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***Abstract***

*The article suggests the model of sensory control of quality at food enterprises. The programme of continuous monitoring of sensory characteristics at a food enterprise is designed on the basis of developed appropriate criteria. In quantitative descriptive tests, the properties of sensory quality are identified using conventional scales.*

*In sensory programme the consumer evaluation is used to specify whether the preferences have changed in respect with the food production.*

*The personnel responsible for the execution of the programme of sensory control of quality include the tasting committee, which evaluate submitted samples and the sensory group, which provides the sampling, preparation and tastings, statistical processing, analysis and interpretation of results, preparation of recommendations for the administration of the enterprise.*

*The identification of raw materials is carried out for selected products, which are tested on parametric characteristics, changeability over the life cycle, as well as a synergistic effect on the final product.*

***Keywords:*** *food enterprises, sensory tests, target consumer, control of sensory characteristics, technological process.*

***Досліджено вміст нітратів, радіонуклідів, солей важких металів в різних ботанічних сортах картоплі, буряку столового, томатів, цибулі ріпчастої, моркви, гарбуза. Отримані дані дають підставу констатувати наявність видової та сортової специфічності рівня накопичення токсикантів***

***Ключові слова: токсичні речовини, картопля, буряк столовий, томати, цибуля ріпчаста, морква, гарбуз***

***Исследовано содержание нитратов, радионуклидов, солей тяжелых металлов в разных ботанических сортах картофеля, столовой свеклы, томатов, лука репчатого, моркови, тыквы. Полученные данные дают основание констатировать наличие видовой и сортовой специфичности уровня накопления токсикантов***

***Ключевые слова: токсические вещества, картофель, свекла столовая, томаты, лук репчатый, морковь, тыква***

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# MONITORING OF THE CONTENT OF TOXIC SUBSTANCES IN DIFFERENT VEGETABLES WIDEN IN UKRAINE

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## Problem definition

The problem of negative influence of harmful substances on human health in modern life activity is becoming very timely. The reasons of its sharpening include intense industrial development, chemicalization of agriculture, and negative indirect consequences of the development of civilization.

The basis for qualitative estimation of vegetable products is their chemical composition (the content of carbohydrates, proteins, fats, vitamins, minerals, etc.). Much attention is paid at the exponents which the products' appearance depend on (size, color, shape). Even the widest and the deepest analysis of organic compounds, which is the part of the plants, doesn't allow make a conclusion on their hygienic quality.

At present, quality characteristics should include safety indicators of vegetable products because besides the compounds with high nutritive value the plant can contain harmful substances. They include: first, the so-called natural toxicants peculiar for the certain type of the product, which can cause toxic effect; secondly, "contaminants" – toxic substances entering into food from the environment in the result of damaging the process of growth, production or storage of products. The most widely spread toxicants are the representatives of the other group including nitrates, salts of heavy metals, radionuclides.

MPC (Maximum Permissible Concentration) in food products are established for the main types of toxic substances. Under insufficient control of their content and absence of material incentives for the manufacturers of wholefood, there is the risk of using polluted raw materials. That is why it is necessary to possess true information about the toxic effect and regularity of toxic substances entering the plant raw materials.

## Analysis of recent researches and publications.

Toxic substances under investigation are placed into the interstitial water in the ionic form and are absorbed by the root system according to the peculiarities of the plants' mineral nutrition, i.e. ion transport. The process of mineral nutrition isn't principally different, and includes ions absorption, their radial transportation by roots, xylem loading, and transportation by it to the aboveground organs [1 – 4].

Under general regularities of mineral nutrition, the plants possess its specific peculiarities determinated genetically, i.e. they are determined by the genetic discrepancies between the sorts of the same plant or between different types. These discrepancies become apparent in different structure of the root system, different general adsorbing root surface, and different types and intensity of metabolic processes. These factors greatly determine the quality and speed of absorption and ion transportation.

## The object and tasks of the article

The object of the article is to investigate the content of toxicants in vegetables depending on their spatial and varietal specifics. The objects of the research are botanical sorts of vegetables widen in Ukraine and grown in Kharkiv area in the conditions of raw-material zones of the Institute vegetable farming and melon cultivation of the Ukrainian academy of agrarian sciences. Running samples of the botanical sorts of vegetables were made in the field during the harvest. They correspond to the requirements of the existing standards. Investigations were held during 14 years. Botanical sorts of beetroots, potatoes, carrots, tomatoes and pumpkins were investigated.

The subject of the research is to study the average content of such toxicants as nitrates and radionuclides – caesium and strontium; salts of heavy metals – cadmium, lead, copper, and zinc – in the vegetables' sorts.

Weight fraction of toxic elements is determined by standard methods: probes preparation, mineralization – by the GOST 26929 – 94 [7], the amount of cadmium, lead, copper, and zinc - by the GOST 30178 – 96 [8]. The amount of radionuclides was determined at the universal spectrometric complex "GAMMA PLUS" [9]. Determination of the specific gravity of caesium-137 was made by the spectrum of γ-radiation (γ-spectrometric tract), and stroncium-90 by β-radiation (β-spectrometric tract), with the following treatment at personal electronic computer [10, 11]. The amount of nitrates was determined by photometric method [12].

## Statement of basic material of the investigation

Results of investigating the amount of toxic substances are presented in tables 1-6. Table 1 presents average amount of toxic substances in beetroots of 12 botanical sorts. Data analysis affirms sizeable fluctuation of the amount of nitrates in different botanical sorts of beetroots. The received amounts exceed permissible concentrations. Only the sorts Skvirsky dar, Bordo 237, Detroit-2-nero RS, Zmina and Delikatesnyi accumulate smaller amount of nitrates. According to the data in table 1, specific gravity of radionuclides $^{137}Cs$ and $^{90}Sr$ in the investigated samples doesn't exceed state hygienic standards. The amount of caesium fluctuates from 3,3 Bq per kilo (sorts Bordo Kharkivskyi and Mistsevyi 26-5) to 5,5 Bq per kilo (sort Egavo). The received data demonstrate that botanical sorts of beetroot accumulate radioactive strontium in the following sequence: Detroit-2-nero RS > Egavo > Libero > Zmina > Diy > Bordo 237 > Delikatesnyi > Bagryanyi> > odnorostkova > Mistsevyi 26-5, Bordo Kharkivskyi > Skvirskyi dar. The amount of cadmium salts I the samples fluctuates from 0,01 to 0,034 mg/kg. The amount cadmium salts in Egavo beetroot (0,034 mg/kg), Odnorostkova (0,033 mg/kg), Diy (0,033 mg/kg), Zmina (0,032 mg/kg) and Libero (0,031 mg/kg) exceeds MPC. Accumulation of the salts of zinc, copper and lead doesn't exceed MPC level in the samples. Zinc salts in the beetroot samples accumulates from 0,5 to 1,6 mg/kg, copper salts in the investigated samples fluctuate from 2,6 to 4,9 mg/kg, lead salts fluctuate from 0,13 to 0,33 mg/kg. On the basis of the investigations held it is possible to state that the sorts of beetroot Skvirskyi dar, Bordo 237, Detroit-2-nero RS and Delikatesnyi are ecologically safe.

The amount of toxic substances in botanical sorts of potatoes is presented in tab. 2.

We revealead great fluctuations of nitrates in botanical sorts of fresh potatoes. The investigated samples of potatoes by the nitrates accumulation level are placed in the following order: Povin'>Radych>Polyana>Slovyanka>Serpanok>Lugovska> > Dnipryanka > Fantazia > Yavir > Lileya. The investigations lead to the conclusion that sorts Lileya, Yavir, Fantazia and Dnipryanka possess the reduced ability to accumulate nitrates. The amount of nitrates in the samples Lugovska, Serpanok, Polyana, Radych, Povin' exceeds MPC 1,4 ... 5,0 times.

Volume activity of radionuclides in all investigated samples of potatoes does not exceed state hygienic standards. Maximum absorption of radionuclides is observed in botanical sorts of potatoes Povin' (18,51 Bq/kg $^{137}Cs$) and Yavir (3,42 Bq/kg $^{90}Sr$).

Experimental data demonstrate that the amount of cadmium exceeds MPC level in all investigated sorts of potatoes except the sorts Yavir and Lileya. According to the results of analyses, the amount of lead in potatoes depending on the sort fluctuates from 0,099 mg/kg (Lileya) to 0,535 mg/kg (Fantasia). It is determined that most of the analyzed sorts except Polyana (0,517 mg/kg) and Fantasia (0,535 mg/kg) do not exceed MPC level by lead. The received data on the amount of zinc and copper in potatoes fluctuate

within 4,79...5,09 mg/kg and 3,51...4,12 mg/kg, i.e. they do not exceed MPC levels. It means that potatoes of these sorts are able to survive and are not harmful for the human organism.

The amount of toxic substances in different sorts of pumpkin is investigated (tab. 3).

Data in the table affirm that the amount of nitrates fluctuates in different botanical sorts of pumpkin: from 163 mg/kg (Slavuta sort) to 630 mg/kg (sort Ukrains'kyi bagatoplidnyi). Most of the investigated sorts exceed the allowed meanings of the nitrates concentration, only sorts Slavuta and Arabatskyi possess reduced ability to accumulate nitrates. Maximum absorption of radionuclides is observed in Ukrainskya bagatoplidnya pumpkin (24,0 Bq/kg $^{137}$Cs and 14,7 Bq/kg $^{90}$Sr), and minimum – in the sorts Slavuta (10,3 Bq/kg $^{137}$Cs) and Arabatskyi (6,4 Bq/kg $^{90}$Sr). Thus, the amount of radionuclides in all investigated samples of pumpkin do not exceed state standards. The differences by the level of accumulating salts of heavy metals in fruits are characteristic for botanical sorts of pumpkin. Nevertheless, the following order of heavy metals by level of accumulation of heavy metals is common for the investigated samples: zinc > > copper > lead > cadmium. Experimental data demonstrate that the amount of the salts of cadmium, copper, and zinc do not exceed boundary permissible amounts. The amount of copper is about 1,6...3,7 mg/kg, zinc – 4,6...8,4 mg/kg, cadmium – 0,009...0,019 mg/kg. It is necessary to note that the amount of lead salts in the fruits of Chudovyi (0,84 mg/kg) sort exceeds MPC level. Arabatskiy and Slavuta botanical sorts of pumpkin are the ones recommended for intake and processing.

**Table 1**

The amount of toxic substances in different botanical sorts of beetroot

| Botanical sort | Name | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nitrates, mg/kg | Radionuclides, Bq/kg | | Salts of heavy metals, mg/kg | | | |
| | | $^{137}$Cs | $^{90}$Sr | zinc | cadmium | lead | copper |
| Diy | 2145,5 | 4,5 | 3,6 | 0,98 | 0,033 | 0,23 | 2,9 |
| Bordo Kharkivskyi | 1606,0 | 3,3 | 2,8 | 1,6 | 0,010 | 0,23 | 3,1 |
| Skvirskyi dar | 1360,3 | 3,9 | 1,3 | 1,14 | 0,022 | 0,22 | 3,5 |
| Bordo 237 | 1179 | 4,6 | 3,5 | 1,36 | 0,021 | 0,25 | 4,9 |
| Odnorostkova | 1525 | 4,7 | 3,0 | 0,69 | 0,033 | 0,13 | 4,7 |
| Egavo | 1711,2 | 5,5 | 3,9 | 0,52 | 0,034 | 0,13 | 3,9 |
| Libero | 1634,8 | 4,2 | 3,8 | 0,94 | 0,031 | 0,19 | 2,6 |
| Detroit-2- nero RS | 1217,2 | 5,3 | 4,1 | 0,50 | 0,020 | 0,30 | 3,8 |
| Mistsevyi 26-5 | 1503,5 | 3,3 | 2,8 | 1,14 | 0,022 | 0,23 | 2,7 |
| Bagryanyi | 2701 | 5,3 | 3,1 | 1,09 | 0,019 | 0,33 | 4,2 |
| Zmina | 1245 | 5,4 | 3,7 | 1,18 | 0,032 | 0,20 | 4,8 |
| Delikatesnyi | 1184 | 4,9 | 3,4 | 1,53 | 0,030 | 0,21 | 4,1 |
| MPC | 1400,0 | 40,0 | 20,0 | 10,0 | 0,03 | 0,5 | 5,0 |

**Table 2**

The amount of toxic substances in different botanical sorts of potatoes

| Botanical sort | Name | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nitrates, mg/kg | Radionuclides, Bq/kg | | Salts of heavy metals, mg/kg | | | |
| | | $^{137}$Cs | $^{90}$Sr | zinc | cadmium | lead | copper |
| Povin' | 596,1 | 18,51 | 1,4 | 4,2 | 0,031 | 0,35 | 3,5 |
| Polyana | 442,5 | 13,57 | 2,1 | 4,4 | 0,035 | 0,51 | 4,0 |
| Dnipryanka | 114,1 | 10,95 | 3,3 | 4,6 | 0,039 | 0,41 | 3,4 |
| Lugovs'ka | 172,0 | 17,3 | 1,17 | 4,6 | 0,038 | 0,15 | 3,6 |
| Serpanok | 221,4 | 10,5 | 0,9 | 4,8 | 0,044 | 0,30 | 3,4 |
| Slovyanka | 377,8 | 13,1 | 1,0 | 4,6 | 0,055 | 0,49 | 3,4 |
| Radych | 570,3 | 14,9 | 1,77 | 4,6 | 0,038 | 0,40 | 3,4 |
| Yavir | 64,2 | 6,85 | 3,42 | 4,3 | 0,027 | 0,10 | 3,4 |
| Lileya | 61,2 | 12,6 | 1,4 | 4,2 | 0,026 | 0,09 | 3,4 |
| Fantasia | 109,5 | 10,37 | 0,8 | 5,0 | 0,043 | 0,53 | 4,0 |
| MPC | 120,0 | 40,0 | 20,0 | 10,0 | 0,03 | 0,5 | 5,0 |

Results of the investigations on the content of toxic substances in carrots are shown in table 4.

We revealead sufficient fluctuations of the nitrates amount in botanical sorts of carrots. Sorts Shantene Skvirska, Veresneva, Olimpus accumulate nitrates 2,5...3 times less than the most widely spread sort in Ukraine - Nantska Kharkivska. Only this sort of carrots exceeds MPC. The Olenka sort is characterized by maximum accumulation of radiocesium (29,0 Bq/kg), while minimum accumulation is observed in Veresneva sort (10,5 Bq/kg). By the level of accumulating radiostrontium botanical sorts of carrots are ranged the following way: Nantska Kharkivska > Darunok $F_1$ > Ranok $F_1$ > Krymchanka > Olimpus > Shantane Skvirska > Chumak $F_1$> >Olenka, Veresneva > Yaskrava. But it is worth noting that specific activity of radionuclides in all samples under investigation does not exceed state hygienic standards. The content of cadmium in all samples under investigation except sorts Olenka, Veresneva, darunok $F_1$, Ranok $F_1$ exceeds MPC level 1,75...4,5 times. Results of the analyses demonstrated that content of lead in carrots change insufficiently depending on the sort: from 0,021 mg/kg (Veresneva sort) to 0,068 mg/kg (Ranok $F_1$ sort). It is determined that the analyzed sorts of carrots do not exceed MPC level.

The amount of copper salts fluctuate from 0,32 to 0,9 mg/kg (which doesn't exceed MPC level) depending on the sort. The amount of zinc salts ranges within 2,51...7,07 mg/kg, which also doesn't exceed MPC level. The results of the investigation concerning the content of toxic substances in tomatoes are presented in tab. 5.

**Table 3**

The amount of toxic substances in botanical sorts of pumpkin

| Botanical sort | Name | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nitrates, mg/kg | Radionuclides, Bq/kg | | Salts of heavy metals, mg/kg | | | |
| | | $^{137}$Cs | $^{90}$Sr | zinc | cadmium | lead | copper |
| Arbats'kyi | 185,0 | 15,0 | 6,4 | 8,401 | 0,010 | 0,350 | 1,901 |
| Slavuta | 163,0 | 10,3 | 8,0 | 6,203 | 0,019 | 0,410 | 3,602 |
| Ukrains'kyi bagatoplidnyi | 630,0 | 24,0 | 14,7 | 4,800 | 0,009 | 0,330 | 1,709 |
| Zhdana | 265,0 | 10,7 | 7,5 | 5,230 | 0,015 | 0,48 | 2,240 |
| Chudovyi | 400,0 | 18,7 | 9,8 | 8,100 | 0,017 | 0,840 | 2,450 |
| Stolovyi Zymovyi | 217,0 | 12,5 | 10,5 | 6,870 | 0,019 | 0,390 | 3,740 |
| Marmurovyi | 292,0 | 14,8 | 11,8 | 8,230 | 0,012 | 0,360 | 1,896 |
| Khersons'kyi | 387,5 | 14,5 | 8,5 | 5,480 | 0,012 | 0,380 | 2,260 |
| Hutoryanka | 387,0 | 17,5 | 6,8 | 4,600 | 0,014 | 0,370 | 1,655 |
| MPC | 200,0 | 40,0 | 20,0 | 10,0 | 0,03 | 0,5 | 5,0 |

**Table 4**

The amount of toxic substances in botanical sorts of carrots

| Botanical sort | Name | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nitrates, mg/kg | Radionuclides, Bq/kg | | Salts of heavy metals, mg/kg | | | |
| | | $^{137}$Cs | $^{90}$Sr | zinc | cadmium | lead | copper |
| Shantene Skvirska | 96,0 | 12,5 | 9,5 | 4,90 | 0,09 | 0,03 | 0,35 |
| Yaskrava | 217,0 | 18,0 | 6,1 | 6,05 | 0,058 | 0,061 | 0,67 |
| Olenka | 129,0 | 29,0 | 8,2 | 7,07 | 0,029 | 0,049 | 0,90 |
| Veresneva | 79,4 | 10,5 | 8,2 | 2,51 | 0,023 | 0,021 | 0,32 |
| Nantska Kharkivska | 292,0 | 19,1 | 15,0 | 4,08 | 0,075 | 0,042 | 0,41 |
| Olimpus | 100,0 | 14,0 | 10,0 | 6,10 | 0,066 | 0,051 | 0,52 |
| Darunok $F_1$ | 105,0 | 17,0 | 12,0 | 5,31 | 0,025 | 0,047 | 0,68 |
| Krymchanka | 120,0 | 15,0 | 10,5 | 5,90 | 0,060 | 0,062 | 0,55 |
| Chumak $F_1$ | 205,0 | 12,0 | 9,0 | 5,80 | 0,091 | 0,055 | 0,64 |
| Ranok $F_1$ | 120,0 | 18,0 | 11,5 | 4,40 | 0,028 | 0,068 | 0,57 |
| MPC | 250,0 | 40 | 20 | 10,0 | 0,03 | 0,5 | 5,0 |

**Table 5**

The amount of toxic substances in botanical sorts of tomatoes

| Botanical sort | Name | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nitrates, mg/kg | Radionuclides, Bq/kg | | Salts of heavy metals, mg/kg | | | |
| | | $^{137}$Cs | $^{90}$Sr | zinc | cadmium | lead | copper |
| Amiko | 10,2 | 3,8 | 2,2 | 0,5 | 0,02 | 0,09 | 1,2 |
| Atlasniy | 8,9 | 3,3 | 2,7 | 0,9 | 0,03 | 0,09 | 0,9 |
| Boyan | 13,7 | 2,9 | 2,6 | 0,6 | 0,03 | 0,12 | 0,7 |
| Iryshka | 18,0 | 3,1 | 2,0 | 0,4 | 0,01 | 0,09 | 0,7 |
| Karas' | 16,5 | 3,9 | 2,8 | 0,7 | 0,02 | 0,10 | 0,9 |
| Lagorange | 32,8 | 3,1 | 2,1 | 0,7 | 0,02 | 0,12 | 0,4 |
| Syayvo | 12,2 | 2,7 | 2,6 | 0,8 | 0,02 | 0,11 | 0,9 |
| Zoreslav | 11,4 | 3,6 | 2,7 | 1,1 | 0,02 | 0,10 | 1,4 |
| Flora | 24,4 | 3,3 | 2,5 | 0,8 | 0,02 | 0,13 | 0,5 |
| Chayka | 14,7 | 3,4 | 2,9 | 1,2 | 0,03 | 0,14 | 2,6 |
| $F_4$ (Gerkules* dark Green) | 14,7 | 2,5 | 2,3 | 1,4 | 0,03 | 0,13 | 3,1 |
| RI 74-43 | 7,7 | 2,9 | 2,3 | 1,3 | 0,02 | 0,14 | 1,2 |
| Marioka 20 | 11,7 | 3,1 | 2,4 | 1,1 | 0,02 | 0,16 | 1,1 |
| Long-Keeper | 13,7 | 3,3 | 2,3 | 1,8 | 0,025 | 0,11 | 0,8 |
| CLN 2116B | 10,4 | 4,2 | 2,7 | 0,9 | 0,02 | 0,11 | 1,5 |
| Maestro | 10,4 | 4,0 | 3,1 | 1,2 | 0,02 | 0,15 | 1,3 |
| Malynove Vikante | 10,6 | 2,4 | 2,0 | 0,6 | 0,02 | 0,08 | 0,4 |
| Klondike | 23,2 | 3,8 | 2,0 | 0,7 | 0,02 | 0,11 | 0,4 |
| Myt' | 9,7 | 3,1 | 2,7 | 1,8 | 0,03 | 0,14 | 1,2 |
| Lagidniy | 10,2 | 2,5 | 2,4 | 0,5 | 0,02 | 0,10 | 0,6 |
| Lyubymiy | 9,7 | 3,1 | 2,8 | 0,4 | 0,01 | 0,10 | 4,2 |
| Gospodar | 18,1 | 3,2 | 2,8 | 0,6 | 0,04 | 0,08 | 0,8 |
| Iskorka | 8,3 | 4,5 | 2,5 | 1,2 | 0,04 | 0,12 | 2,0 |
| Kremenchutskiy | 27,3 | 2,3 | 2,3 | 0,7 | 0,015 | 0,11 | 0,4 |
| MPC | 150,0 | 40 | 20 | 10 | 0,03 | 0,5 | 5,0 |

**Table 6**

**The amount of toxic substances in botanical sorts of onion**

| Botanical sort | Name | | | | | | |
|---|---|---|---|---|---|---|---|
| | Nitrates, mg/kg | Radionuclides, Bq/kg | | Salts of heavy metals, mg/kg | | | |
| | | $^{137}Cs$ | $^{90}Sr$ | zinc | cadmium | lead | copper |
| Globus | 0,78 | 2,4 | 1,4 | 3,1 | 0,08 | 0,41 | 1,8 |
| Veselka | 9,82 | 3,2 | 1,6 | 3,1 | 0,06 | 0,35 | 2,1 |
| Mavka | 5,40 | 5,1 | 1,7 | 3,8 | 0,05 | 0,44 | 2,7 |
| Lyubchik | 31,06 | 2,3 | 1,3 | 3,2 | 0,08 | 0,42 | 1,2 |
| Amfora | 9,60 | 3,9 | 1,3 | 3,5 | 0,029 | 0,45 | 1,3 |
| Kharkivska 82 | 5,40 | 7,6 | 1,9 | 3,4 | 0,07 | 0,45 | 2,0 |
| Tkachenivska | 4,92 | 2,7 | 1,9 | 3,3 | 0,08 | 0,43 | 1,9 |
| Bilyanka | 20,31 | 2,6 | 2,2 | 2,5 | 0,06 | 0,34 | 1,4 |
| Zolotista | 12,95 | 4,3 | 1,7 | 3,4 | 0,08 | 0,44 | 2,1 |
| Yaltinskiy rubin | 5,25 | 3,1 | 2,2 | 2,8 | 0,03 | 0,37 | 1,6 |
| Sterling $F_1$ | 49,22 | 2,9 | 1,2 | 3,6 | 0,04 | 0,46 | 1,8 |
| MPC | 80 | 40 | 20 | 10 | 0,03 | 0,5 | 5,0 |

We observed small fluctuations of the nitrates content in some botanical sorts of tomatoes: from 7,7 to 32,8 mg/kg. The investigations we carried out allowed us make a conclusion that tomatoes have decreased ability to accumulate nitrates because MPC equals 150 mg/kg. Based on the experimental data it is possible to say amount of cesium radio isotopes fluctuates from 2,3 to 4,5 Bq/kg, strontium – from 2,0 to 3,1 Bq/kg that doesn't exceed MPC level (40 Bq/kg and 20 Bq/kg respectively). Cadmium content in two investigated botanical sorts Gospodar and Iskorka equals 0,04 mg/kg that exceeds MPC level 1,25 times. The highest content of zinc is found in the sorts Myt' and Long-Keeper, the smallest (0,4 mg/kg) is in the sorts Lyubymiy and Iryshka. The amount of copper salts ranges between 0,4 to 4,2 mg/kg. *All analyzed tomato sorts do not exceed* MPC level by zinc and copper. All the investigated samples contain lead from 0,08 mg/kg (Malynove Vikante, Gospodar) to 0,16 mg/kg (Marioka 20). During the investigations and analysis of the received data it was revealead that this vegetable is characterized by the decreased ability to accumulate contaminants.

The investigation proves that in all sorts of onions the amount of nitrates doesn't exceed MPC. The largest amount of nitrates is in the Sterling$_1$ – 49,2 mg/kg, the smallest – sorts Globus, Tkachenivsk, Yaltinskiy Rubin, Mavka and Kharkivskiy 82 (0,78...5,40 mg/kg).

The amount of $^{137}Cs$ fluctuates within 2,3...7,6 Bq/kg, the amount of $^{90}Sr$ – in the range 1,2...2,2 Bq/kg. All results of the investigated samples of onion by the amount of radionuclides are within normative limits. Cadmium content exceeds MPC level in all the investigated sorts of onions except sorts Amfora and Yaltinsky rubin. Maximum content is characteristic for botanical sorts Lyubchik, Globus, Tkachenivska and Zolotysta (0,08 mg/kg). According to the results of the investigations the amount of lead salts in onions fluctuates in the range from 0,34 (Bilyanka) to 0,46 mg/kg (Sterling $F_1$). It is determined that the investigated samples of botanical sorts of onions do not exceed MPC level by the amount of lead salts.

The received value of zinc salts and copper in the investigated samples of onion do not vary greatly and are found within 2,5...3,8 mg/kg respectively, i.e. they do not exceed MPC level. The biggest amount of zinc and copper salts is found in Mavka sort. It is worth noting that sorts of onion are characterized by the increased ability to accumulate cadmium salts.

## Conclusions

The received data give ground stating availability of spatial and varietal specifics of the level of toxicants accumulation. According to the results, the plants are placed in the following range by the level of accumulating nitrates in productive organs: tomatoes < onions < carrots < <pumpkins < potatoes < beetroots.

Selective relationship of plants is maintained to the full and during the absorption of radioactive substances from the ambient medium. Under similar conditions of growth, the investigated kinds of vegetables differ 1,3-8,7 times by the amount of caesium, and 1,3-8,8 times by the amount of strontium. Also we can denote both spatial and varietal differences by the rate of radioactive isotopes strontium and caesium accumulation. Thus, for example, interspatial difference achieves by the content of caesium 2,4 times and strontium 2,5 times in carrots. On the basis of experimental data we can make a conclusion that all samples of vegetables under investigation accumulate more caesium than strontium. It is connected with the fact that strontium is closer to calcium by its chemical properties, and caesium is closer to potassium. Behavior of chemical elements–analogues possesses definite similarity during their transmission from soil to the plants. Investigated vegetables contain more potassium that is why they absorb caesium in the increased amounts. Nevertheless, it is worth noting that specific activities of radionuclides in all investigated samples do not exceed state hygienic standards.

As in the case with nitrates and radionuclides, various sorts of vegetables sharply differ according to the ability of accumulating salts of heavy metals. Thus, zinc concentration in different botanical sorts of carrots comprises from 3 to 7 mg/kg, pumpkin – from 4,5 to 8,5 mg/kg, etc. The differences by the level of accumulating in vegetables are characteristic for other salts of heavy metals. Nevertheless, the fact that heavy metals can be placed in the following order: zinc > copper > lead > cadmium, is common for the investigated samples. Experimental data demonstrate that content of cadmium – one of highly toxic metals – exceed MPC in all investigated samples of carrots, onions, and most sorts of potatoes and tomatoes.

Represented data demonstrate that it is necessary to select vegetables of the sorts with smaller ability of accumulating toxicants. The correct selection of vegetables and their sorts will allow reduce the level of toxic substances providing nutritive harmlessness and high quality of ready products.

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***Abstract***

*Monitoring of the content of nitrates, radionuclides, salts of heavy metals in different botanical sorts of potatoes, beetroots, tomatoes, onions, carrots, pumpkin has been performed. The received data allow us state the presence of spatial and varietal specifics of the level of accumulating toxicants. The researched plants can be placed in the following order according to the level of accumulating nitrates in productive organs: tomatoes < onion < < carrot < pumpkin < potatoes < beetroot. All researched samples of vegetables accumulate cesium more than strontium. It is determined that not only spatial but varietal divergence by the level of accumulating radioactive isotopes of strontium and cesium are observed in the vegetables under research. Heavy metals can be placed in the following order by the level of accumulation: zinc > copper > lead > cadmium*



***Keywords:*** *toxic substances, potatoes, beetroot, tomatoes, onion, carrot, pumpkin*