Analysis of conformity with quality and safety requirements of fruits and vegetables sold on the Russian market

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Abstract. The effectiveness of agribusiness is determined by many factors, including the degree of confidence of supervisory authorities and consumers in the manufacturer and its products. A high degree of trust and a positive image is formed by the history of inspections of agricultural producers and the absence of consumer complaints about the quality or safety of goods. An analysis of the results of the compliance of fruits and vegetables marketed in the Russian Federation with quality and safety requirements allows business entities and supervisory authorities to assess priority risks, to formulate action plans to minimize or eliminate them. During the study, an analysis of the results of the control and supervision measures of the sanitary service in relation to fruits and vegetables for the period 2014-2019 was performed. It has been established that most of the products are of high quality and safe. The proportion of non-standard samples ranges from 0.3% - 2.7%. The main violations of the mandatory requirements for quality and safety of fruits and vegetables are recorded in relation to the content of microbiological agents, chemicals, physical and chemical indicators. The largest share of non-standard samples on the content of chemicals in the product falls on nitrates, mycotoxins, cadmium. The priority risk factors for mismatch in gourds are physicochemical parameters and nitrate content; in table greens - microbiological indicators and the content of nitrates and cadmium, in fruits and berries - the content of radionuclides (mainly Cesium-137), etc. The results can be used by representatives of agribusiness to plan activities to prevent non-compliance, improve the quality and safety of agricultural products, and supervisory authorities to organize a risk-oriented model of goods control.

1. Introduction

One of the most important components of ensuring food security of the country was called the development of its own production of fruits and vegetables [1]. The Ministry of Agriculture has expanded the doctrine of food security in Russia by setting goals such as increasing the share of domestic vegetables in the domestic market at least 90%, and fruits and berries at least 70% [2]. At the same time, the issue of quality and safety of fruits and vegetables grown and sold on the country’s market becomes relevant. "Food and Agriculture” was included in the list of sectoral issues identified by the United Nations in its "Environmental Perspective until 2000 and Beyond." This sector highlighted, among others, the environmental impact of agricultural policies, including the improper use of fertilizers and pesticides and industrial pollution. Excessive use of pesticides, chemical fertilizers pollutes water and...
soil, damaging the ecology of agriculture, and is a source of danger to human and animal health. For example, groundwater in many places is polluted by nitrates, and the level of nitrate content in rivers is constantly increasing [3]. Chemicals can migrate from soil and water to plants, including agricultural products [4]. In addition, when growing fruits and vegetables, a large number of pest control agents, growth stimulants, preservatives, growth accelerators, etc. are used. All this further affects the properties and characteristics of products, its competitive advantages and risks to consumer health [5,6].

At this stage, it is of interest to study the statistics of the results of quality and safety of fruits and vegetables actually circulating on the market of the Russian Federation. The purpose of this analysis is to establish priority indicators of non-compliance with the mandatory quality and safety requirements for the subsequent concentration of manufacturers' attention on these factors. The absence of inconsistencies in the course of inspections undoubtedly contributes to increasing the degree of confidence of supervisory authorities and consumers in the producer and its products, and, consequently, in increasing the efficiency of agribusiness and increasing the level of food security in the country as a whole [6,7,8].

2. Problem statement and research methods

Object of study - indicators of quality and safety of fruits and vegetables circulated on the market of the Russian Federation.

The goal is to perform an analysis of the results of monitoring levels of pollution of fruit and vegetable products traded on the Russian Federation market.

Research methods: statistical analysis of the data of the form of federal statistical observation No. 18 “Information on the sanitary condition of the subject of the Russian Federation” of the Federal Service for Supervision of Consumer Rights Protection and Human Well-being for 2014–2019.

3. The main results

Every year in the Russian Federation, the largest number of studies of fruit and vegetable products for compliance with quality and safety requirements is accounted for by the analysis of sanitary and chemical indicators - 47.2% in the structure of studies of samples of fruits and vegetables (on average for 2014-2019 - 98,149.8 samples), in second place - studies on the conformity of fruit and vegetable products by parasitological indicators - 33.5% (69,624.3 samples), on the third - research on microbiological indicators - 8.9% (18,449 samples), on the fourth - research on fruits and vegetables on radioactive substances - 6.5% (13,415.2 samples), on the fifth - product research for compliance with physico-chemical indicators - 2.9% (5,989.0 samples).

In the structure of non-standard samples of fruit and vegetable products (by the number of non-standard samples), the largest number falls to sanitary-chemical indicators - 54.7% (on average for 2014-2019 - 1135.8 non-standard samples for this indicator of product samples), in second place - microbiological indicators - 23.7% (491.3 samples), parasitological indicators 10.7%, (222.7 samples) in third place, non-standard samples in physical and chemical parameters - 6.8% (140.3 samples) in fourth place, non-standard samples in terms of radioactive substances content in fifth - 3.2% (on average - 66.0 samples).

It was established that for the period 2014–2019, the proportion of non-standard samples of all fruits and vegetables by microbiological indicators was 2.66%, by physicochemical indicators - 2.35%, by sanitary-chemical indicators on average - 1.15%, by radioactive content - 0.50%, by parasitological indicators - 0.32% (table 1). Compared with 2014, there is a positive trend towards a decrease in the share of non-standard samples of fruits and vegetables in terms of sanitary and chemical indicators - the rate of decline of the indicator was 39.8%, for parasitological indicators, the rate of decrease of the indicator was 33.3%, microbiological indicators - 12.0%. In relation to the proportion of non-standard samples of fruits and vegetables according to the content of radioactive substances and physico-chemical parameters, the trend is unstable. Compared to 2015, the proportion of non-standard product samples in terms of the content of radioactive substances is reduced, the rate of decline is 53.8% (table 1).
Table 1. The proportion of non-standard samples of fruits and vegetables in the context of individual indicators, %

| Years | on sanitary and chemical indicators | on the content of radioactive substances | on physical and chemical indicators | on parasitological indicators | in microbiological indicators |
|-------|--------------------------------------|------------------------------------------|-------------------------------------|-------------------------------|-----------------------------|
| 2014  | 1.65                                 | 0.32                                     | 2.35                                | 0.33                          | 2.83                        |
| 2015  | 1.36                                 | 0.74                                     | 2.38                                | 0.36                          | 2.83                        |
| 2016  | 1.10                                 | 0.76                                     | 1.96                                | 0.36                          | 2.28                        |
| 2017  | 0.91                                 | 0.44                                     | 1.92                                | 0.35                          | 2.91                        |
| 2018  | 0.90                                 | 0.37                                     | 2.61                                | 0.31                          | 2.61                        |
| 2019  | 1.00                                 | 0.34                                     | 2.88                                | 0.22                          | 2.49                        |
| Average value | 1.15                                 | 0.50                                     | 2.35                                | 0.32                          | 2.66                        |
| Rate of increase/decrease 2019/2014% | -39.8                                 | +6.4                                     | +22.2                               | -33.3                         | -12.0                       |

The analysis of the situation on the quality and safety of fruit and vegetable products by regions according to the main indicators of non-compliance with the quality and safety requirements showed the following: on average for the period 2014-2019, in the territory of 32 constituent entities of the Russian Federation, the proportion of non-standard samples of fruits and vegetables in microbiological indicators exceeded the average Russian indicator (2.66%) in the range from 1.2 to 22.2 times. The largest share of non-standard samples was recorded in the Arkhangelsk region, the Kabardino-Balkarian Republic, the Republics of Buryatia, Komi, Sakha. On average for 2014-2019 the proportion of non-standard samples of fruits and vegetables in these territories ranged from 4.0 to 7.2%. It was noted that despite the high average values of the proportion of non-standard product samples by microbiological indicators, samples with violations are not recorded annually in the territories. For example, in 2017, in the territories of the Arkhangelsk region and the Kabardino-Balkarian Republic, there were no non-standard samples of fruits and vegetables according to microbiological indicators.

On average for the period 2014-2019 in the territory of 39 constituent entities of the Russian Federation, the share of non-standard samples of fruits and vegetables in physical and chemical indicators exceeded the average Russian indicator (2.35%) in the range from 1.2 to 16.7 times. The largest share of non-standard samples was recorded in the territories of the Republics of Buryatia, Dagestan, Perm Territory. On average for 2014-2019 the proportion of non-standard samples of fruits and vegetables in these territories ranged from 9.2 to 16.7%.

Regarding the proportion of non-standard samples of fruits and vegetables according to sanitary-chemical indicators, it was found that on average for the period 2014-2019, in the territory of 34 constituent entities of the Russian Federation, the share of non-standard samples of fruits and vegetables in terms of sanitary-chemical indicators exceeded the average Russian indicator (1.15%) in the range from 1.2 to 4.9 times. The largest share of non-standard samples was recorded in the territories of the Republic of Buryatia, Krasnoyarsk Territory, the Republic of Khakassia, North Ossetia-Alania, Ingushetia. On average for 2014-2019 the proportion of non-standard samples of fruits and vegetables according to the sanitary-chemical indicator in these territories ranged from 3.1 to 4.9%.

In the subgroups of fruits and vegetables such as vegetables, including potatoes, the structure of the proportion of non-standard samples of products was generally similar to the whole group of fruits and vegetables, but in the categories of gourds, table greens, fruits and berries, there were some peculiarities.

So, for example, gourds most often did not meet the quality and safety requirements for physical and chemical indicators - the average for 2014-2019, the proportion of non-standard samples is 5.2%, for sanitary-chemical indicators - 4.0%, for microbiological - 2.6%. For all indicators, there is an increase in the share of non-standard samples in the range from 2.6% (the share of non-standard samples
according to microbiological indicators) to 5.2% (the share of non-standard samples according to physicochemical parameters).

Table greens most often did not meet the quality and safety requirements for microbiological indicators - the average for 2014-2019 the proportion of non-standard samples is 4.8%, according to sanitary-chemical indicators - 1.2%, according to physicochemical indicators - 0.7%. For all indicators, there is a decrease in the proportion of non-standard samples in the range from 13.4% (the share of non-standard samples according to sanitary-chemical indicators) to 44.1% (the share of non-standard samples according to microbiological indicators).

Fruits and berries most often did not meet the quality and safety requirements for the content of radioactive substances - average for 2014-2019 the proportion of non-standard samples is 5.2%, according to physicochemical indicators - 4.6%, according to microbiological indicators - 3.0%. The trend continues to remain unfavorable, in all respects, compared with 2014, there was an increase in the proportion of non-standard samples ranging from 18.0% (content of radioactive substances) to 30.5% (microbiological indicators).

With a more in-depth assessment of non-compliance of fruits and vegetables with the requirements for the content of chemicals in it, it was found that the main share of non-standard samples falls on the content of nitrates in the products. The proportion of non-standard samples for all vegetable products in terms of nitrate content, on average, was 1.39%, in dynamics since 2014 a decrease in this indicator was noted, the rate of decrease was 32.9%. In the subgroups of fruits and vegetables, the largest share of non-standard samples of products for this indicator was recorded in the group of gourds - 4.37%, since 2014 there has been a tendency to growth of this indicator - 85.3%, in the group - table greens - 1.32%, since 2014 there has been a growth trend this indicator - the growth rate is 0.1% (table 2).

In second place in the proportion of non-standard samples is the non-compliance of products with safety requirements for the content of mycotoxins. On average for 2014-2019 the proportion of non-standard samples of all fruits and vegetables amounted to 0.09%, and violations on this indicator in the subclass — fruits and berries — were recorded — the percentage of non-standard samples on average was 0.04% (table 2).

Exceeding the standards for the content of heavy metals such as cadmium and lead is set at 0.05% and 0.01% of fruit and vegetable samples. At the same time, the largest share of non-standard samples in terms of cadmium content is in table greens (0.21%) and potatoes (0.12%), and in terms of lead content - in potatoes (0.02%) (table 2).

The proportion of non-standard samples of fruits and vegetables in terms of arsenic content was 0.09%. Violations are mainly recorded in vegetable crops - the proportion of non-standard samples is 0.002%, including in potatoes - 0.004%.

The proportion of non-standard samples on the content of pesticides in fruits and vegetables is on average - 0.01%. All investigated samples of fruits and vegetables for the period 2014-2019. safety requirements for the content of chromium and mercury (table 2).

### Table 2. The proportion of non-standard product samples by the content of certain chemicals, the average value for 2014-2019 %

| Name of production | Nitrates | Pesticides | Microtoxins | Arsenic | Mercury | Chromium | Lead | Cadmium |
|--------------------|----------|------------|-------------|---------|---------|----------|------|---------|
| Fruit vegetable products. Total | 1.39 | 0.01 | 0.09 | 0.002 | 0.0 | 0.0 | 0.01 | 0.05 |
| Gourds | 4.37 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Vegetables | 1.28 | 0.02 | 0.0 | 0.002 | 0.0 | 0.0 | 0.01 | 0.06 |
Vegetables.  
including Potatoes  
Fruits and berries  
Dining greens  

|                        | 0.59 | 0.01 | 0.0 | 0.004 | 0.0 | 0.0 | 0.02 | 0.12 |
|------------------------|------|------|-----|-------|-----|-----|------|------|

4. Conclusion

The results of the studies indicate that most of the fruit and vegetable products traded on the market of the Russian Federation are of high quality and safe. The proportion of non-standard samples of products that do not meet the quality and safety requirements for various indicators, varies on average from 0.32% to 2.66%.

The main violations of the mandatory quality and safety requirements are recorded in relation to: the content of microbiological agents in fruits and vegetables, physical and chemical parameters of the product, and the content of chemicals.

A tendency towards a decrease in the share of non-standard product samples by these indicators was noted, the rate of decline since 2014 was from 12.0% to 39.8%. The largest share of non-standard samples on the content of chemicals in the product falls on nitrates, mycotoxins, cadmium.

On average, excesses of the average Russian value of the share of non-standard samples of fruit and vegetable products by priority indicators are recorded in the territories of 32-39 constituent entities of the Russian Federation. The highest value of the share of non-standard samples of fruits and vegetables in the content of microbiological agents in it was recorded in the territories of the Arkhangelsk region, the Kabardino-Balkarian Republic, the Republics of Buryatia, Komi, Sakha (from 4.0 to 7.2%), and physicochemical indicators - in the territories of the Republics of Buryatia and Dagestan Perm region (from 9.2 to 16.7%), for sanitary-chemical - the Republic of Buryatia, Krasnoyarsk Territory, the Republic of Khakassia, North Ossetia-Alania, Ingushetia (from 3.1 to 4.9%).

The structure of the proportion of non-standard samples of vegetables, including potatoes, is similar to the whole group of fruits and vegetables. The subgroups of fruits and vegetables have their own characteristics.

Melons most often do not meet the quality and safety requirements for physical and chemical indicators and for sanitary and chemical indicators (for nitrate content in products). Noteworthy is the increase in the proportion of non-standard samples of gourds according to the above indicators.

Table greens most often do not meet the quality and safety requirements for microbiological indicators, for sanitary-chemical (the content of nitrates and cadmium in the products), physical and chemical indicators.

Fruits and berries most often do not meet the quality and safety requirements for the content of radioactive substances (mainly due to the content of Cesium-137 in them), physico-chemical, microbiological indicators. In the study of chemical impurities in fruits and berries, attention must be paid to nitrates and mycotoxins.

Based on the results, it is recommended that when assessing the conformity of fruits and vegetables to quality and safety requirements, it is first of all necessary to evaluate the content of microbiological agents and the physical and chemical characteristics of the products, the content of chemicals (nitrates, mycotoxins, cadmium). Particular attention should be paid to the study of fruits and berries for the content of radioactive substances. The results can be used in organizing events aimed at preventing contamination of fruits and vegetables.

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