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Organoleptic, Physico-Chemical and Palynological Properties of Honey in the West Siberian Region of Russia

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***Abstract*—This article describes the results of studies of honey from the West Siberian region. Organoleptic and physico-chemical parameters were defined; melissopalynological analysis of mono- and polyfloral honey gathered in the Altai, as well as in the Omsk and Tomsk regions was carried out. It was noted that organoleptic and physico-chemical characteristics of honey have differences associated with climatic and geographical features of various natural and agricultural areas. The range of monofloral honey types produced in the areas of studied region was defined, as well as the dominant nectariferous plants for polyfloral honey. Most common for this region falsifications are also identified. It was established that in order to conduct an adequate veterinary and sanitary assessment and establish the flora type of the honey in a particular region, palynological studies with the definition of the main nectariferous plants should be routinely carried out. The declaration of the botanical origin of honey should only be based on the results of melissopalynological tests.**

Keywords—honey, sensory analysis, physico-chemical parameters, palynological studies, veterinary and sanitary assessment.

I. INTRODUCTION

Production of high-quality and safe food is currently a global problem. Major international organizations, such as FAO and WHO, supervise the corresponding activity. Research in the field of quality and safety of honey including the identification of counterfeit honey and confirmation of botanical and geographical origin led to the development of requirements that are mentioned in Codex Alimentarius and taken into account by Apimondia International Beekeping Technology and Economy Institute for the development of European regional honey standards [1]. World Trade Organization takes these requirements into account for the access products to the international market. Requirements for the quality and safety of honey were also established in other countries that produce natural honey, such as the United States, Mexico, China, Canada and Australia. Russia also has a number of regulatory documents which form the basis for honey monitoring, such as the Technical Regulation of the Customs Union 021/2011 and state standards. Nevertheless, while the quality parameters of product can be confirmed in accordance with these documents, the confirmation of the botanical and geographical origin of honey is quite difficult and sometimes impossible. A comprehensive assessment of the quality of honey should include organoleptic, physico-chemical, melissopalinological studies, as well as establishing of safety indicators because each consumer, in accordance with his preferences, would like to buy natural, high-quality, healthy and safe honey with pronounced flavor. Confirmation of botanical and geographical origin is for now a current problem in assessing the quality of natural honey [2-4].

The relevance of research includes describing the peculiarities of the qualitative characteristics of honey from the West Siberian region taking into account its botanical and geographical origin. Results of these studies allow expanding scientific knowledge regarding the role of climatic conditions, anthropogenic factors, and their impact on the quality and safety of food products depending on the region. Honey falsifications most commonly found in this region were also identified.

II. LITERATURE REVIEW

Increased honey consumption is associated with rising standards of living and growing interest in natural products, first of all, in Germany, Japan, and the USA. In most cases, consumers prefer honey with mild flavor, low crystallization, but the significant number of consumers also chooses honey with pronounced flavor. The composition of honey of the same botanical variety may vary depending on the place of origin [5]. As a rule, monofloral honey and honey from certain geographical areas, such as Altai or Bashkiria, are more expensive than polyfloral ones. Therefore, the questions that arise during the identification and examination of monofloral honeys constantly take the attention of researchers [2-4], [6].

Improving the methods of organoleptic analysis leans towards reasoned tasting assessment and instrumental research methods [7].

Natural honey has a multicomponent composition; at present, researchers report about more than 400 chemical compounds contained in it. Therefore, physico-chemical properties are extremely important in honey quality inspection. First of all, enzymes are meant that are produced by bees and form the part of nectar contributing to its conversion into honey. Decreased level of enzymes or their absence is an indicator of counterfeit honey or of the honey produced and stored in breach of technological regimes [8].

Honey also contains antioxidants [9]. A number of researchers confirmed that they had found that in honey microbiota and honey bag of bee there were bacterial strains with the high level of antimicrobial activity against pathogens which were resistant to antibiotics. This reveals antimicrobial properties of honey [10-11].

Findings show that honey products contain all macro- and microelements. Most researchers believe that the mineral composition of honey can be taken into account when confirming the authenticity and geographical origin of honey, as well as for identifying falsifications [3], [6], [12]. Currently, to determine the authenticity of honey in Russia and abroad the content of proline is assessed which is the predominant free amino acid of natural honey indicating its authenticity and maturity [13].

When assessing the physical properties of honey, you should keep in mind that honey of different botanical origin has different electrical conductivity. This is due to the content of organic acids and mineral salts. High- (honeydew) and low-conductivity (melilot) honey are distinguished [14] International honey standards include the assessment of electrical conductivity for the control of quality and botanical origin of honey.

When confirming the qualitative indicators of honey, a number of researchers proposed to determine the geographical origin by pollen type and the botanical origin of honey by quantitative spectrum [2-3], [7].

EU regulation 2001/110 provides pollen analysis for the determination of the botanical and geographical origin of honey. In Russia, pollen analysis is currently not mandatory; the corresponding information can be mentioned on the product label based on the statement of beekeeper.

Studies on methods for determining the authenticity of honey, identifying fake honey, confirming the botanical and geographical origin are conducted in Russia and other countries of the world [1-2], [6-7].

Currently, study of the peculiarities of the qualitative characteristics of honey produced in different regions of Russia is one of the forms of support for domestic beekeeping. For a wide range of consumers, these are differences in flavor caused by the place of honey gathering, climate characteristics and the combination of honey plants in a particular region [7].

To strengthen the position of domestic beekeeping, it is necessary to improve the requirements for product quality and harmonize Russian regulatory documents with international ones.

III. Research methodology

Research methodology is based on the need for theoretical justification and practical confirmation of the methods and criteria of authenticity and type of honey gathered in the West Siberian region of Russia. Performed comprehensive studies were based on regulatory documents that are currently relevant in the Russian Federation and experimental methods. Sampling and assessment of organoleptic and physico-chemical parameters were carried out in accordance with GOST 19792-2001 [15] and GOST R 54644-2011 [16]. Appearance, flavor, taste, signs of fermentation were assessed organoleptically. Tasting evaluation of honey was carried out according to the method of M. Gonnay and G. Wash [17].

Weight content of water in honey was found with refractometric method using IRF-454 refractometer according to GOST 31774-2012 [18]. Weight content of reducing sugars and weight content of sucrose were found with colorimetric method according to GOST 32167-2013 [19]. Diastase number was defined using colorimetric determination of the amount of substrate decomposed in the course of enzymatic reaction, and weight content of honey water-insoluble substances was determined by gravimetric method according to GOST R 54386-2011 [20]. Weight content of hydroxymethylfurfural was estimated by Seliwanoff's test according to GOST 31768-2012 [21]. Active and free acidity were studied by the titrimetric method GOST 32169-2013 [22]. Electrical conductivity was defined using ST 3231 device according to GOST 31770-2012 [23]. Proline content was found using a spectrophotometer according to GOST R 54947-2012 [24]. Botanical origin was established by determining the frequency of pollen grains according to GOST 31769-2012 [25].

Methods of variation statistics and Microsoft Office Excel 2010 software were used for analyzing quantitative data.

IV. Results

Based on the results of the research performed, a conclusion can be made that in the studied areas of the region mainly polyfloral honey is gathered; the weight content of which in different years of the studied period was 50-58%. Types of monofloral honey characteristic for the studied areas of the West Siberian region were also identified. In Omsk and Tomsk Regions, as well as in Altai Krai, buckwheat, sunflower, melilot and rapeseed honey are gathered. The proportion of buckwheat honey in the total honey amount was 10-12% in different years; that of sunflower honey was 8-10%; of melilot honey – 6-8%. The Omsk Region and the Altai Krai are also suppliers of sainfoin honey with the proportion of 3-5%.

Our melissopalynological studies by the method of pollen grains identification revealed that even recognizing honey to be monofloral one, we find in it the pollen of plants belonging to 9-14 families. So, during the analysis of monofloral buckwheat honey, the pollen of plants belonging to 11 families was found, and during the analysis of phacelia honey – that of 14. It is expected that the bees visited the widest range of nectariferous and pollen plants – 13-18 families –while gathering polyfloral honey. Maximal number of pollen belonging to different plant families was found in polyfloral honey of the Altai Republic. Palynological studies revealed a very high percentage of falsified consumer information. In such cases the consumer receives, not always intentionally, wrong information about the botanical origin of honey. If at retail spots the percentage of such falsification ranges from 52-62%, then at short-term exhibitions, according to our data, it was higher.

In the Omsk region – in some areas in the north of this region – gathering of linden honey is also noted which, however, is extremely unstable in different years; sometimes it is practically absent or its proportion ranges from 0.5% to 1%. Annually, honey from cruciferous plants is gathered, its proportion is consistently 2-3%, and also annually, but in small quantities – dandelion honey. Its weight content in different years did not exceed 1.5%. The Altai Krai annually

supplies angelica honey to the market which accounts for 1-2%, the Altai Republic supplies acacia honey (2-3%), and the Tomsk Region – phacelia honey (1-2%).

Tasting assessment of honey showed that in each region there is honey worthy to be highly appreciated, such as polyfloral honey of the Altai Republic and Altai Krai. Also high marks were given to the melilot honey of the Omsk region, acacia honey of the Altai Republic, sainfoin, angelica, buckwheat honey of the Altai Krai.

When studying the physico-chemical parameters (water content, reducing sugars, sucrose, free acidity, pH, diastase number) and safety criteria of honey from the West Siberian region, values were noted that were within the limits established by the Russian regulatory documents. It should be noted that buckwheat honey showed the highest diastase activity; it amounted to 30-32 Gothe units. The smallest diastase activity was found in acacia honey (7-8 Gothe units) and melilot honey (11-12 Gothe units). Proline content ranged from 198 to 382 mg/kg, it was higher than standard limits but did not reach high values of 600-800 mg/kg which other researchers refer to. We have found no correlation between the color of honey and proline content. The relationship between the electrical conductivity of monofloral honey types and their botanical origin was noted. Acacia honeys were characterized by the lowest electrical conductivity of 0.08-0.09 mS/cm, linden honey had the greatest one – 0.41-0.43 mS/cm. Other monofloral honeys showed intermediate values. Conductivity of polyfloral honey was in the range of 0.14-0.26 mS/cm. Thus, a high level of both tasting characteristics and physico-chemical properties of the honey from studied region was established what allows us to talk about their possible use as curative and prophylactic food.

V. Offers and implementation results

Based on the results of the research performed, the recommendation is to introduce proline content evaluation for assessing the authenticity of honey according to GOST R 54947-2012 in the routine practice of laboratories assessing the quality and safety of livestock products. Performing assessment of the electrical conductivity of honey as an express method in order to determine its botanical origin is also recommended. It is also necessary to make palynological tests with the evaluation of weight content of pollen from the five main nectariferous plants a mandatory element of honey examination. Information about botanical origin of honey upon its sell should be presented only on the basis of laboratory test results.

VI. Practical significance

Practical significance of this research involved establishing the sensory, physico-chemical and palynological parameters of honey from the studied areas of the West Siberian region, as well as defining the types of monofloral honey gathered in the Altai, Omsk and Tomsk Regions.

VII. Experimental findings

These findings were obtained on the basis of the study of 312 samples from the different areas of Altai, Omsk and Tomsk Regions, as well as from honey fairs held in the cities of Omsk, Tomsk and Gorno-Altaysk in the period from 2014 to 2018.

Evaluation of the organoleptic properties of honey showed that amber and dark amber types of honey with cream (66.8%) or fine-grained (19.9%) consistency prevail in the studied areas of this region.

Moisture weight content in the honey from the north of the Omsk Region, the Altai Republic, and the Tomsk Region was higher than that from the Altai Krai and the southern part of the Omsk Region what can be explained by the climatic conditions of these regions. The content of reducing sugars of all the studied samples was high and ranged from 90.1-98.9%. At the same time, sucrose content was different and amounted to 1.57-4.41%. Diastase number ranged from 7.5 Gothe units in acacia honey and 10.1 Gothe units in linden honey of the Omsk region to the maximal values characteristic for the buckwheat honey from all studied areas, i.e. 30.2-32.5 Gothe units. Seliwanoff's test showed no hydroxymethylfurfural in the samples. Hydrogen index varied in the range of 3.2-4.4 pH units. The highest level of acidity was in Altai buckwheat honey. At the same time, free acidity of polyfloral honey was 17.4-28.8 meq/kg. Conductivity assessment showed that linden honey had a maximal value of 0.41 ± 0.02 mS/cm with dominant pollen at the level of 34-38%, and acacia honey (0.09 ± 0.01 mS/cm) and dandelion honey (0.13 ± 0.01 mS/cm) had minimal values with dominant pollen at the level of 38-41%. Assessment of proline content showed its presence in the samples in the range of 192.2-389.8 mg/kg.

Melissopalynological assessment revealed that samples of polyfloral and monofloral honey from the studied region contain the pollen from plants of Asteraceae, Cruciferous, Euphorbiaceae, Campanulaceae, Ranunculaceae, Fabaceae, Boraginaceae, Rosaceae, and Umbelliferae families. At the same time, melilot pollen is present in 78%, buckwheat one – in 35%, sainfoin – 18% of samples. Polyfloral and monofloral honey from the mountain and mountain taiga areas of the Altai Republic also contained the pollen from plants of Labiatae, Scrophulariaceae, Caprifoliaceae, Lythraceae, and Berberidaceae. Angelica pollen grains were found in 32% of samples, these of melilot – in 30%, Siberian cornflower – in 27%, yellow acacia – in 17% of samples.

VIII. Conclusion

Our research has shown that honey gathered in the West Siberian region, in general, meets the requirements of Russian and international documents, has good tasting, organoleptic and physico-chemical properties determined by climatic conditions and different types of nectariferous plants growing in this area. Colors of polyfloral honey range from light to dark amber, with a predominance of amber and dark amber shades. The flavor is predominantly delicate, mild. However, several local types of honey – with buckwheat as one of the nectariferous plants – are more flavorful and more intense colored. For Omsk and Tomsk Regions, Altai Krai this is honey from meadow and forest forbs, for the Altai Republic it is also honey from mountain taiga. Omsk and Tomsk Regions and Altai Krai also have monofloral honey from sown plants: melilot, sunflower, buckwheat, rapeseed, sainfoin. In the Omsk Region, dandelion and linden honey are also obtained in small quantities; in the Tomsk region – phacelia honey; in the Altai Republic – acacia honey; in the Altai Krai – angelica honey.

Thus, we have studied the physico-chemical and palynological characteristics of the regional types of honey. Description of the peculiarities of honey in this region allows it to be more competitive in the Russian and international markets. The distinguishing characteristics of honey are

mainly in its flavor which, in turn, is due to the botanical and geographical origin of honey.

However, honey evaluation in Russia at present does not allow an unambiguous answer on honey conformity to the declared name, since its palynological analysis is not mandatory, and botanical origin, polyflorality or monoflorality of honey is declared on the basis of the opinion of the producer, seller, or even wishes of the buyer. According to our research, only 42-44% of samples at retail spots corresponded to the declared name while during exhibition trade this value was even lower – 32-34%. This becomes possible because at this stage none of the Russian documents provides for the mandatory determination of the botanical origin of honey. To manage this situation, it is necessary to introduce palynological analysis with the evaluation of pollen from at least three dominant nectariferous plants in the mandatory practice for conducting honey expert examination.

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