Food quality as a risk factor for public health

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Abstract. The article is concerned with quality evaluation and food safety products, which were delivered to Irkutsk region. According to the average daily intake doses priority pollutants in the body, the public health risks were identified for public health with consuming food, including radiation risk. It is shown that the quality of food products as available chemical contaminants is generally satisfactory in the Irkutsk region.

1. Introduction

Organization of food safety is priority area state policy in the field of public health in all developed countries. Food security is considered as an indispensable condition for the normal ontogenetic development of a person, the prevention of diseases, the preservation of working capacity and the prolongation of life. Food should not compare only the physiological requirement of a person, but also be a high quality in sanitary and epidemiological terms, protecting consumers from the health risks posed by polluters. Unsafe for human health food is the cause of more than 200 diseases. According to World Health Organization estimates, every year about 420 thousand people die from diseases associated with the use of substandard products [1]. In this regard, food contamination has become one of the global problems of our life [2].

Pollution can be of a physical, chemical and biological nature. The greatest threats to health are substances that are foreign to the natural environment substance – xenobiotics and also pathogenic microorganisms. The most commonly encountered chemical pollutants are heavy metals, radioisotopes, pesticides, nitrates and nitrites. In addition, polycyclic aromatic hydrocarbons (PAHs), growth stimulants, nitrosamines and other compounds may be present in food products. Food stuff are the main source of xenobiotics in the human body from the environment. With products of vegetable and animal origin over 90% of pesticides, nitrates and radionuclides [3], more than 70% of PAHs [4] get into the human body. The presence of chemical contaminants in food depends on the conditions of production and processing of agricultural raw materials, method of preparation, packaging material, as well as the ecological status of the production region (water, soil, atmospheric air) [5-7].

Microbial contamination of products with pathogens can be the result of environmental excursion in the manufacture region, contravention sanitary and epidemiological standards at different stages of raw materials processing and product delivery to the client. Mass outbreaks of infectious diseases which were caused by the consumption of fresh vegetables periodically occur throughout the world [8]. Attempts to prevent microbiological pollution by themselves pose a threat because there are risk emergence a new race bacteria, which resistant to antibiotics [9].

The food quality, which entering the Irkutsk region as a research object is rather poorly presented in the scientific literature [10, 11], although pollution control of food raw materials and food products is carried out regularly. The sanitary and chemical indicators of 12322 test portion of food samples
were analyzed by the Office of the Federal Service for Supervision of Consumer Rights Protection and Human Welfare (Rospotrebnadzor) in the Irkutsk Region and its territorial divisions the last three year. About 5 thousand different objects (food, feed, water) are examined by the Irkutsk interregional veterinary laboratory every year. The working purpose was assessing the quality of food products in the Irkutsk Region and the risk of exposure to contaminants in their health.

2. Materials and methods
For this research we used the data of chemical-toxicological and radiological analyzes of food samples 2018 year, which were provided by the Federal State Institution Irkutsk Interregional Veterinary Laboratory. The assessment of non-carcinogenic hazard level was carried out according to ME 2.3.7.2519-09 "Exposure determination and risk assessment of exposure to chemical contaminants food products on the population" and the Guidelines for assessing the risk to public health under exposure to environmental pollutants (R 2.1.10.1920-04).

3. Results
At the first stage risk assessment influence of chemical contaminants determine their exposure, which allows to establish the contribution of each of the sources of contamination. For calculations it use data about consumption food products and the content of pollutants.

The food consumption level on a per capita basis in the Irkutsk region was not change for the last three year and the nutrition is unbalanced. If the consumption of meat and meat products is lower than recommended by the Ministry of Health of Russia by 8%, eggs - by 10% then vegetables, fruits and berries by half, dairy products - by 40% (Figure 1). Calories deficiency is compensated by introducing more potatoes and bread products (bread, pasta, cereals) into the diet. Their number, on the contrary, is higher than the norms of food consumption - by 40 and 10%, respectively.

![Figure 1. Consumption basic foods in the Irkutsk region (per year per capita).](image)

According to research, meat and dairy products most often do not to be equal to the requirements. In particular, falsification of the last group product is pervasive phenomenon, which is determined by the incompatibility of the fatty acid composition of the fatty part of the product and the presence of plant sterols. About 3% of dairy products do not to be equal to the requirements for fraud. In separate samples of milk (drinking and condensed) and meat, the presence of antibacterial drugs - antibiotics and sulfonamides was established. The defections also concerned the acidity, humidity, porosity of bakery products. Exceeding the permissible levels of mercury content was recorded in one sample of
vegetable oil, on the content of the mass fraction of total phosphorus - in one sample of meat and on nitrates in fruits and vegetables. In all groups of the products were studied, the average annual concentrations of contaminants did not exceed the permissible levels (table 1).

Table 1. The content of contaminants in food, 2018.

| Group product    | mercury | lead  | arsenic | cadmium | nitrates | strontium-90 | cesium-137 |
|------------------|---------|-------|---------|---------|----------|--------------|------------|
| Bread products   | <0.0025 | 0.0144| <0.0100 | <0.0100 | -        | 1.8147       | 1.7388     |
| Meet products    | <0.0025 | 0.0279| 0.0215  | <0.0100 | -        | 1.4000       | 1.5200     |
| Milk products    | <0.0025 | <0.010| <0.0100 | <0.0100 | -        | 2.7033       | 1.2548     |
| Fish products    | 0.0840  | 0.0928| 0.0764  | 0.0089  | -        | 7.5633       | 1.1433     |
| Egg              | <0.0025 | <0.010| <0.0250 | <0.0100 | -        | -            | -          |
| Vegetables       | <0.0025 | 0.0117| <0.0100 | <0.0100 | 212.885  | 0.8857       | 0.1286     |
| Potatoes         | <0.0025 | <0.010| <0.0250 | <0.0100 | 119.400a | -            | -          |

* A According to [10].

4. Discussion

According to date on per capita food consumption by residents of the Irkutsk region, they calculated exposure of the population to contaminants. The ranking of food products showed that the greatest contribution to the total value of cadmium exposure (83.3% of the total load) is made by milk and dairy products, potatoes, vegetables and fruits and vegetables, bakery products (table 2). Lead exposure is determined by 81% of fish, meat products, bread and bread products, vegetables and fruits and vegetables. The largest contribution to the exposure mercury comes from fish and fish products (70.1%); arsenic exposure (83.2%) - fish and fish products, potatoes, meat and meat products, dairy products. Thus, the group of products with the largest contribution to the exposure of mercury, lead and arsenic in the Irkutsk region is fish and fish products. Contamination of fish was by these substances is largely the result of accumulated environmental damage to the Baikal region [12]. Exposure to nitrates by 63.3% is caused by vegetables and fruit and vegetable products and by 36.7% by potatoes, which practically coincides with the data obtained for the Belgorod region [13]. It should be noted that a significant contribution of milk, dairy products and potatoes to the total value of cadmium, mercury and arsenic exposure is not associated with high average annual concentrations of contaminants, but with a large consumption of products of these groups.

Table 2. Contribution of the main product groups to the total exposure value.

| Group product    | mercury | lead  | arsenic | cadmium |
|------------------|---------|-------|---------|---------|
| Bread products   | 5.2 (5) | 18.1 (3) | 7.8 (6) | 16.2 (4) |
| Meet products    | 3.3 (6) | 22.2 (2) | 21.3 (3) | 10.3 (5) |
| Milk products    | 9.4 (2) | 11.5 (5) | 14.3 (4) | 29.7 (1) |
| Fish products    | 70.1 (1) | 23.7 (1) | 24.3 (1) | 5.9 (6) |
| Vegetables       | 5.9 (4) | 17.0 (4) | 9.0 (5) | 18.7 (3) |
| Potatoes         | 6.1 (3) | 7.5 (6) | 23.3 (2) | 19.2 (2) |

Than it was made calculations of the hazard coefficients (HQ) from the intake of the contaminants with foodstuffs (table 3). Because HQ values of individual contaminants are not to exceed 1.0, the risk is considered acceptable, and an in-depth assessment of exposure is not required. At the same time, in case of simultaneous receipt of several contaminants the total risk (HI) is above the permissible value. This suggests that need strengthening of control nitrates content, which giving the main contribution to the load in vegetables, fruits and vegetables and potatoes.

Using the obtained data about on the average daily come contaminants with food, the risks to public health were identified (table 4). The maximum values of the hazard indexes are found for substanc-
es that affect the cardiovascular system and blood. The main is nitrates. In third place at risk - the hormonal system; if the products have metal heavy and arsenic.

**Table 3.** Exposure load and hazard coefficients for non-carcinogenic effects from oral ingestion of contaminants.

| Chemical substance | Exposure, mg / kg body weight / day | Hazard coefficients HQ | Critical organs / systems |
|--------------------|-------------------------------------|------------------------|--------------------------|
| Mercury            | 1.0E-04                             | 0.140                  | Immune, reproductive, hormonal systems, central nervous system, renal system |
| Lead               | 3.3E-04                             | 0.092                  | Central nervous system, nervous, reproductive, hormonal systems, blood, personal growth |
| Arsenic            | 2.6E-04                             | 0.121                  | Cardiovascular system, central nervous system, nervous, immune, hormonal systems, gastrointestinal tract, skin |
| Cadmium            | 1.3E-04                             | 0.130                  | Renal system, hormonal systems |
| Nitrates           | 1.6E+00                             | 1.000                  | Blood, cardiovascular system |
| **Total hazard index HI** |                                     | **1.483**             |                          |

**Table 4.** Total hazard indexes of non-carcinogenic effects from chronic exposure to toxic substances in food.

| Critical organs / systems | Total hazard index (HI) | Rank |
|--------------------------|-------------------------|------|
| Cardiovascular system    | 1.12                    | 1    |
| Central nervous system   | 0.35                    |      |
| Nervous system           | 0.21                    |      |
| Hormonal system          | 0.48                    | 3    |
| Reproductive system      | 0.23                    |      |
| Immune system            | 0.26                    |      |
| Renal system             | 0.27                    |      |
| Gastrointestinal tract   | 0.12                    |      |
| Personal growth          | 0.09                    |      |
| Blood                    | 1.09                    | 2    |
| Skin                     | 0.12                    |      |

About 5% of the products investigated in the Irkutsk region are not biologically safe. Four groups of products have high levels of microbiological contamination: meat and meat products, dairy products, confectionery and fish. In particular, in 2018 according to microbiological indicators the proportion of non-standard samples were 6.5, 6.3, 6.8, and 11.6%, respectively [14].

The specific activity of radionuclides in the investigated products did not exceed permissible levels. However, the danger of radionuclides is becoming stochastic effects that have not a dose threshold. This means is even a very low level of exposure can lead to adverse effects (carcinogenic and genetic). For the average annual levels of specific activities radionuclides, taking into account the average per capita consumption of individual groups products in the Irkutsk region was calculated individual radiation risk. It was $6.8 \times 10^{-6}$ person$^{-1}$ year$^{-1}$, which is below the established limit of permissible radiation risk for the population ($5 \times 10^{-5}$ person$^{-1}$ year$^{-1}$). For the population quantity is transformed into 16 cases of stochastic effects. It is decrease in life expectancy by an average of 15 years for one case of fatal cancer. This is a rather low value, considering that the population in the Irkutsk Region is almost 2.4 million people.

**5. Conclusions**

In our time food safety has established itself as a leader in sustainable development. In our country, the importance of this aspect in human life is confirmed by the Strategy for Improving the Quality of Food Products in the Russian Federation until 2030, adopted by the order of the Government of the
Russian Federation of June 29, 2016 No. 1364-r. Among the tasks to be implemented are monitoring food quality, encouraging manufacturers to produce products that meet the principles of healthy cooking, development of scientific research in the sphere of population food.

References

[1] Food safety. World Health Organization [Electronic resource] URL: https://www.who.int/news-room/fact-sheets/detail/food-safety (accessed: 30.03.2019)

[2] Fukuda K 2015 Food safety in a globalized world Bulletin of the World Health Organization 93 (4) p 212

[3] Docenko V A, Vlasova V V and Mosiychuk L V 2019 Quality and safety of food Bezopasnost’ zhiznedeatelnosti 218 (2) pp 9–21

[4] Oopol N I, Syrku R F, Pynzar Yu V, Bogdevich O P and Kadochnikov O P 2015 Hygienic assessment of polycyclic aromatic hydrocarbons content and estimation of their intake with food by the population Hygiene and sanitation 94 (4) pp 52–56

[5] Baeumner A J 2003 Biosensors for environmental pollutants and food contaminants Anal. Bioanal. Chem. 377(3) pp 434–445

[6] Perello G, Marti-Cid R, Castell V, Llobet J M and Domingo J L 2009 Concentrations of polybrominated diphenyl ethers, hexachlorobenzene and polycyclic aromatic hydrocarbons in various foodstuffs before and after cooking Food Chem. Toxicol. 47(4) pp 709–715

[7] Rather I A, Koh W Y, Paek W K and Lim J 2017 The sources of chemical contaminants in food and their health implications Front. Pharmacol. 8 p 830

[8] Malik A H 2016 Food contamination: major challenges of the future. Foods 5(2) p 21

[9] Pruden A, Pei R, Storteboom H and Carlson K H 2006 Antibiotic resistance genes as emerging contaminants: studies in northern Colorado Environ. Sci. Technol. 40 pp 7445–7450

[10] Kuzmina M V, Yefimova N V and Zaykova Z A 2013 Nutrition as a factor influencing human health in the Irkutsk region Health Risk Analysis 3 pp 48–54

[11] Parmar I Yu, Efimova N V and Baglushkina S Yu 2015 Hygienic evaluation of the quality and safety of food raw materials and food products traded on the consumer market of the Irkutsk region Journal of Ural Medical Academic Science 53(2) pp 117–120

[12] Timofeeva S S 2012 Baikal region accumulated environmental damage Proceedings of Irkutsk State Technical University 65(6) pp 53–59

[13] Fetter V V 2013 Human health risk assessment of the chemical contamination of food products and raw foods Health Risk Analysis 4 pp 54–63

[14] 2019 State report “On the state of sanitary and epidemiological welfare of the population in the Irkutsk region in 2018” (Irkutsk)