Assessment of vegetable and animal products in the Murmansk region within the implementation of the federal project “Public Health Promotion”

I. V. Uskova*, *O. G.* Krivenko, *I. N.* Rogacheva, *V. A.* Poteshkina, and *L. A.* Mishanina

Department of Microbiology and Biochemistry, Institute of Nature and Technology, Murmansk State Technical University, 13, Sportivnaya Str., Murmansk 183010, Russian Federation

Abstract. Monitoring studies of the quality of food products of plant and animal origin, including vegetable oils, some confectionery products and dietary supplements were carried out in the Murmansk region as a part of the implementing the federal project “Public Health Promotion” of the National Project “Demography”. Within the framework of monitoring studies, data allowing to evaluate the quality of food products in circulation on the territory of the Murmansk region were obtained, the share of products, up to 12% of the volume of the studied range not meeting the established requirements in safety quality indicators is revealed. The highest percentage of food products that do not conform to the technical regulation requirements is defined in the category of animal products and made up 7.8% of the total amount the of studied samples, the second place (2.5%) is given to the products of plant origin, other products – 1.8% complete the list. Toxic elements, pesticides, antibiotics, preservatives, mycotoxins, nitrates, dry low-fat milk residue, genetically modified enzymes (microbial transglutaminase) and sanitary-indicative microorganisms were determined among the safety indicators. Products of animal origin like eggs, milk, yogurt, kefir, sour cream, cake cheese, cheeses, condensed milk, butter, bockwurst sausages, sausages, were not safe for the consumer as a result of violating the production technology, including storage conditions failure, the use of low-quality raw material, or product falsification. The assessment of apples, cucumber, tomato, sunflower and olive oil, cookies and dietary supplements samples showed unsatisfactory results in the residual content of pesticides, nitrates, toxic elements, antibiotics and peroxide.

1 Introduction

State laboratory monitoring of prohibited and harmful substances traces in the raw materials and products of animal and vegetable origin is the main complex of measures capable of ensuring the safety of food products in order to protect people’s life and health [1, 2].

In August 2012, Russia joined the World Trade Organization (WTO), thus our products must meet the international standards and be competitive. With this goal, on the territory of the Russian Federation, within the framework of the national program, the veterinary services carry out laboratory monitoring of residual traces of prohibited and hazardous substances, both in the feed and in the organisms of farm animals, as well as in the finished products of animal origin [3].

When conducting socio-hygienic monitoring, one of the main tasks of the Office of the Federal Service for Supervision of Consumer Rights Protection and Human Welfare is collecting reliable and objective information about the quality and safety of food products manufactured by the Russian enterprises, imported foods and manufactured products for free circulation on the territory of the Russian Federation and already found in the circulation, as well as the data concerning nutrition and state of population health in terms of the conditions and quality of foodstuffs [3].

2 Materials and Methods

The studies determined general safety indicators regulated for food products taking into account the peculiarities of their component composition and processing technology.

The method of highly efficient liquid chromatography with various detectors was used to reveal the mycotoxins content. Pesticides were determined by gas chromatography. The content of toxic elements was determined by the spectral analysis method (atomic absorption spectroscopy). To identify genetically modified organisms and microorganisms typing, the method of polymerase chain reaction (PCR) was used. Accounting and identification of sanitary microorganisms were performed according to the generally accepted methods of microbiology.

The results were evaluated in accordance with the regulatory technical documentation, which acts towards the specific food category.

According to the technical regulations of the Customs Union "Requirements for the safety of food

* Corresponding author: uskovaiv@mstu.edu.ru

additives, flavors and processing aids" (TR CU 029/2012), the presence of food additives was assessed, as well as their quantitative content [4].

3 Results and Discussion

In 2020 489 samples of food products in circulation on the territory of the Murmansk region were investigated to assess the quality of foods, of them 140 samples (28.6%) were the products of plant origin, 279 samples (57.1%), – of animal origin and 70 (14.3%) – other products, including dietary supplements (Table 1).

Table 1. The amount of food products in circulation on the territory of the Murmansk region, taken for quality assessment in 2020.

Category of Food Product	Total number studied (number of tests, items.)	Total number studied (number of tests, %)
Foods of plant origin	140	28.6
Foods of animal origin	279	57.1
Other products	70	14.3
Total	489	100

Of the 489 samples studied, 58 were found as not corresponding to safety indicators, established values of regulatory and technical documentation (RTD), which is almost 12% of the total number (Table 2).

The largest percentage of samples not meeting the requirements of the regulatory technical documentation has been identified in animal products – 7.8% of the total number of the samples studied. The second place (2.5%) as unsafe products were taken by products of plant origin, and the category “Other products” count for 1.8% (Table 2).

Table 2. The amount of food products in circulation on the territory of the Murmansk region studied for safety assessment in 2020.

Category of Food Product	Number of tests, conforming to RTD		Number of tests, not conforming to RTD	
	Abs. number	%	Abs. number	%
Foods of plant origin	128	26.2	12	2.5
Foods of animal origin	242	49.5	38	7.8
Other products	61	12.4	9	1.8

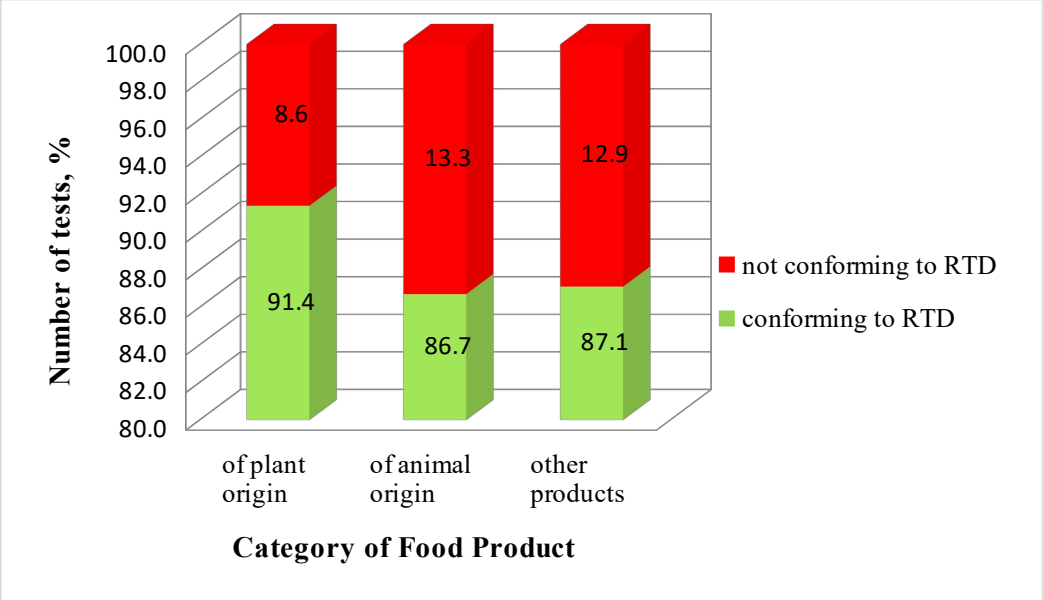

Fig. 1. The share of low-quality samples of food products of various categories in circulation on the territory of the Murmansk region in 2020.

Foods from the category “Products of animal origin” turned out to be the most unfavorable in terms of safety for a consumer. It should be noted that, in this category a broader range of products compared to two other groups (Figure 1, Table 3) was assessed. Of the 279 samples 38 (13.6%) do not correspond to the safety indicators of established RTD values, or 11 positions from 22 taken for tests: eggs, milk, dairy products and meat processing foods (Figure 1, Table 3).

Table 3. The number of food products of animal origin, in circulation on the territory of the Murmansk region, taken for safety assessment in 2020.

No	Foodstuffs	Number of tested samples	Conform to RTD	Do not conform to RTD
1.	Cottage cheese	15	15	–
2.	Ice cream	10	10	–
3.	Boiled sausages	10	10	–
4.	Ft included short bratwursts	4	4	–
5.	Semi-finished products	20	20	–
6.	Canned meat	10	10	–
7.	National meat products	10	10	–
8.	Oceanic chilled and frozen fish	18	18	–
9.	Fish preserves	7	7	–
10.	Canned fish	8	8	–
11.	Curd	10	10	–
12.	Eggs	15	13	2
13.	Milk	20	19	1
14.	Yogurt	20	13	7
15.	Kefir	10	0	10
16.	Sour cream	20	19	1
17.	Cake cheese	10	9	1
18.	Cheese	15	13	2
19.	Condensed milk	15	14	1
20.	Butter	15	9	6
21.	Bbockwurst sausages	8	3	5
22.	Sausages	9	7	2
	Total	279	241	38
	%	100	86.4	13.6

Among the safety indicators, toxic elements, pesticides, antibiotics, preservatives, mycotoxins (aflatoxin), nitrates, DLFMR (dry low-fat milk residue), genetically modified enzymes (microbial transglutaminase) and sanitary-indicatory microorganisms were identified (Table 4).

All chemical and biological substances that may be dangerous for functioning of a macroorganism, either enter the finished products in technological processing, including the stages of processing the raw materials, packaging, storage and selling of goods, or accumulate in a food chain, on the one hand, and in the environment - on the another.

Therefore, from this point of view, food chemicals can be conventionally divided into the substance's characteristic or specific for a product, substances introduced into the food in order to achieve technological effect and contaminants.

One of the main problems of the food industry is to increase the shelf life of foods preserving and preferably enhancing the quality of products. For this purpose, various possibilities associated with inhibiting the chain mechanism of organic substances oxidation, in particular fat, by adding various food antioxidants to the product are utilized.

Considering that the toxicity of antioxidants depends on their concentration, any complications are not excluded when using antioxidants in the production of food products, thus the stringent control is needed.

No less danger to the consumer is contaminants, both of natural and man-made origin, up to 80% of the total amount of foreign chemicals entering with food.

Contaminants and nutritional supplements, like micotoxins and genetically modified enzymes, were not detected in any of the tested food categories.

Among the sanitary-indicatory microorganisms' bacteria from the Escherichia coli genera were found in cake cheeses in one of the tests, 12 samples of fermented milk products were revealed to have the excessive amount of mold and yeast fungi (sour cream, kefir, yogurt). Most likely, this indicates the unfavorable sanitary and hygienic condition of manufacturing or violating the shelf-life of these products.

The three products: condensed milk (1 sample), kefir (1 sample) and yogurt (7 samples) do not meet the standards and technical documentation in terms of the quality of the lactic dairy products DLFMR (dry low-fat milk residue), reflecting the natural origin and full value of the raw materials. The low rate of DLFMR in these products may indicate the use of poor-quality raw materials or falsification of the product, that is, the replacement of the product's part with some additives (for example, starch and water).

Determining the presence of toxic elements in foods is one of the most commonly monitored indicators (Hg, Cd, As, Pb, Cu, Fe). Toxic elements were found in all types of raw materials, largely in the final foods. In the raw materials of animal origin, the accumulation of toxic elements is possible when animals are fed on contaminated feed. In finished food products, toxic substances or, as they are called, impurities of endogenous origin are formed as a result of various processing methods (enzyme, heat, ionizing irradiation) [5].

Table 4. Foods of animal origin circulating on the territory of the Murmansk region in 2020 and tested for safety indicators required by the standards and technical documentation.

Foodstuffs	Safety indicator,

	% from the total number of animal products samples						
	Sanitary-indicative m/o		DLFMR	TE	Antibiotics	Preservation agents (acids)	
	conditionally pathogenic (including pathogenic)	sanitary-hygienic indicators				sorbic	benzoic
Eggs				0.7			
Milk				0.35			
Yogurt		0.35	2.5				
Kefir		3.6	0.35				
Sour cream		0.35					
Cake cheese	0.35						
Cheese				0.35	0.35		
Condensed milk			0.35				
Butter				2.15			
Bockwurst sausages						0.35	0.35
						1.1	
Sausages						0.35	0.35

The excess of the maximum permissible concentration of toxic elements was found in some samples of the foods of animal origin. The "leader" in the toxic elements content was butter (ferrum was found in 5 of the 15 samples, in 1 sample copper was detected), the excess of the maximum permissible concentration of arsenic and cadmium (2 samples) was revealed in eggs, in milk – lead (1 sample), in cheese – mercury (1 sample).

Moreover, the residual content of antibiotics (1 sample) was found in cheese. Antibiotics are not used in the cheese-making technology; therefore, the medical drugs can get there only with the dairy raw materials. In the process of cow breeding, a lot of drugs, including antibiotics are used for medical and preventive measures. Also, manufacturers of animal feed increase the shelf-life of their production by adding antibiotics. In turn, the feed enriched with antibiotics stimulates the animal growth.

In the process of cheese ripening, antibiotics present in the dairy raw materials can suppress the enzymatic activity of the lactic acid and aroma-forming microbiota, which cause the taste-aromatic bouquet of the finished product.

Moreover, the risk of eating the foods with antibiotic components which enter the environment passing through the consumer's organism leads to the formation and propagation of antibiotic-resistant microorganisms and genes, as well as increases the costs of subsequent medical and preventive measures and causes long-term bacteria carrying [6].

In bockwurst sausages and sausages, a high content of preservatives (sorbic and benzoic acid) was found. When analyzing the sausages, 2 negative samples from the 9 tested ones were obtained. The analysis of bockwursts showed five samples of non-compliance, and 3 samples were found to fail in both preservatives simultaneously. Sorbic and benzoic acids are preservatives, their action is essential, mainly against the microscopic fungi, including aflatoxin-forming. Dosage of preservatives depends on the initial degree of bacterial dissemination, from the functional properties of the product, processing and storage technology [7]. However, the rigid manufacturers' competition in the food industry market leads to an increase in the number of preservative additives used [8].

It should be noted that all fish products samples were found to be safe for the consumer.

The residents of Murmansk and the Murmansk region, can eat such foods as boiled sausages, meat semi-finished products and canned food, national meat products, fat included short bratwursts, as well as cottage cheese, curds and ice cream without fear for their health.

In terms of safety indicators, 90% of samples of the plant origin products and the ones referred to the category "other foods" met the requirements specified for the products (Table 5).

When analyzing some samples of apples, cucumbers, tomatoes, sunflower and olive oils, cookies and dietary supplements unsatisfactory results were obtained, constituting 10% of the total number of the tested products of the corresponding categories (Table 5).

The content of pesticides unstated in RTD exceeded the maximum permissible level in fresh vegetables and fruits (5.3% of samples in the category of products of plant origin and other products) (Table 6).

In order to preserve and increase the crop, the use of pesticides in agriculture is quite justified. At the same time, these substances negatively affect the environment, violating the balance in the environmental system of flora and fauna. Their presence in agricultural raw materials and food is a significant danger to public health.

The constant admission of low-toxic pesticides to the body, even in small quantities, can lead to poisoning, decrease of immunity, development of allergic responses of different severity [2].

Table 5. The number of food product samples of plant origin and other products assessed for safety indicators in circulation on the territory of the Murmansk region in 2020.

No	Foodstuffs	Number of tested samples	Conform to RTD	Do not conform to RTD
1.	Bakery products	40	40	–

2.	Fortified grains	15	15	–
3.	Pasta	15	15	–
4.	Gluten-free foods	15	15	–
5.	Juice, fruit nectar	15	15	–
6.	Canned fruit and berries	15	15	–
7.	Apples	10	8	2
8.	Cucumbers	8	4	4
9.	Tomatoes	7	1	6
10.	Iodinated salt	10	10	–
11.	Confectionery	10	10	–
12.	Sunflower oil	10	9	1
13.	Olive oil	10	6	4
14.	Cookies	10	9	1
15.	Dietary supplements	20	17	3
	Total	210	189	21
	%	100	90	10

When analyzing cucumbers from the 1st sample, besides pesticides, an excessive concentration of nitrates was found. The presence of nitric acid salts (nitrates) in cucumbers is a common phenomenon, especially in the early ripening varieties. Nitrates enter the plants not only from fertilizers, but also from the soil. Not harmful to the fruits themselves, nitrates (already in the form of nitrites) harm a human organism [2], being hematoxic, they violate the properties of hemoglobin. As a result, tissue hypoxia develops, which is accompanied by weakness, dizziness, headache, shortness of breath, heartbeat.

Excess of the permissible values of cadmium and iron was noted in single samples of cookies and sunflower oil, respectively (Table 6). In 4 samples of olive oil, excess of the maximum permissible level of arsenic, lead, copper and a peroxide value were revealed. In one of the samples, non-compliance in the content of cadmium and lead was defined in the assessment of dietary supplement samples. In 4 olive oil samples and 2 dietary supplement samples, the discrepancy in peroxide value reflects the degree of oxidative spoilage of fat. In oils and dietary supplements with high peroxide number, partial or complete loss of biological activity occurs. Ultimate oxidation products are toxic and can cause a carcinogenic effect [2].

Table 6. Food products of plant origin and other products assessed for the safety indicators from regulatory technical documentation requirements, in circulation on the territory of the Murmansk region in 2020.

Foodstuffs	Safety indicator, % from the total number of plant products and other products samples							
	Pecticides	Nitrates	Cd	As	Pb	Cu	Fe	Peroxide value
Apples	0.95	–	–	–	–	–	–	–
Cucumbers	1.4	0.475	–	–	–	–	–	–
Tomatoes	2.9	–	–	–	–	–	–	–
Sunflower oil	–	–	–	–	–	–	0.475	–
Olive oil	–	–	–	0.475	0.475	0.475	–	0.475
Cookies	–	–	0.475	–	–	–	–	–
Dietary supplements	–	–	0.475	–	0.475	–	–	0.475

4 Conclusion

As a result of the study the range of products in circulation on the territory of the Murmansk region, capable of providing the body's needs with essential nutrients, most of meat and milk processing products samples, as well as chicken, egg and milk do not meet the stated safety indicators. This reduction in the quality of the products is mostly associated with violations in production technology, including falsification of raw materials and the conditions of selling the finished product.

Fresh fruits and vegetables (apples, tomatoes and cucumbers) were not of good quality for the presence of residual content of pesticides (apples, tomatoes and cucumbers).

Vegetable oils (in particular olive oil) and dietary supplies are featured with high content of toxic elements and peroxide value, which is also an indicator of violation in processing and storage conditions of the product.

References

1. MR 2.3.7.0168-20. Assessment of the quality of food products and evaluating the access of the population to domestic food products promoting the elimination of macro and micronutrients

deficiency, retrieved from: http://www.consultant.ru/document/cons_doc_LAW_359586/
2. G. G. Onishchenko, et al., Health risk analysis in the strategy of state social and economical development monography, *Perm National Research Polytechnic University* p 737 (2014)
3. About the state veterinary laboratory monitoring of safety and reinforced laboratory control of food raw materials of animal origin in the Russian Federation, retrieved from: http://www.consultant.ru/document/cons_doc_LAW_137013/
4. On the organization and conduct of monitoring of quality, food safety and public health: Government Resolution Ros. Federation No 883, retrieved from: https://base.garant.ru/12121276/
5. I. A. Rogov, et al., *Food Biotechnology*. *Basics of Food Biotechnology* vol 1 (Moscow: Colossus, 2013)
6. L. V. Shulgina, Antibiotics in Aquaculture Facilities and Their Ecological Significance, *Tinro News* **181,** 217 (2015)
7. M. F. Tsukanov, et al., *Methodology Human Nutrition* (St. Petersburg: Publishing House of SPbGEU, 2015)
8. N. V. Zaitseva, P. Z. Shur, Actual issues of methodological support for public health risk assessment while ensuring the safety of products: World Foreign Experience and Practice of the Customs, Union *Risk analysis of health* **4,** 4–16 (2013)