Monitoring the research results on the toxic elements content (lead, cadmium and arsenic) in food

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Abstract. The high quality of the services provided is a component that determines the competitiveness of laboratories. It is necessary to update laboratories in modern conditions of the development of scientific and technological progress. Another important task is to ensure control of the quantitative content of toxic elements, the introduction and application of fast and reliable methods of their analysis. Analysis of monitoring the quantitative content of toxic elements in food samples confirms the need for analytical express control; its implementation allows tracking the content of potentially hazardous elements in products and preventing their influence on human health. The analysis of monitoring results for 2017-2019 showed the predominant ranges of toxic elements’ concentrations in various categories of products. It was revealed that when the quantitative content of cadmium is detected, the maximum number of test results falls within the range of less than 0.001 mg/kg. In the case of the quantitative content of lead detection, the maximum number of test results falls within the range of less than 0.01 mg/kg; in the case of detecting arsenic, the range is less than 0.02 mg/kg.

1. Introduction

In a market economy, testing laboratories, as enterprise, should strive to ensure such level of quality of services that will satisfy the needs of consumers. The high quality of the services provided is a component that determines the competitiveness of laboratories. It is necessary to update laboratories in accordance with the present-day development of scientific and technological progress.

The introduction of modern automated equipment with software for keeping test results records, as well as for processing and storing the data obtained, ensures reliable research results due to less probability of the analytical chemist’s errors; control and management of records; simplifying the procedure for searching and analyzing information during corrective and preventive measures [1–6].

Analytical laboratories that monitor safety performance for the purposes of state supervision and certification have for photometric, atomic absorption, chromatographic analysis equipment. It is a
relevant task to master the equipment for inversion voltammetry, to introduce microwave decomposition of samples into the field of practical use and food safety control techniques using new high sensitivity methods.

The development of effective algorithms for optimizing the laboratory equipment base, as well as the search for a solution that will allow laboratories to provide reliable test results at minimal cost in the shortest possible time, is another important task [7–10]. Due to an import increase, the research problem becomes relevant since hardware need to cover a wide range in the determination of toxic elements acceptable for use in other countries. Control of the quantitative content of toxic elements, introduction and application of fast and reliable methods of their analysis remain the primary tasks.

Analysis of monitoring the quantitative content of toxic elements in food samples confirms the need for analytical express control; its implementation allows tracking the content of potentially hazardous elements in products and preventing their influence on human health [11–17].

2. Material and methods
The standards for research methods, test methods, operating manuals and instructions for the use of equipment form the methodological basis.

3. Results and discussion
In 2017–2019, monitoring was carried out to quantify the content of lead, cadmium and arsenic in food samples; the data obtained was analyzed. The distribution of research results was assessed depending on the concentration of the determined toxic element, taking into account various food groups.

Bar charts (figures 1–3) highlight and present data of test results obtained during 2017–2019 monitoring for the following groups:

- vegetables;
- fish, fish products, sea animals and other hydrobionts;
- meat and meat products (except for poultry and products of its processing);
- alcoholic drinks and beer;
- poultry and products of its processing;
- milk and dairy products;
- bakery and confectionery.

The bar charts reflect the distribution of the number of test results depending on the concentration of the designated element for the selected product groups. It should be noted that the graphically presented “percentage of total number of studies” reflects the proportion of results per concentration range in relation to the total amount of tests per group.
Figure 1. Distribution of test results depending on the concentration of lead in samples for different product groups.

It has been established that in the range of the quantitative content of lead less than 0.01 mg/kg, the following groups prevail: “Milk and dairy products”, “Alcoholic drinks and beer”, “Poultry and products of its processing” and “Bakery and confectionery”. In the range of 0.01-0.03 mg/kg of the quantitative content of lead, the following groups prevail: “Meat and meat products (except for poultry and products of its processing)”, “Vegetables” and “Fish, fish products, sea animals and other hydrobionts”. In the range of 0.03-0.05 mg/kg of the quantitative content of lead, the following groups prevail: “Fish, fish products and other hydrobionts” and “Vegetables”. In the range of 0.05-0.1 mg/kg of the quantitative content of lead, the group “Fish, fish products, sea animals and other hydrobionts” prevails; in the range of 0.1-1.0 mg/kg the group “Vegetables” prevails.

Figure 2. Distribution of test results depending on the concentration of cadmium in samples for various product groups.
It has been established that in the range of quantitative content of cadmium less than 0.001 mg/kg the following groups prevail: “Alcoholic drinks and beer”, “Bakery and confectionery”, “Fish, fish products, sea animals and other hydrobionts” and “Vegetables”; in the range of 0.001-0.005 mg/kg, the group “Milk and dairy products” prevails.

In the range of 0.005-0.010 mg/kg of the quantitative content of cadmium, the following groups prevail: “Fish, fish products, sea animals and other hydrobionts”, “Vegetables” and “Milk and dairy products”; and in the range of 0.01-0.05 mg/kg; the group “Poultry and products of its processing” prevails.

**Figure 3.** Distribution of test results depending on the concentration of arsenic in samples for various product groups.

It has been established that in the range of the quantitative content of arsenic less than 0.02 mg/kg, the following groups prevail: “Alcoholic drinks and beer”, “Milk and dairy products”, “Bakery and confectionery”.

In the range of 0.02-0.05 mg/kg of the quantitative content of arsenic, the groups “Meat and meat products (except for poultry and products of its processing)” and “Poultry and products of its processing” prevail; in the intervals of 0.05-0.10 mg/kg and 0.1-1.0 mg/kg the group “Fish, fish products, sea animals and other hydrobionts” prevails.

Bar charts based on monitoring data for 2017-2019 are shown in figures 4–6.
Figure 4. Distribution of test results at intervals depending on the quantitative content of arsenic in the samples.

Figure 5. Distribution of test results at intervals depending on the quantitative content of lead in the samples.
Based on the results of the data analysis of the above bar charts, it was established that when the quantitative content of cadmium is detected, the maximum number of test results falls within the range of less than 0.001 mg/kg. In the case of detection of the quantitative content of lead, the maximum number of test results falls within the range of less than 0.01 mg/kg; in the case of detection of arsenic they fall in the range of less than 0.02 mg/kg.

4. Conclusion
The analysis of monitoring the quantitative content of toxic elements in food samples confirms the need for analytical express control.

The analysis of 2017–2019 monitoring results revealed predominant ranges of toxic elements concentration in various categories of products. It is evident that when the quantitative content of cadmium is detected, the maximum number of test results falls within the range of less than 0.001 mg/kg. In the case of detection of the quantitative content of lead, the maximum number of test results falls within the range of less than 0.01 mg/kg; in the case of detection of arsenic the maximum number of test results falls within the interval less than 0.02 mg/kg.

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