www.sworld.education

*Совместно с:*

**Бельцкий Государственный Университет «Алеку Руссо»** *(Молдова)*
*Alecu Russo State University of Bălţi*

*При научной поддержке:*

Экономическая академия им.Д.А.Ценова (Болгария)
Московский государственный университет путей сообщения (МИИТ)
Украинская государственная академия железнодорожного транспорта
Научно-исследовательский проектно-конструкторский институт морского флота
Луганский государственный медицинский университет
Харьковская медицинская академия последипломного образования
Институт морехозяйства и предпринимательства
Институт водных проблем и мелиорации Национальной академии аграрных наук
Одесский научно-исследовательский институт связи

Входит в международные наукометрические базы
**INDEXCOPERNICUS**

**Международное периодическое научное издание**

**International periodic scientific journal**

# SWorld Almanahul

**Выпуск №4, апрель 2020**

Issue №4, **April** 2020

2020
*Бельцы*

ISSN 2663-5720

УДК 08
ББК 94

**Главный редактор:**
***Шибаев Александр Григорьевич,*** доктор технических наук, профессор, Академик
**Головний редактор:**
***Шибаєв Олександр Григорович, доктор технічних наук, професор, Академік***
**Chief Editor:**
**Shibaev Alexander Grigoryevich, Doctor of Technical Sciences, Professor, Academician**

**Заместитель Главного редактора:**
***Куприенко Сергей Васильевич,*** кандидат технических наук
**Заступник головного редактора:**
**Купрієнко Сергій Васильович, кандидат технічних наук**
**Deputy Chief Editor:**
**Kuprienko Sergey Vasilievich, Candidate of Technical Sciences**

**Редакционный Совет:**
***Более 150 докторов наук.*** Полный список представлен на страницах 3-5.
**Редакційна Рада:**
**Понад 150 докторів наук. Повний список представлений на сторінках 3-5.**
**Editorial Board:**
**More than 150 doctors of sciences. The full list is available on pages 3-5.**

---

*Журнал предназначается для научных работников, аспирантов, студентов старших курсов, преподавателей, предпринимателей.*
*The journal is intended for researchers, graduate students, senior students, teachers and entrepreneurs. Published quarterly.*

**УДК 08**
**ББК 94**
**DOI: 10.30888/2663-5720.2020-04-01**

© Коллектив авторов, научные тексты 2020

## О журнале

**М**еждународный научный периодический журнал "Almanahul SWorld" получил большое признание среди отечественных и зарубежных интеллектуалов. Сегодня в журнале публикуются авторы из России, Украины, Молдовы, Казахстана, Беларуси, Чехии, Болгарии, Литвы Польши и других государств.

**У**чрежден в 2018 году. **П**ериодичность выхода: два раза в год.

**Ос**новными целями журнала являются:

- содействие обмену знаниями в научном сообществе;
- помощь молодым ученым в информировании научной общественности об их научных достижениях;
- создание основы для инноваций и новых научных подходов, а также открытий в неизвестных областях;
- содействие объединению профессиональных научных сил и формирование нового поколения ученых-специалистов в разных сферах.

**Ж**урнал целенаправленно знакомит читателя с оригинальными исследованиями авторов в различных областях науки, лучшими образцами научной публицистики.

**П**убликации журнала предназначены для широкой читательской аудитории – всех тех, кто любит науку. Материалы, публикуемые в журнале, отражают актуальные проблемы и затрагивают интересы всей общественности.

**К**аждая статья журнала включает обобщающую информацию на английском языке.

**Ж**урнал зарегистрирован в INDEXCOPERNICUS.

## Про журнал

**М**іжнародний науковий періодичний журнал "Almanahul SWorld" отримав велике визнання серед вітчизняних і зарубіжних інтелектуалів. Сьогодні в журналі публікуються автори з Росії, України, Молдови, Казахстану, Білорусі, Чехії, Болгарії, Литви, Польщі та інших держав.

**Д**ата заснування в 2018 році. **П**еріодичність виходу: два рази на рік

**О**сновними цілями журналу є:

- сприяння обміну знаннями в науковому співтоваристві;
- допомога молодим вченим в інформуванні наукової громадськості про їх наукові досягнення;
- створення основи для інновацій і нових наукових підходів, а також відкриттів в невідомих областях;
- сприяння об'єднанню фахових наукових сил і формування нового покоління вчених-фахівців в різних сферах.

**Ж**урнал цілеспрямовано знайомить читача з оригінальними дослідженнями авторів в різних областях науки, кращими зразками наукової публіцистики.

**П**ублікації журналу призначені для широкої читацької аудиторії - усіх тих, хто любить науку. Матеріали, що публікуються в журналі, відображають актуальні проблеми і зачіпають інтереси всієї громадськості.

**К**ожна стаття журналу включає узагальнюючу інформацію англійською мовою.

**Ж**урнал зареєстрований в INDEXCOPERNICUS.

## About the journal

**T**he International Scientific Periodical Journal "***Almanahul SWorld***" has gained considerable recognition among domestic and foreign researchers and scholars. Today, the journal publishes authors from Russia, Ukraine, Moldova, Kazakhstan, Belarus, Czech Republic, Bulgaria, Lithuania, Poland and other countries.

**J**ournal Established in 2018. **P**eriodicity of publication: twice a year

**T**he journal activity is driven by the following objectives:

- Broadcasting young researchers and scholars outcomes to wide scientific audience
- Fostering knowledge exchange in scientific community
- Promotion of the unification in scientific approach
- Creation of basis for innovation and new scientific approaches as well as discoveries in unknown domains

**T**he journal purposefully acquaints the reader with the original research of authors in various fields of science, the best examples of scientific journalism.

**P**ublications of the journal are intended for a wide readership - all those who love science. The materials published in the journal reflect current problems and affect the interests of the entire public.

**E**ach article in the journal includes general information in English.

**T**he journal is registered in the INDEXCOPERNICUS.

DOI: 10.30888/2663-5720.2020-04-01-011

UDC 631.4: 638.178.2

# ECOLOGICAL EVALUATION OF WAX PRODUCED IN CONDITIONS OF POLLUTION OF MEDIUM OILS BY RADIONUCLIDES AND HARD METALS

## ЕКОЛОГІЧНА ОЦІНКА ВОСКУ ВИРОБЛЕНОГО В УМОВАХ ЗАБРУДНЕННЯ МЕДОНОСНИХ УГІДЬ РАДІОНУКЛІДАМИ І ВАЖКИМИ МЕТАЛАМИ

**Razanov S.F. / Разанов С.Ф.**
*d. agr. s., prof. / д. с.-г. н., проф.*
*ORCID:0000-0002-4883-2696*
*Vinnytsia National Agrarian University, Vinnytsia, Sonaychna St., 3, 21008*
*Вінницький національний аграрний університет, Вінниця, Сонячна, 3, 21008*
**Mudrak O.V. / Мудрак О.В.**
*d. agr. s., prof. / д. с.-г. н., проф.*
*ORCID: 0000-0002-1776-6120*
*KVNZ «Vinnytsia Academy of Continuing Education», Vinnytsia, st. Hrushevskogo, 13, 21050*
*КВНЗ «Вінницька академія неперервної освіти», Вінниця, Грушевського, 13, 21050*
**Mudrak H.V. / Мудрак Г.В.**
*c. g. s., as. prof. / к. г. н., доц.*
*ORCID: 0000-0003-1319-9189*
*Vinnytsia National Agrarian University, Vinnytsia, Sonaychna St., 3, 21008*
*Вінницький національний аграрний університет, Вінниця, Сонячна, 3, 21008*

***Abstract.*** *The article defines the influence of $^{137}Cs$, $^{90}Sr$, Pb, and Cd on the quality of beeswax. It was established that their concentration in the wax obtained from bee families for the honey fields of the Northern Polissya contaminated by radionuclides and heavy metals as a result of the Chernobyl disaster was lower than the Maximum permissible concentration (MPC) that make up $^{137}Cs$ – 200 Bq/kg, $^{90}Sr$ – 50 Bq/kg, Pb – 1 mg/kg and Cd – 0.05 mg/kg.*

*It is proved that due to the washing of not wax components from the wax raw material before suspension of their transition to the solvent there is a decrease in the concentration of $^{137}Cs$, $^{90}Sr$, Pb and Cd in the wax produced, respectively, by 34.2%, 48.6%, 58.8% and 83.4 % At a water temperature of 60°C, which was used as a solvent for non-volatile components of wax raw materials, during the process of washing, a decrease in the transition of $^{137}Cs$, $^{90}Sr$, Pb and Cd in the resulting wax is observed, respectively, at 0.9%, 0.5%, 13.4%, and 1.05%.*

*The article analyzes that dry processing of wax raw materials compared to wet contributes to a lower transition of non-volatile components contaminated by radionuclides into produced waxes. In particular, there was a decrease in the produced wax $^{137}Cs$ by 28.3%, Cd by 23.1%, Pb by 23.7%.*

***Key words****: cesium – 137, strontium – 90, lead, cadmium, wax, wax raw materials.*

**Introduction.** Bee wax is widely used in more than 40 branches of the national economy: in the foundry, radio engineering, textile, leather, aviation, metallurgy, automotive, printing, paper, woodworking, and other industries. It is also an important raw material for medicine. Practice shows that demand for beekeeping products, including wax, is increasing every year. Along with this, the requirements for its quality and safety are increasing.

The composition of beeswax contains more than 300 different substances, the main of which are: esters, free fatty acids, hydrocarbons, mineral coloring, and aromatic substances. It contains ethers of ceric acid – 76.0%, cholesterol esters – 1.0%, colorants – 0.3%, lactones – 0.6%, free alcohol – 1.25%, free cerium acids – 13.5% , hydrocarbons – 10,5-13,5% and mineral impurities 1-2% [1].

It is known that the quality and safety of wax depends to a certain extent on the ecological state of honey fields, which has deteriorated significantly in the territories contaminated by radionuclides as a result of the Chernobyl accident [8, 11, 17]. This is especially true for the territory of Northern Polissya Ukraine, in particular, Zhytomyr region [4, 9, 10, 16]. Studies have shown that in these areas there is a certain accumulation of $^{137}$Cs, $^{90}$Sr, Pb and Cd in bee feed products and in a bee nest, in particular in the waxy source of wax [2, 3, 12, 14]. Detected radionuclides and heavy metals are dangerous to live organisms, including humans. Thus, accumulating in living organisms, they cause a number of physiological disorders on the cellular, organ and organism levels. The use of such products in the food industry enhances the ionizing effect on the health of the population [5-7, 13, 15]. Therefore, under such conditions and in separate territories, there is a need to control the level of concentration of the above-mentioned pollutants and to improve the technology of wax production.

**Material and methods of the study.** Experimental investigations were carried out on the territory of Northern Polissya of Ukraine in the conditions of contamination of honey-bearing lands with radionuclides as a result of the Chernobyl accident in the zone of voluntary resettlement of inhabitants.

Materials for research were bee families of the Ukrainian steppe breed, which were kept in the hives of sunbeds.

To study the intensity of contamination of $^{137}$Cs, $^{90}$Sr, Pb, and Cd wax, we used wax derived from wax raw materials in which 5, 10 and 15 generations of bees were grown. The processing of wax raw materials was carried out according to the generally accepted method, which was described by V.P. Polishchuk [1].

The study of the effect of washing of non-volatile components from wax raw materials on the quality of wax produced was carried out according to the following scheme. From the wax raw material, in which the same number of generations of bees were grown (10 generations), four parts of it were selected. The first part of the wax raw material was kept for 48 hours in water without replacing it during this period. The second part of the wax raw material was kept in water for 48 hours at three times its replacement. In the third part of the wax raw material was repeated water replacement until the transition to this solution of non-wax soluble components was suspended. Wax raw materials of the fourth group continued to wash up for 45 hours after the suspension of the transition of non-volatile components to the solvent. After processing, the wax raw material was reheated on a steam kettle.

The influence of temperature (to) of the solvent (water) of not wax components of the wax raw material was carried out at + 20$^{o}$C, + 40$^{o}$C and + 60$^{o}$C.

The influence of the external environment on the concentration of radionuclides and heavy metals in waxes was carried out by defending it from liquid density to solid at + 20$^{o}$C and + 45$^{o}$C.

The influence of the processing of wax raw materials on the quality of wax was carried out using a solar and paper wax. In this case, wax raw materials were used in which 15 generations of bees were grown.

The specific activity of $^{137}$Cs in wax raw material and wax was determined by the spectrometric method, and $^{90}$Sr is chemical. The concentration of Pb and Cd in

wax and wax was determined by the atomic absorption method.

**Results of research and their discussion.** The analysis of the intensity of contamination by radionuclides and heavy metals of beer wax, produced in the conditions of Northern Polissya, indicates a low concentration of $^{137}Cs$, $^{90}Sr$, Pb and Cd in it (Table 1).

**Table 1**

**Contamination of wax with radionuclides (Bq/kg) and heavy metals (mg/kg)**

| Products | Radionuclides | | Heavy metals | |
|---|---|---|---|---|
| | $^{137}Cs$ | $^{90}Sr$ | Pb | Cd |
| Wax is made from wax raw materials in which up to 5 generations of bees are grown | 4,0 ± 0,004 | 0,52 ± 0,0001 | 0,003 | 0,0003 |
| Wax is made from wax raw materials in which up to 10 generations of bees are grown | 7,0 ± 0,007 | 0,61 ± 0,0003 | 0,058 ± 0,0004 | 0,009 ± 0,0003 |
| Wax is made from wax raw materials, in which up to 15 generations of bees are grown | 9,6 ±0,006 | 1,24 ± 0,00004 | 0,0002 | 0,014 ± 0,0003 |

*Author's development*

Based on the performed studies, it was found that the specific activity of $^{137}Cs$ and 90Sr and Pb and Cd was lower than the MPC, which is equal to 200 Bq/kg and 50 Bq/kg for radionuclides and 1.0 mg/kg and 0.05 mg/kg At the same time, it was found that the specific activity and concentration of heavy metals in wax depended on the number of bee generations in the cells, the wax raw materials of which were used for the production of these products. Thus, for the elimination of the ten generations of bees in the cells, the concentration of $^{137}Cs$ and $^{90}Sr$ and Pb and Cd in the wax increased respectively by 2,4 and 2,3 and 1,9 and 2,0 times in comparison with the similar products obtained from the wax raw materials of honeycombs, in which have been raised to five generations.

The widespread use of beeswax, especially in medicine, requires its high quality and safety. Therefore, our further research was aimed at improving its quality. So, it is known that wax contains soluble and insoluble components. The main ones include cocoons, non-permeable remains of the stern feed, residual honey, propolis, pergia, and others. It is proved that some of these substances can be removed from the wax raw material by dissolving them in a solvent (water). Taking into account that part of radionuclides and heavy metals concentrates in non-volcanic components, with their preliminary removal it is possible to expect a reduction of the substances in the produced wax. In view of this, we studied the effect of the previous partial removal of not wax components from the wax raw material by washing them up to the termination of their transition to the solvent and on the activity of radionuclides and the concentration of heavy metals in the wax produced from this raw material (Table 2).

As a result of the conducted investigations, it was found that when the wax raw material was soaked with multiple substitutions of water before the termination of the transition of non-volatile components to the solvent, compared to a one-time solvent replacement, the activity of $^{137}Cs$ and $^{90}Sr$ and the concentration of lead and cadmium in the wax produced decreased by 34, 2 and 48.6% and 58.8 and 83.4% respectively.

At three-time water change, the specific activity of cesium-137 and strontium-90 decreased by 21.3% and 40%, respectively, compared to a one-time replacement of the solvent in the washing of not wax components from the wax raw material.

**Table 2**

**Accumulation of radionuclides and heavy metals in wax depending on the intensity of washing of non-volatile components from wax raw materials**

| Explored material | Radionuclides, Bq/kg | | Heavy metals, mg/kg | |
|---|---|---|---|---|
| | $^{137}Cs$ | $^{90}Sr$ | Pb | Cd |
| Wax raw materials | 1991 ± 4,38 | 43,3 ± 0,46 | 0,728 ± 0,007 | 0,152 ± 0,003 |
| Wax from wax raw materials: with a one-time replacement of water for 48 hours (control) | 23,1 ± 0,45 | 0,35 ± 0,01 | 0,177 ± 0,012 | 0,03 ± 0,0009 |
| at three-time water change for 48 hours | 18,2 ± 0,23 | 0,21 ± 0,012 | – | – |
| at repeated water replacement before the termination of the transition of non-volatile components to the solvent for 48 hours (experiment) | 15,2 ± 0,52** | 0,18 ± 0,001*** | 0,074 ± 0,001*** | 0,005 ± 0*** |
| Wax obtained from wax raw materials with the continuation of the replacement of water after the termination of the transition of non-volatile components to the solvent (test) | 14,8 ± 0,34*** | 0,172 ± 0,014*** | – | – |

*Author's development*

The result of a decrease in the activity level of radionuclides and the concentration of heavy metals in the wax is the washout of soluble non-volatile components from the wax raw material such as perg, honey, non-pereduratic remnants of larval food, some of which contain a certain amount of these harmful substances. Further washing of non-volatile components from wax raw materials led to a slight decrease in the activity of radionuclides and the concentration of heavy metals in the wax produced. Thus, the most effective was the washing of non-volatile components from the wax raw material before the suspension of their transition into the solvent.

When washing out not wax components from wax raw materials it is recommended to use cold or warm water. Taking into account the temperature effect of dissolution of substances, we assumed that the temperature of water in the maturation of not wax components from the wax raw material may to some extent influence the intensity of removal of these components from it, as well as the amount of transition to the wax of radionuclides and heavy metals. On this basis, relevant studies were carried out, the results of which are given in Table. 3

The analysis of the data showed that at the temperature of water + 20°C, which was used for dipping the wax raw material, from the latter was converted into wax cesium-137 and strontium-90, lead and cadmium, respectively (%): 1.16 and 0.8; 24.3 and 1.97; at water temperature + 40°C – 1,08 and 0,6; 18.1 and 1.3, and at the

temperature of water + 60ºC the transition was 0.9 and 0.5; 13.4 and 1.05.

When treating wax raw materials at + 40ºC, the activity of cesium-137 and strontium-90 and the concentration of lead and cadmium in wax were 7.0% and 17.2% respectively, and 25.5% and 33.4% lower, respectively. and as the water temperature rises to + 60ºC, the harmful substances in the wax decreased – by 18.7 and 31.5%; 44,7 and 46,7% in comparison with similar indicators of wax, the raw material of which was treated with water at a temperature of + 20ºC.

**Table 3**

**Influence of temperature of the water during sucking of wax raw material on the accumulation of radionuclides and heavy metals in wax** (n = 3, M ± m)

| Explored material | Radionuclides, Bq/kg | | Heavy metals,mg/kg | |
|---|---|---|---|---|
| | $^{137}$Cs | $^{90}$Sr | Pb | Cd |
| Wax raw material (control) | 1991± 4,38 | 43,30± 0,46 | 0,728± 0,007 | 0,152± 0,003 |
| Wax obtained from wax raw materials for a one-time replacement of water: за t° +20 °C (experiment) | 23,1± 0,45*** | 0,35± 0,01*** | 0,177± 0,012*** | 0,030± 0,0009*** |
| за t° +40 °C (experiment) | 21,5± 0,43*** | 0,29± 0,005*** | 0,132± 0,006 | 0,020± 0*** |
| за t° +60 °C (experiment) | 18,8± 0,35*** | 0,24± 0,005*** | 0,098± 0,008** | 0,016± 0,001*** |

*Author's development*

Taking into account the results of the research, we found that the air temperature during waxing also somewhat influenced the activity of radionuclides and the concentration of heavy metals in it (Table 4).

**Table 4**

**Influence of air temperature during wax resistance on cesium-137 activity (Bq/kg) and concentration of lead and cadmium (mg/kg) (n = 3, M ± m)**

| The temperature of the air when defending, °C | To stand up | | | After defending | | |
|---|---|---|---|---|---|---|
| | Pb | Cd | $^{137}$Cs | Pb | Cd | $^{137}$Cs |
| +20 | 0,078± 0,0008 | 0,011± 0,0008 | 0,82± 0,01 | 0,071± 0,02* | 0,0093± 0,0003 | 0,74± 0,01 |
| +45 | 0,078± 0,0008 | 0,011± 0,0008 | 0,82± 0,01 | 0,062± 0,001*** | 0,0083± 0,0003* | 0,66± 0,01*** |

*Author's development*

Thus, at an air temperature of + 20ºC, the concentration of lead and cadmium and cesium-137 after wax defending decreased by 9.0 (P <0.5) and 15.5% (P <0.1) and 9.8% (P <0,01), whereas at the temperature of + 45ºC these indicators were significantly higher – by 20,6 (P <0,001) and 24,6% (P <0,5) and 19,6% (P <0.001). Consequently, when defending wax at a temperature of + 45ºC, the content of harmful substances in it (lead, cadmium, and cesium-137) was lower (by 11.6 pp, 9.1

and 9.8 pp) compared with that which defended at temperature + 20°C. That is, an increase in the temperature of air while defending wax contributed to a decrease in the concentration of heavy metals and radionuclides in it.

As a result of studies on the effectiveness of the use of processing methods of wax raw materials, a positive result was obtained from its dry processing. Thus, in dry wax, the concentration of cesium-137 decreased by 28.3% ($P < 0.001$), lead by 23.7% ($P < 0.05$) and cadmium by 23.1% ($P < 0.01$) compared to wet (Table 5).

**Table 5**

**Influence of various methods of processing wax raw materials on the activity of cesium-137 and the concentration of heavy metals in wax** (n = 3, M ± m)

| Investigating material, place of sampling | $^{137}$Cs, Бк/кг | Heavy metals, mg/kg | |
|---|---|---|---|
| | | Pb | Cd |
| Wax raw material harvested on the territory of Northern Polissya | 2867,0±13,7 | 1,390±0,026 | 0,093±0,0017 |
| Wax produced by a wet process of processing of wax raw materials – North Polissya (control) | 25,80±0,69 | 0,190±0,005 | 0,013±0,0005 |
| Wax produced by a dry process of processing of wax raw materials – North Polissya (experiment) | 18,50±0,32*** | 0,145±0,003** | 0,010±0,0005* |

*Author's development*

**Conclusions.** As a result of the conducted researches, optimal technologies of processing wax raw materials contaminated with radionuclides and heavy metals have been discovered, which makes it possible to obtain wax with the lowest concentration of $^{137}$Cs, $^{90}$Sr, Pb and Cd:

- washings from wax raw materials of non-volatile components before the suspension of their transition into a solvent;
- washings from the wax raw material of non-volatile components per solvent t 60°C;
- defending wax for t 40°C;
- processing of wax raw materials in a dry manner.

Literature

1. Razanov S.F., Nedashkivsky V.M., Razanov O.S. Fundamentals of beekeeping production technology. Ltd. Nilan LTD, 2018. 196 p.

2. Razanov S.F. Influence of duration of use and appointment of honeycombs on concentration of cesium-137 in honey / «Current problems of intensive development of animal husbandry». Bitter. Belarus. 2009. P. 117-122.

3. Razanov S.F. Content of radionuclides and heavy metals in beekeeping products // Agroecological journal №1. 2009. P. 9-11.

4. Experimental Substantiation and Parameterization of the Model Describing $^{137}$Cs and $^{90}$Sr Behavior in a Soil-Plant System / [B.S. Prister, V.G. Baryakhtar, L.V. Perepetyatnikova at all.] // Environmental Science and Pollution Research.

2003. Special Issue N 1. P. 126 – 136.

5. Ezaki T. Analysis for threshold levels of cadmium in urine that induce tubular dysfunction among women in non-polluted areas in Japan / [T. Ezaki, T. Tsukahara, J. Moriguchi et al.] // Arch Occup Environ Health. 2003. Vol. 76(3). P. 197–204.

6. Hoppe R. T. Effects of irradiation on the human immune system / R. T. Hoppe // Radiat. Tolerance Norm. Tissue: 23-rd Annu. San. Francisco Cancer Symp. 1989. P. 140–149.

7. Karavoltsos S. Cadmium and Lead in Organically Produced Foodstuffs from Greek Market / S. Karavoltsos, A. Sakellari, M. Dassenakis, M. Scoullos // Food Chemistry. 2008. Vol. 106, Is. 2. P. 843–851.

8. Ling W. Use of bentonite to control the release of copper from contaminated soils /W. Ling, Q.Shen, Y.Gao, X.Gu, Z. Yang // Australian Journal of Soil Research. – Vol.45. – No. 8. – 2007. – P. 618–623.

9. Mamikhin S. V. Dynamics of Cs-137 in the forest of 30-km zone around the Chernobyl nuclear power station //Seminar on the dynamic behavior of radionuclides in forest / S. V. Mamikhin, A. I. Shcheglov //. Stockholm, May 18–22/ 1992. Stockholm. 1992. – P. 10.

10. Michel R. 20 years after Chernobyl: Radiation exposure in the highly contaminated regions / R. Michel // Experience of overcoming the consequences of the Chornobyl disaster in agriculture and forestry - 20 years after the Chernobyl disaster: Coll. ext. participants of the fifth between the b. of sciences. conference May 18-20, 2006 Zhytomyr. 2006. pp. 64–69.

11. Mmolawa K. B. Assessment of heavy metal pollution in soils along major roadside areas in Botswana /K. B. Mmolawa, A. S. Likuku, G. K. Gaboutloeloe // African Journal of environmental science and technology.–Vol.5(3). 2011.P.186–196.

12. Perugini M. Heavy Metal (Hg, Cr, Cd, and Pb) Contamination in Urban Areas and Wildlife Reserves: Honeybees as Bioindicators [Електронний ресурс] / M. Perugini, M. Manera, L. Grotta et al. // Biol Trace Elem Res. 2010: http://www.ncbi.nlm.nih.gov/pubmed/20393811.

13. Rhind S. M. Effects of Environmental Pollutants on the Reproduction and Welfare of Ruminants / S. M. Rhind, N. P. Evans, M. Bellingham et al. // Animal. 2010. Vol. 4, No. 7. P. 1227–1239.

14. Rosen K. Field studies the behavior of radiocaesium in agricultural environments after the Chernobyl accident. Dissertation. Uppsala, Sweden, 1996. 40 p. (Swedish University of Agricultural Sciences).

15. Sources and effects of ionizing radiation // UNSCEAR 2000 Report to the General Assembly, with Scientific Annexes. V.1 Sources. 2000. New York.: United Nations. P. 10–9.

16. Territory contamination with the radionuclides representing the fuel component of Chernobyl fallout / [V.A. Kashparov, S. M. Lundin, S. I. Zvarich at all.] // The Science of The Total Environment. 2003. V. 317, Iss. 1–3. P. 105–119.

17. Environmental safety of Vinnytsia region: monograph / For the head. ed. Alexander Mudrak. Vinnytsia: OJSC «City Printing House», 2008. 456 p.

Стаття відправлена: 15.04.2020 р.

© Мудрак О.В.

Scientific publication

*Международный периодический рецензируемый научный журнал*
*International periodic scientific journal*

# Almanahul SWorld

**Issue №4**
April 2020

*На украинском, русском и английском языках*

Входит в международные наукометрические базы (высокий импактфактор):
**INDEXCOPERNICUS**

*Научные достижения Авторов были также представлены для открытого обсуждения на международной научной конференции «PERSPECTIVE SCIENTIFIC TRENDS '2020» (с 21 по 22 апреля 2020 г.)*
*Решением международной научной конференции работы, которые получили положительную оценку, были рекомендованы к изданию в журнале.*

**With the support of research project SWorld**
**www.sworld.education**

***www.sworld.education***

Signed: 25.05.2020

*SWorld*
*совместно с*
*Бельцкий Государственный Университет «Алеку Руссо»*
*Moldova*

*The publisher is not responsible for the reliability of the information and scientific results presented in the articles*

ISSN 2415-7538
9 772415 753802 40001