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Quality indicators of natural polyflorous honey in different native zones of Carpathian region

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The purpose. To determine basic quality indicators of natural polyflorous honey selected from beehives, placed in different native zones of Carpathian region. **Methods.** In samples of natural polyflorous honey selected according to National standard DSTU 4497:2005, developed in NSC «I. Prokopovich Institute of beekeeping», the following basic quality indicators were determined: diastasis number and content of deoxidiziry sugars, proline, hydroxymethylfurfurol, lead, cadmium, arsenic. **Results.** In natural polyflorous honey, sampled from beehives, placed in forest-steppe zone of Carpathian region, most considerably varies diastasis number and content of recovering sugars, proline, hydroxymethylfurfurol and toxic mineral elements. High diastasis number of honey specifies greater intensity of fission in them of polysugars -and -amylase. High content of deoxidiziry sugars and proline in honey confirms their natural origin. Low level of hydroxymethylfurfurol in honey testifies, first of all, to their prolonged keeping ability. It can be confirmed by urbanization and industrialization of that native zone. **Conclusions.** Basic quality indicators aggravated most of all (in 1,32 – 45 times) in natural polyflorous honey, sampled from beehives, placed in forest-steppe zone of Carpathian region.

Key words: *bees, native zones of Carpathian region, quality indicators of natural polyflorous honey.*

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Honey bee is a unique indicator of the pollution of the environment with heavy metals [2,3]. This is due to the fact that during one light day it covers the area of 12 km2 and collects pollen and nectar. From the pollen, the honey bee prepares bee pollen, and from the nectar - honey [1, 9].

Heavy metals in large quantities have mutagenic and carcinogenic effects, they cause poisoning (often with fatal outcome) and violations of various physiological functions of the human body and animals [3]. The main natural source of heavy metals entering the soil and plants is soil-forming rocks. Recently, this process began to be strongly influenced by man-made human activities [4]. In particular, heavy metals began to enter soils and plants with solid waste from industry, agriculture, energy and transport [5, 9]. In addition, the most polluted heavy metals of the territory appear near industrial centers and highways [2].

Studies carried out by various scientific institutions found out that heavy metals migrate in the biosphere and move freely along the trophic chain: soil - plant - bees - bee products - man [9, 10]. Heavy metals began to accumulate intensively in honey plants, tissues of honey bees and products of beekeeping [7]. The analysis of the trophic chain allows us to assess the quality and safety of beekeeping products [6, 8].

The statistical data indicate that Ukraine has emerged one of the world leaders in the production and export of natural polyphosphoric honey [8]. Therefore, the development in Ukraine of high-quality and environmentally safe beekeeping products is relevant. Taking into the account all mentioned above, the question arises about the study of qualitative indices of natural polyphloric honey in different terrestrial ecosystems of Ukraine.

The literature does not contain data about the main quality indicators of natural polyphlore honey obtained from the beehives located in different terrestrial ecosystems of the Carpathian region. Therefore, the purpose of our research was to establish the main qualitative indicators of natural polyphlore honey, selected from the beehives, located in the mountain, foothill and forest-steppe areas of the Carpathian region.

Materials and methods of the research. Pollen basket (pollen from the medicinal dandelion - Taraxacum officinale Wigg, and apple tree - Malus) and natural polyphlore honey for the research were taken from three beehives in three apiaries located in the mountain, foothill and forest-steppe areas of the Carpathian region. Particularly from the private beekeeping farms of the mountain (Slavske, Skolivskyi district), foothill (Stynava village, Stryi district) and forest-steppe (Myklashiv village, Pustomyty district).

The content of iron, zinc, copper, chromium, nickel, lead, cadmium, and arsenic in the pollen of the dandelion and apple tree was determined by the intensity of the technogenic load on the environment. To clarify the species belonging to the selected pollen from dandelion and apple tree, the identification tests were conducted using computer programs "LUCIA" (Laboratory Color Image Analysis) and "Pollen Data Bank". The content of these heavy metals in pollen from the dandelion and apple tree was determined by atomic absorption spectrophotometer (Selmi-115).

In selected samples of natural polyphosphoric honey according to the current national standard (State Standards of Ukraine) 4497: 2005, developed by the employees of the Institute of beekeeping named after P. I. Prokopovich, determined the main qualitative indicators: diastase number and content of reducing sugars, proline, hydroxymethylfurfural, lead, cadmium and arsenic. Moreover, the diastase number and content of reducing sugars, proline and hydroxymethylfurfural in natural polyphosphoric honey were determined photocollarimetrically at the wavelengths of 590, 440, 510, and 550 nm, respectively. The content of toxic mineral elements of lead, cadmium and arsenic in the mentioned above honey, according to the current national standard, was determined by the State Standards of Ukraine, respectively, 26932, 26933 and 26930.

The received digital material was processed by the method of variation statistics using Student's criterion. The average arithmetic values (M) and errors of mean arithmetic (± m) were calculated. The differences were considered probable for $p < 0.05$. For calculations, the computer program Origin 6.0, Excel (Microsoft, USA) was used.

Results of the research. It was stated that the pollen from the dandelion and apple tree obtained from the beehives located in the foothill and forest-steppe areas of the Carpathian region, in comparison with the pollen of the dandelion and apple tree, taken from the beehives located in the mountain area, has a higher content of iron, zinc, copper, chromium, nickel, lead and cadmium (Table 1). It is also evident from the data in the table that the pollen from the dandelion and apple tree obtained from the beehives in the forest-steppe area of the Carpathian region contains the largest number of heavy metals mentioned above. The following should be stated. The content of the investigated heavy metals in the pollen from the dandelion and apple tree, taken from the beehives located in the mountain, foothill and forest steppe areas of the Carpathian region is within the maximum permissible limit defined by the current national standard (State Standards of Ukraine) 3127: 1995.

It has been stated that with the increasing intensity of technogenic load on the environment, the main quality indicators of natural polyphosphoric honey deteriorate. In particular, in natural polyphlore honey obtained from the beehives located in the foothill and forest-steppe areas of the Carpathian region, the diastase number and content of reducing sugars and proline decreases in comparison with the natural polyphlore honey, taken from the beehives located in the mountain area, but the level of hydroxymethylfurfural increases(Table 2).

Table 1 The content of heavy metals in the pollen taken from the dandelion and apple tree, g · 10-3 / kg air-dry mass (M ± m, n = 3)

Heavy metals	Terrestrial ecosystems of the Carpathian region		
	Mountain	Foothill	Forest-steppe
Dandelion pollen			
Iron, Fe	32,04±1,101	40,27±1,010**	49,95±1,144***
Zinc, Zn	43,54±0,773	52,70±1,169**	62,51±0,803***
Copper, Cu	3,34±0,181	4,80±0,307*	6,57±0,338**
Chromium, Cr	2,99±0,124	5,20±0,171***	7,81±0,146***
Nickel, Ni	0,46±0,029	0,62±0,029*	0,90±0,043**
Lead, Pb	1,05±0,083	1,87±0,047**	2,53±0,104***
Cadmium, Cd	0,04±0,006	0,08±0,008*	0,13±0,008**
Arsenic, As	traces	traces	traces
Apple tree pollen			
Iron, Fe	14,24±0,511	18,58±0,751**	24,00±0,513***
Zinc, Zn	16,51±0,527	22,94±0,595**	28,70±0,638***
Copper, Cu	1,23±0,049	1,91±0,060***	2,83±0,077***
Chromium, Cr	1,21±0,072	2,09±0,081**	3,00±0,113***
Nickel, Ni	0,12±0,011	0,19±0,014*	0,30±0,020**
Lead, Pb	0,43±0,024	0,62±0,032**	1,01±0,052***
Cadmium, Cd	0,01±0,003	0,03±0,003*	0,07±0,005**
Arsenic, As	traces	traces	traces

Footnote. Here and beyond the differences probably are compared with the control group: * - p <0,05-0,02; ** - p <0.01; *** - p <0.001.

The high diastase number of honey indicates a greater degree of splitting of polysaccharides in α- and β-amylase [2]. The high content of reducing sugars and proline in honey confirms their natural origin [1, 10]. The low level of hydroxymethylfurfural in honey indicates, first and foremost, their resilience to long-term storage [4, 6].

According to the requirements of the current State Standard of Ukraine 4497: 2005, in good natural polyphlore honey, the diastase number should be at least 10 units of Gothe [8]. In such honey, the content of reducing sugars should be not less than 70% [7, 8]. They should also be at least 300 and not more than 10 g · 10-3 / kg of natural weight, respectively, of proline and hydroxymethylfurfural [2, 5].

In the natural polyphlore honey, in accordance with the requirements of the State Standard, the content of such toxic minerals as lead, cadmium and arsenic is controlled. Good natural poliphlore honey, containing not more than 1,00, 0,05 and 0,50 g · 10-3 / kg of cadmium and arsenic respectively, is considered as good. The content of the latter in natural poliphlore honey obtained from the beehives located in the foothill and forest-steppe areas of the Carpathian region is increasing in comparison with natural polyphlore honey, taken from the beehives located in the mountain area (Table 2).

Table 2 The main qualitative indicators of natural polyphosphoric honey (M±m, n=3)

Indicators under research	Terrestrial ecosystems of the Carpathian region		
	Mountain	foothill	Forest-steppe
Diastase number (to anhydrous substance), unit. Gotta	35,4±2,78	24,1±1,81**	18,9±1,28***
The content of renewable sugars (to anhydrous substance),%	240,8±16,45	178,3±14,52**	124,4±11,20***
Proline content, g · 10-3 / kg	452,3±22,05	384,2±15,45**	342,2±12,84***
The content of hydroxymethyl furfural, g · 10-3 / kg	2,1±0,16	4,9±0,38**	8,1±0,69***
The content of toxic minerals, g · 10-3 / kg:			
Lead, Pb	traces	0,20±0,014	0,45±0,036
Cadmium, Cd	traces	0,01±0,001	0,03±0,002
Arsenic, As	traces	0,06±0,003	0,15±0,006

The following should be stated. The main qualitative indices (diastase number and content of renewable sugars, proline, hydroxymethylfurfural and toxic mineral elements) of natural polyphlore honey obtained from the beehives located in the mountain, foothill and forest steppe areas of the Carpathian region are within the maximum permissible limit established by the State Standard of Ukraine 4497: 2005.

In the natural polyphlore honey obtained from the beehives located in the forest-steppe area of the Carpathian region, the diastase number and content of renewable sugars, proline, hydroxymethylfurfural and toxic mineral elements has significantly changed. This may indicate the level of urbanization and industrialization of this terrestrial ecosysytem.

Conclusions

1. In the pollen basket taken from the beehives located in the foothill (increases in 1,2 -2 times) and forest-steppe areas (increases in 1,5-7 times) of the Carpathian region, in comparison with the pollen basket selected from the beehives located in the mountain area, contain more iron (Fe), zinc (Zn), copper (Cu), chromium (Cr), nickel (Ni), lead (Pb), cadmium (Cd) and arsenic (As).
2. Natural polyphlore honey obtained from the beehives located in the foothill and forest-steppe areas of the Carpathian region, the diastase number (in1,47 and 1,87 times) and the content of renewable sugars (in 1,35 and 1,94 times) and proline (in 2,33 and 3,86 times) decrease in comparison with the natural polyphlore honey, taken from the beehives located in the mountain area. Instead, the content of hydroxymethylfurfural (in 2,33 and 3,86 times) and toxic mineral elements (lead in 20 and 45 times, cadmium in 2 and 3 times and arsenic in 6 and 16 times) increases.
3. In the natural polyphlore honey, obtained from the beehives located in the forest-steppe area of the Carpathian region, the main qualitative indicators change significantly, in 1,32-45,00 times.

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