissible value (MPC).
Values of lead content in honey ranged from 0.012 Sample No. 1 to 0.014 mg/kg (Sample No. 2), which corresponds to the standard.

At inspection of samples of honey from the Solikamsk district on the content in it of arsenic, it less than 0.001 mg/kg were found. This result meets safety requirements.

The study of honey from the Osinsky district found that the content of cadmium was 0.032 mg/kg, arsenic less than 0.001 mg/kg and lead 0.017 mg/kg, which also corresponds to the normative values of heavy metal content in beekeeping products (see table 3).

Table 3. Content of heavy metals in honey.

| Name of an indicator, mg/kg | Sample No. 1 | Sample No. 2 | Sample No. 3 |
|-----------------------------|--------------|--------------|--------------|
| Lead                        | 0.012        | 0.014        | 0.017        |
| Cadmium                     | 0.014        | 0.022        | 0.032        |
| Arsenic                     | ≤0.001       | ≤0.001       | ≤0.001       |

3.2. Discussion of the received results

Summary table 4 clearly demonstrates the results of the test samples. After organoleptic and physical-chemical studies, all samples except No. 2 correspond to GOST.

Table 4. Summary table on organoleptic, physical and chemical parameters and content of heavy metals.

| Indexes | Sample No. 1 | Sample No. 2 | Sample No. 3 |
|---------|--------------|--------------|--------------|
| **Organoleptic indexes** | | | |
| Color   | Bright golden-yellow | Light-golden | Golden – amber |
| Aroma   | Gentle, pleasant, without foreign smells | Weak, without foreign odors | Floral aroma of the lip, without foreign smells |
| Taste   | Sweet, gentle without foreign tastes | Sweet, pleasant, without foreign tastes | Pleasant, gentle taste, without foreign tastes |
| Consistence | Viscid | Viscid | Viscid |
| Crystallization | Compact-grained | Largely-grained | Compact-grained |
| **Physical and chemical indexes** | | | |
| Reaction to GMF | The negative | The negative | The negative |
| Free acidity (M eq/kg) | 12.6 | 10.9 | 14.2 |
| Diastazny number (unit. To Gotha) | 39.37 | 37.37 | 37.38 |
| Mass fraction of water (%) | 17.80 | 17.2 | 17.2 |
| Mass fraction of water insoluble substances (%) | 0.08 | 0.050 | 0.050 |
| Weight fraction of reducing sugars (%) | 89.47 | 87.00 | 88.86 |
| Mass fraction of sucrose (%) | 4.02 | 7.87 | 4.00 |
| **Heavy metal ion content, mg/kg** | | | |
| Pb⁴⁺ | 0.012 | 0.014 | 0.017 |
| Cd²⁺ | 0.014 | 0.022 | 0.032 |
| As³⁺ | ≤0.001 | ≤0.001 | ≤0.001 |
Sample No. 2 has an increased percentage of sucrose – 7.87, with a maximum allowed value of 5%. By this indicator, it can be assumed that this batch of honey was falsified by adding sugar, or about immature honey. The remaining claimed samples meet the requirements of the regulatory document.

According to the results of the test of samples for safety indicators, content of heavy metals, cases of exceeding the maximum permitted values, which meets the safety requirements of the Technical Regulation.

According to the results of the quality examination, all honey samples, except No. 2, on organoleptic, physical and chemical and safety indicators meet the requirements of GOST 19792-2017-Honey natural. Technical Conditions and TR TS 021/2011 - Technical Regulations of the Customs Union "On Food Safety."

Sample No. 2 due to non-compliance with quality requirements must be rejected and returned to the manufacturer, without further right to sell this batch of honey.

4. Conclusion

When buying honey, you should require a compliance certificate from the seller confirming that the controlled indicators of honey produced do not exceed sanitary standards. By results of the carried-out expertize of quality all samples of honey, except No. 2, on organoleptic, physical and chemical and to indicators of safety conform to requirements of GOST 19792-2017 – natural honey. Technical Conditions and TR TS 021/2011 - Technical Regulations of the Customs Union "On Food Safety”.

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