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QUALITY OF HELIANTHUS ANNUUS HONEY OBTAINED IN THE CONDITIONS OF RADIOACTIVE CONTAMINATION

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Abstract. Natural honey is a source of vital amino acids, easily digestible carbohydrates, macro, microelements, biologically active substances that determine nutritional, antibacterial and antioxidant properties. In the conditions of man-caused pollution of Polissya of Ukraine due to the accident at the Chernobyl nuclear power plant, systematic control of the quality and safety of beekeeping products is important. To conduct such research, we created a group of twelve bee families – analogs of the Ukrainian breed, medium strength. Families were kept in unified multifunctional hives. At the beginning of the honey harvest, the bee families were transported to the sunflower fields, where they stayed during the blossoming of the plants. The density of radioactive contamination of ^{137}Cs soils where sunflower was grown was 47.0 kBq/m^2. We used organoleptic, physicochemical, microscopic, microbiological, and radiological methods in the study. According to standard methods, we studied the species composition of pollen grains, physicochemical parameters of centrifugal, honeycomb, and «zabrus» sunflower honey.(zabrus honey was obtained from wax caps, which we cut with an apiary knife from honeycombs filled with nectar and sealed by bees). The content of lead (Pb) in honey from sunflower obtained in the conditions of Polissya is 1.8–2.1 times higher than the State sanitary norms. The largest amount of it is in the centrifugal honey. In acceptable amounts, the heavy metals cadmium (Cd), arsenic (As), and ^{137}Cs were present in honey. Pesticides, dichlorodiphenyltrichloromethylmethane, and hexachlorane were not detected in the samples. We investigated the bactericidal action against bacterial growth of typical cultures of *Proteus vulgaris, Escherichia coli, Klebsiella pneumonia, Salmonella Typhimurium*, and *Staphylococcus aureus*. Zubrus sunflower honey showed the highest antimicrobial and antioxidant properties. We found that the value of antioxidant activity (AOA) of sunflower honey depends on the method of its production, duration of storage, and solutions of extracts (alcohol, aqueous) used in research. Laboratory control of transgenic organisms in flowers and sunflower pollen did not reveal the target sequences of the cauliflower mosaic virus (CaMV) 35S promoter and the NOS terminator (nopaline synthase) of the plasmid *Agrobacterium tumefaciens*.

Keywords: honey, heavy metals, ^{137}Cs, antibacterial properties, antioxidant activity.

Introduction. Formulation of the problem

One of the trends in world agricultural land use development is the increase in the area for growing monocultures, such as winter rape, spring rape, and annual sunflower. In the territory of Zhytomyr Polissya, the sunflower's sown areas in the region's radioactively contaminated areas have significantly increased over the last five years. On an industrial scale in Ukraine produce linden, buckwheat, acacia honey, but 70–80% of sunflower honey is obtained in apiaries of various forms of ownership [1]. In the conditions of radioactive contamination of Polissya, Zhytomyr region, it is essential to control the content of radioactive isotope ^{137}Cs, heavy metals Pb, Cd, As, which migrate through the biological system soil-plant-flower - nectar - pollen - bees - bee products - the human body. They are able to accumulate and remain for a long time in the tissues of bees and honey [2]. However, the growing awareness of consumers about healthy food leads to the constant expansion of the global honey market and increase public demand for this product. Therefore, it is important to control the quality of products derived from honey plants and pollen plants, including the presence of genetically modified organisms, because getting into the human food chain, transgenic structures can also pose a threat to health [3].

Analysis of recent research and publications

Flower honey is the most famous and most important biological product of honey bees (*Apis mellifera*). It is a natural, sweet substance made from the nectar of living parts of plants by bees. They collect, process, deposit, dehydrate and store for maturation in honeycombs (Ministry of Agrarian Policy and Food of Ukraine "Requirements for honey," 2019). Honey's properties and composition depend on the ecological condition of lands, biodiversity of nectar-bearing and pollinating phytocenoses, geographical origin, climatic conditions, type of processing, and storage [4]. Given the number of honey sources, it is obvious that honey from different places can not be the same [5-7].

This is one of those products that are easily digested in the human body. Therefore, it is precious as a high-energy, carbohydrate food. The main component of honey is carbohydrates (80–85%), as in many fruits [8], but the fructose content in nectar honey should exceed the amount of glucose. In addition, the amount of fructose and glucose, the ratio of fructose to glucose, and the ratio of glucose to water are important components related to the quality of honey and determine the ability of honey to crystallize [9]. Honey contains 200 substances [10], including proteins, amino acids, enzymes, vitamins, minerals, organic acids, and phenolic compounds. Due to its composition, it has antibacterial, antioxidant, anti-inflammatory properties [11-13].

The moisture content of bee honey is important for its resistance to fermentation and granulation. A small amount of moisture protects honey from the microbiological activity and, thus, it can be stored longer [14]. Therefore, determining the mass fraction of water in honey is of practical importance during the qualitative assessment, and its content determines the maturity of honey [5]. Physicochemical properties of honey, low water activity, and high sugar concentration interfere with the growth and survival of various bacteria [9,15].

The total amount of enzymes that enter the honey with the nectar and secretion of the salivary glands of bees is characterized by the diastasis number, expressed in Goethe units (Shade units in international standards). Natural honey has an acidic environment and contains a variety of acids. Organic - apple, ant, oxalic, dairy, acetic, etc., and inorganic - phosphorus, salt [16].

Due to the difficult environmental situation after the accident at the Chernobyl nuclear power plant, along with the improvement of technological processes for the production of bee products, the honey market needs to be systematically monitored in terms of quality and safety.The purpose of the study is to determine the quality and safety of centrifugal, honeycomb, and zabrusnogo honey from annual sunflower, obtained under conditions of radioactive contamination of Polissya, Ukraine.

The **purpose** of the work is to investigate the indicators of quality, safety and biological activity of sunflower honey obtained in the conditions of radioactive contamination of Polissya of Ukraine. To achieve this goal, we set the **tasks:**

- to confirm the botanical origin of honey to study the species composition of pollen and establish the presence of genetically modified organisms;

- to determine the physico - chemical and organoleptic characteristics of honey, depending on the method of production (centrifugal, honeycomb, zabrus), as well as the content of heavy metals and ^{137}Cs in honey;

- evaluate the antibacterial, antioxidant properties of sunflower honey.- evaluate the antioxidant and antibacterial properties of three types of sunflower honey.

Research materials and methods

Twelve bee families - analogs of the Ukrainian breed, formed by strength, number of brood, age of queens, feed reserves [17] were used for the study. At the time of family formation, they were of medium strength and kept in unified multifunctional hives. During the winter-spring period, the families were on the territory of the subsidiary "Slovechansky Forestry" of the agro-industrial complex of the Zhytomyr Regional Council. The density of ^{137}Cs soil contamination of natural lands in the radius of productive flight of bees ranged from 37.0 to 296.1 kBq/m^2. According to the results of statistical analysis, it was found that the main share of annual sunflower sown areas in the radioactively contaminated territory of Zhytomyr Polissya falls on the districts: Ovruch – 5.3%, Narodytsky 4.7% and Malynsky 2.8%. Seeds of early-maturing NK Rocky sunflower hybrid were used for sowing. [18]. The predecessors on this area for the last two years were winter rapeseed and corn.

At the beginning of the main honey harvest, we transported the bee families to sunflower crops where they remained were until the end of flowering plants. At the end of sunflower flowering, we selected fresh honeycombs from beehives, which had more than 1/3 of the sealed cells for analysis. **(**Fig. 1). «Zabrus» honey was obtained from wax caps, which we cut with an apiary knife from honeycombs filled with nectar and sealed by bees. This honey was also filtered through a metal filter. Centrifugal honey was pumped out of the honeycombs using a four-frame centrifugal honey extractor. Samples of honeycomb honey were cut from honeycombs five pieces measuring 5x5 cm by the envelope method and filtered through a metal mesh with holes up to 0.5 mm in diameter. (Fig. 2).

Fig. 1. Honeycomb with mature sealed honey

Fig. 2. Sampling of honeycomb by the envelope method

Five pieces of honeycomb measuring 5x5 cm were cut and filtered through a metal mesh with holes up to 0.5 mm in diameter. Honey samples were taken with a tubular sampler with a diameter of 12 mm, which was immersed along the vertical axis along the entire length of the container. It was removed, first allowing the liquid to drain from the outer surface of the sampler, and the honey that was inside the tube, poured into a clean, dry, sterilized container. In addition, we determined the number of mechanical impurities by filtering the honey through a metal mesh with holes of 0.5 mm. (Natural honey. Technical requirements. DSTU 4497: 2005).

In freshly selected samples, we investigated the mass fraction of water, reducing sugars, diastase number, acidity, the presence of pesticides (dichlorodiphenyltrichloromethylmethane and hexachlorane) according to the methods.

To determine the botanical origin of honey, the species composition of pollen was investigated using a Leverhuk D320L Digital microscope with a magnification of approx. 16 x vol. 40. Identification was performed using the electronic global database PalDat, 2016.

Preparation of honey samples and determination of lead, cadmium, arsenic in them was carried out by dry mineralization on the atomic absorption spectrometer "Quantum - 2A" (DSTU 7670: 2014).

The content of 137Cs in the soil, vegetative organs of sunflower, and honey were determined by gamma spectrometric method, using scintillation gamma spectrum based on a personal computer with software PROGRESS - 2000 (gamma beta spectrum). (Methodical instructions of the Ministry of Health of Ukraine "Sampling, primary processing and determination of 90Sr 137Cs content in food products" (2008).

The total potential of antioxidant activity of sunflower honey was detected by spectrophotometric method with high sensitivity to anti radicals. For this purpose, we prepared solutions of honey extracts, and the optical density of DPPH solutions was measured [19]. In addition, we determined the indicator in alcohol and aqueous solutions. We conducted the research based on the Institute for Biodiversity Conservation and Biosafety of the Slovak Agricultural University in Nitra (Slovakia) laboratory.

We determined the antimicrobial properties of honey by assessing the bacterial growth of typical cultures of *Proteus Vulgaris* (strain NH 19 № 222), *Escherichia coli* (strain ATCC 25922 (F-50), *Klebsiella pneumonia* (strain 12-56*), Salmonella typhimurium* (strain 79) and *і Staphylococcus aureus* (strain) ATCC 25923 (F-49).

Laboratory control of the presence of genetically modified organisms in flowers and sunflower pollen was performed by real-time polymerase chain reaction (PCR - RF). The method was based on the detection of transgenic DNA. The target sequence of the cauliflower mosaic virus (CaMV) 35S promoter and the NOS terminator (nopaline synthase) of the plasmid *Agrobacterium tumefaciens* were determined [3].

The obtained results were presented as the mean value ± standard error (x ± SE). The research results were processed by the method of variation statistics using the analysis package of the computer program Microsoft Office Excel.The probability of difference was determined by Student's t-test.

Results of the research and their discussion

Recently, flower honey is often obtained in a polluted environment. The most common potential contaminants are veterinary drugs, pesticides, herbicides, heavy metals, radionuclides [20-22]. It is known that bees are receptive to the ecological state of the environment. Therefore, honey and other bee products can accumulate radioactive elements, heavy metals, pesticides. These harmful substances in bee honey are controlled by the Codex Alimentarius Commission and the Council Directive in the European Union (Codex Alimentarius Commission, 2001; Council Directive of the European Union, 2001, [23]).

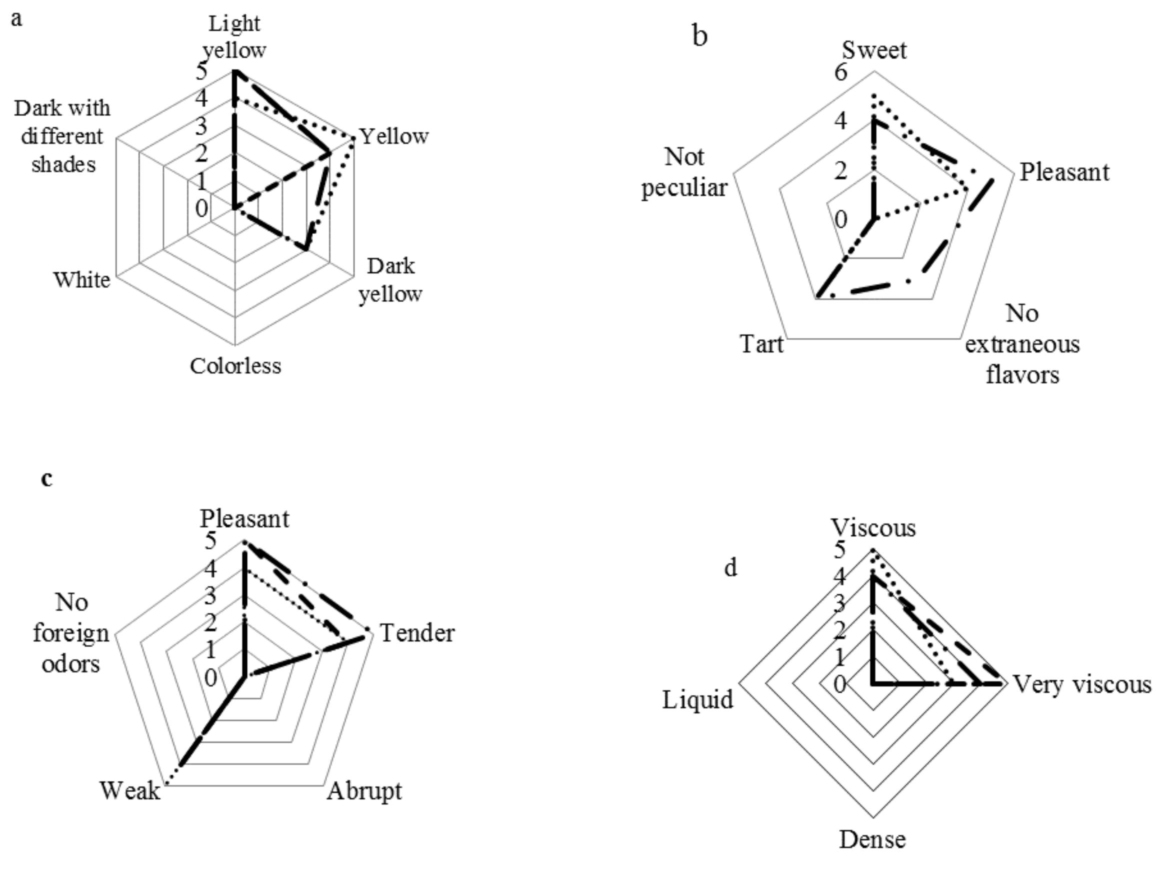
We studied the organoleptic, physicochemical, antibacterial, and antioxidant properties of sunflower honey obtained under conditions of radioactive contamination. We found that they vary depending on the methods of their production and shelf life. At the beginning of the research, the density of radioactive contamination of ^{137}Cs soils, where sunflower was grown, was determined, and it was 47.0 kBq/m^2.The specific activity of ^{137}Cs in sunflower flowers was in the range of 15.1 Bq/kg with a significant difference ($p \leq 0.05$), compared with its content in the leaves (24.9 Bq/kg), while in the stems found 12.7 Bq/kg. Analysis of organoleptic and physicochemical parameters of centrifugal, honeycomb, zabrus sunflower honey showed that all its samples fully meet the standards of "Requirements for honey", 2019 (Table 1).

Table 1 – Qualitative indicators of sunflower honey (n = 36, x ± SE)

Indexes	Honey		
	centrifugal	honeycomb	zabrus
Mass fraction of pollen grains of sunflower,%	57.9 ± 2.9	not determined	not determined
Mass fraction of water, %	19.9 ± 0.7	15.5 ± 0.1	17.5 ± 0.3
Mass fraction of reducing sugars, %	87.0 ± 2.6	86.7 ± 2.4	95.9 ± 2.2
Diastasis number, units Gotte	37.4 ± 7.9	28.4 ±5.3	32.1 ± 4.6
Acidity, m.-eq/kg	25.5 ± 1.3	42.2 ± 8.3*	28.5 ± 1.9
Lead, mg/kg	0.21±0.007	0.18±0.007	0.18±0.004
Cadmium, mg/kg	0.02±0.006	0.02±0.043	0.02±0.008
Arsenic, mg/kg	0.002±0.0001	0.001±0.0003	0.002±0.0004
^{137}Cs, Bq/kg	7.9±1.4	5.9±1.3	6.4±1.1

Note: * $p \leq 0.05$ - between the group difference is statistically significant

The mass fraction of sunflower pollen grains in centrifuged honey used for research was 57.9%, which indicates a dominant botanical origin. As can be seen from the profilogram (Fig. 3), the color of honey varied from light yellow to yellow.



•••Centrifugal; – – – Zabrus; — • Honeycomb;

Fig. 3. Profilogram of organoleptic assessment of the quality of centrifugal, honeycomb, zabruso sunflower honey: a) color; b) taste; c) aroma; d) consistence.

All products had a sweet characteristic of sunflower honey tart taste and a pleasant, delicate, faint aroma without odors. The consistency is viscous in centrifugal honey, very viscous - in zabrus and honeycomb. We found no signs of fermentation and mechanical impurities in the samples.

Since honey has a hygroscopic effect, bees seal the cells when the humidity of honey is less than 20%, there by preventing the growth of bacteria and microorganisms in their environment for the existence of which water is needed [15]. Our studies are presented in table 1. Excess moisture affects yeast development, can cause fermentation, change the taste and aroma [20].We recorded renewable sugars the most in zabrus honey – 95.9%.

An important sign of the naturalness of honey is its enzymatic activity due to the presence of phytoncides, enzymes, high concentration of sugars, low pH [24,25]. These substances play an important role in normalizing the human body, prevention, treatment, and risk reduction. Honey does not have the same enzyme activity, which also varies depending on its production methods, as indicated by the rate of diastase activity in our studies. Low levels of diastase in honey may indicate heat treatment and adulteration. [26]. Natural honey contains alpha and beta-amylase, glucose oxidase, diastase, catalase, lipase, invertase, acid phosphatase, polyphenol oxidase, peroxidase, esterase, and proteolytic enzymes. Their number and composition in honey depend on its botanical and geographical origin, natural climatic conditions, the technology of growing crops, primary processing, and other factors [27]. Therefore, the diastase number of honey can vary considerably even within one species.

According to our research, the acidity of honey also differs depending on the method of production. For example, the highest acidity of honey was 42.2 m.-eq/kg, which is significantly higher ($p \leq 0.05$) than that of centrifugal and bar honey.

From the point of view of food safety, it is important to determine the content of heavy metals in honey because most of them are very toxic, and honey, as an important ingredient in many medical and dietary supplements, must meet the requirements for lead, cadmium and arsenic and others [28].

The content of lead in honey from sunflower obtained in Polissya ranged from 0.18 to 0.21 mg/kg, which is 1.8–2.1 times higher than the State sanitary norms ("Maximum permissible levels of certain contaminants in food," 2013), where the maximum level is 0.10 mg/kg. We found the largest amount in centrifugal honey. The cadmium content in the honey of different production methods was 0.02 mg/kg. Arsenic ranged from 0.001 to 0.002 mg/kg, significantly less than the permissible level (DSTU 4497: 2005). TThe specific activity of 137Cs in honey was in the range of 6.0 - 8.0 Bq/kg, which is 1.9–2.6 times less than in sunflower flowers and much lower than the approved in Ukraine State Hygienic Standards for Permissible Levels (DR) of radionuclides in food (DR 2006 – 200 Bq/kg).

The pesticides dichlorodiphenyltrichloromethylmethane and hexachlorane were not detected in the product. Laboratory studies of transgenic organisms in flowers and sunflower pollen did not reveal the target sequences of the cauliflower mosaic virus (CaMV) 35S promoter and the NOS terminator (nopaline synthase) of the plasmid *Agrobacterium tumefaciens.* Honey strengthens the immune system, anti-inflammatory, antibacterial, antifungal, and antiviral activity. Positive results have been obtained in the treatment of some cancers [28]. In addition, pollen contained in honey is also a valuable source of protein, fat, macro and micronutrients, and vitamins [29].

Honey is not sterile; scientists have isolated various microorganisms from honey. The primary sources of their entry into honey are pollen, flower nectar, the digestive tract of honey bees, soil, water, air. Secondary contamination is possible under conditions of violation of sanitary and hygienic rules of pumping, processing, and storing honey [30].

It has been established that anaerobes are the predominant microflora, in particular *Clostridium botulinum* was found in honey, which can cause botulism in children [31-33]. Several species of *Bacillus* spp can also survive in honey [32,34,35]. Other groups of microbes are yeasts and molds, which are responsible for the fermentation and spoilage of honey [30,36]. The high ability of honey to inhibit was observed against gram-negative bacteria *Escherichia coli* at a dilution of 1: 6 with water and *Proteus vulgaris* [37]. Sunflower *(Helianthus annuus*) honey was found to have antimicrobial activity against *Escherichia coli*, while rapeseed honey (*Brassica rapa*) showed moderate activity, and honey from linden (*Tilia* spp.) And robinia (*Robinia pseudoacacia*) did not affect this pathogen. According to the authors, sunflower honey contains a significant amount of flavonoids that contribute to the antimicrobial activity of honey [37].The best bactericidal properties showed zabrus sunflower honey (Fig. 4).

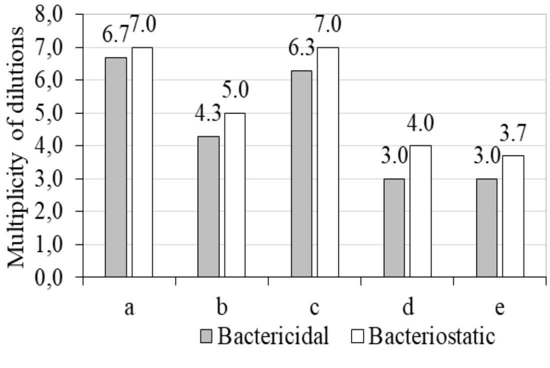


Fig.4. Antibacterial properties of zabrus sunflower honey
a) *Escherichia coli;* b*) Klebsiella pneumonia;* c) *Proteus vulgaris;* d) *Staphylococcus aureus;* e*) Salmonella typhimurium*

It showed the highest antimicrobial properties against *Escherichia coli* and *Proteus vulgaris*. The multiplicity of dilution with water was 1: 6 for bactericidal and 1: 7 for bacteriostatic action. The bactericidal action of zabrus honey against the microorganisms *Salmonella typhimurium and Staphylococcus aureus* was noted before dilution with water 1: 3, and bacteriostatic – 1: 4. The death of *Klebsiella pneumonia* bacteria was observed before dilution with water 1: 4, and their growth retardation was 1: 5. Honeycomb sunflower honey showed high antibacterial activity against *Escherichia coli* (1: 6 and 1: 7) Fig.5.

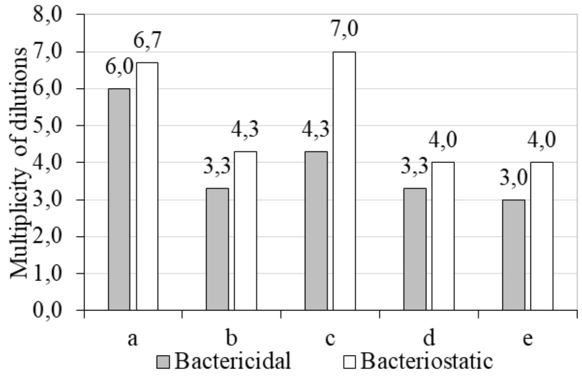


Fig.5. Antibacterial properties of honeycomb sunflower honey;*a) Escherichia coli; b) Klebsiella pneumonia; c) Proteus vulgaris; d) Staphylococcus aureus; e) Salmonella typhimurium*

The bactericidal effect of honey on microorganisms *Proteus vulgaris* occurred before dilution 1: 4, but the delay in growth and reproduction of the culture, he showed up to 1: 7. The antibacterial properties of honey in relation to *Klebsiella pneumonia, Salmonella typhimurium* and *Staphylococcus aureus* were approximately the same. Complete death of bacteria occurred at a dilution of 1: 3, and their growth retardation – 1: 4.

Compared with zabrus and honeycombs, centrifugal honey showed a slightly lower antimicrobial effect (Fig.6).

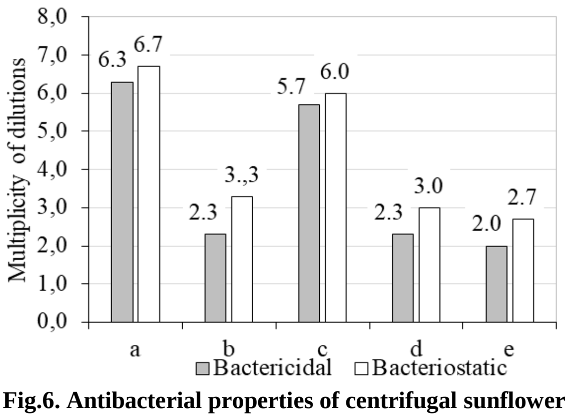


Fig.6. Antibacterial properties of centrifugal sunflower honey; *a) Escherichia coli; b) Klebsiella pneumonia; c) Proteus vulgaris; d) Staphylococcus aureus; e) Salmonella typhimurium*

We found the best antimicrobial activity of centrifugal honey against *Escherichia coli* and *Proteus Vulgaris*; their average antibacterial titer was 1: 6. Bactericidal and bacteriostatic action against the microorganisms *Klebsiella pneumonia, Salmonella Typhimurium,* and *Staphylococcus* aureus centrifugal honey showed a dilution in the range of 1:2–1: 3. Compared with barberry and honeycomb honey, the antimicrobial activity against these crops is lower by 1–2 titers.

Our studies have confirmed that centrifugal, honeycomb, and sunflower honey in different dilutions may have different antimicrobial activity against gram-positive and gram-negative bacteria. It is known that the bactericidal properties of honey depend on their botanical origin, so some microorganisms are differently sensitive to certain types of honey [15,32,35]. Honey can also have beneficial microorganisms that protect the human body from disease by creating a barrier to pathogens [2]. Honey, which contains less sugar, is prone to fermentation processes and has a low quality, but too high a reducing sugar content may indicate falsification [41]. Our results are consistent with the fact that natural honey has natural antimicrobial properties due to the content of phytoncides and enzymes.

Our experiments showed that in the second year of storage, the antioxidant activity of sunflower honey decreased. Similar data were obtained from studies of sunflower honey produced in Turkey. [38].

The study found that in an aqueous solution AOA of sunflower honey is greater than in alcohol. We confirmed the high biological value of zabrus sunflower honey for its AOA. In the first year of storage of zabrus honey, its AOA in alcohol and aqueous solutions was 8.6 and 11.4%, respectively, which is dominated by honeycomb and centrifugal honey in both extracts (Fig. 7).

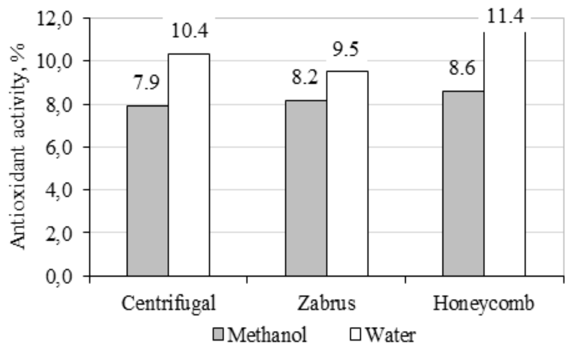


Fig. 7. Antioxidant activity of sunflower honey

It has been established that the antioxidant activity is influenced by the method of obtaining honey, the type of solutions and extracts, and its shelf life (Fig. 8).

Honey's antioxidant activity for the second year of storage was significantly ($p \leq 0.05$) decreased in both solutions, but most in zabr honey when dissolved in water (Fig. 8). A year later, the antioxidant activity of zabrus honey became significantly lower in methanol and aqueous solutions; in particular, their values decreased by 2.5 and 4.5 units, respectively. A potential decrease of 1.3

units in methanol and 0.7 units in water was observed in honeycomb honey, but the difference is not probable. One year after production, centrifugal honey's antioxidant activity decreased by 1.9 in methanol and 1.1 units in aqueous solutions, with an incredible difference. The highest potential of antioxidant activity of honey after a year of storage was honeycomb – 6.9 in methanol solution, and water – centrifugal 9.3 units

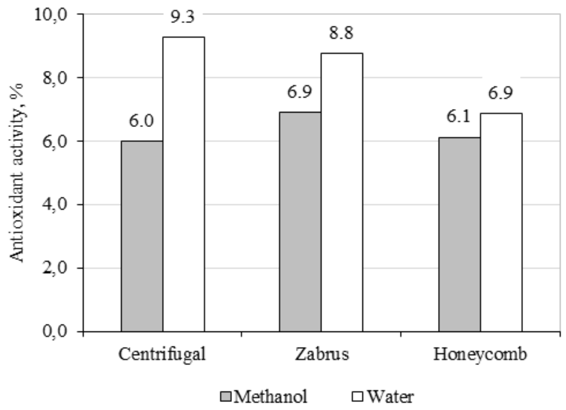


Fig. 8. Antioxidant activity of honey for the second year of storage

Conclusion

In the conditions of radioactive contamination of Polissya of Ukraine up to 47.0 kBq / m2, it is possible to obtain honey from annual sunflower (Helianthus annuus), which has high quality and naturalness, as evidenced by the results of physical and chemical studies of centrifugal, honeycomb and zabrus sunflower honey. But at the same time, it is necessary to adhere to the technology of production, primary processing, and product storage methods. The maximum amount of cesium-137 accumulates in the stems and leaves of the plant, and the generative organs (inflorescences) accumulate less. The results of the honey test show that the maximum permissible levels are exceeded by 1.8–2.1 times only for lead. The content of cadmium, arsenic, ^{137}Cs in honey is much lower than the permissible level .

The method of obtaining honey and the duration of storage affects its antibacterial and antioxidant activity. Zabrus and honeycomb had higher antibacterial properties due to the complex of biologically active substances in their composition. The results of the experiments showed the highest biological value of zabrus sunflower honey in terms of its antioxidant properties. In freshly pumped ground honey, the AOA index in alcohol and aqueous solutions was 8.6 and 11.4%, respectively, which is predominant in honeycomb and centrifugal honey in both extracts.

Further study of these issues will scientifically substantiate and improve technological processes to ensure sustainable production of quality and safe beekeeping products in conditions of radioactive contamination, and will promote the efficient use of natural and cultural honey lands, preservation and increase of bee colonies.

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ЯКІСТЬ МЕДУ ІЗ HELIANTHUS ANNUUS, ОТРИМАНОГО В УМОВАХ РАДІОАКТИВНОГО ЗАБРУДНЕННЯ

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Анотація. Мед натуральний – джерело життєво необхідних амінокислот, легко перетравних вуглеводів, макро, мікроелементів, біологічно активних речовин, які обумовлюють харчові, антибактеріальні та антиоксидантні властивості. В умовах техногенного забруднення Полісся України в результаті аварії на Чорнобильській атомній електростанції важливе значення має системний контроль якості та безпеки продуктів бджільництва. Для проведення таких досліджень ми створили групу із дванадцяти бджолиних сімей – аналогів української породи, середньої сили. Утримували сім'ї в уніфікованих багатофункціональних вуликах. На початок медозбору бджолині сім'ї перевезли до угідь соняшнику, де вони знаходились протягом цвітіння рослин. Щільність радіоактивного забруднення ґрунтів ^{137}Cs, де вирощували соняшник складала 47.0 кБк/м^2. В процесі дослідження використали органолептичні, фізико-хімічні, мікроскопічні, мікробіологічні та радіологічні методи. За стандартними методиками дослідили видовий склад пилкових зерен, фізико-хімічні показники центрифужного, стільникового та забрусового соняшникових медів (забрусовий мед отримали із воскових кришок, які зрізали пасічним ножем у стільників, що були заповнені нектаром і запечатані бджолами). Вміст свинцю (Pb) в медах із соняшника отриманого в умовах Полісся в 1.8– 2.1 рази перевищує Державні санітарні норми. Найбільша його кількість у складі центрифужного меду. Важкі метали кадмій (Cd), миш'як (As), а також ^{137}Cs, знаходились в меду у допустимих кількостях. Пестицидів, дихлордифенілтрихлорметилметану та гексахлорану в зразках не виявили. Дослідили бактерицидну дію проти бактеріального росту типових культур *Proteus vulgaris, Escherichia coli, Klebsiella pneumonia, Salmonella typhimurium і Staphylococcus aureus.* Забрусовий соняшниковий мед проявив найвищі протимікробні та антиоксидантні властивості. Встановили, що значення антиоксидантної активності (АОА) соняшникового меду залежить від способу його отримання, тривалості зберігання, а також розчинів екстрактів (спиртовий, водний) які використовувались при дослідженнях. Лабораторний контроль трансгенних організмів у квітках і пилку соняшнику не виявив цільових послідовностей промотора 35S вірусу мозаїки цвітної капусти (CaMV) та NOS-термінатора (нопалін синтази) плазміди *Agrobacterium tumefaciens*.

Ключові слова*:* мед**,** важкі метали, ^{137}Cs, антибактеріальні властивості, антиоксидантна активність.

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