Monitoring of meat raw material with increased heavy metal content according to traceability principles

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Abstract – **Urgency of the challenge to preserve the natural environment is dictated by poor ecological conditions prevailing in the regions and cities with intense industrial activity. Among the pollutants of the biosphere, heavy metals are of particular danger because of their high ecotoxicity, cumulative and synergistic effect when combined with other agents of different nature. The main danger of metals for human body is not apparent poisoning, but their ability to accumulate gradually in food chains.**

The purpose of this study was to improve the methodology for assessing the quality and safety of food products and raw materials based on the principles of traceability for accumulation of toxic substances.

Keywords – **heavy metals, traceability, monitoring**

I. INTRODUCTION

Currently, great attention is paid to the quality and safety of produced foods. In Russia, unlike the EU, safety monitoring of meat and meat products is carried out at the final stage of production, when lots of money and time are already spent to produce the final product. Thus, there is no ability to affect its quality.

Risk of contamination of foods and raw materials with potentially hazardous substances could be reduced only by means of effective system for monitoring of food safety at all stages of production and sales.

Scientific explanation and practical implementation of measures to supply the population of industrialized areas with safe food products of animal origin will result in obtaining high quality raw materials and thus ensure the safety of the final product.

The V.M. Gorbatov All-Russian Meat Research Institute has developed the concept of production of guaranteed safe meat products, which includes a comprehensive quality and safety system based on the use of barrier technology, predictive microbiology, critical control points, production management principles, and product traceability system through the entire chain of production, transportation and sales to the consumer. Toxic substances contained in soil and water are transferred into plants (industrial and fodder). The constituents of plants accumulate in animal body and then in animal products and foods.

Therefore, the urgent task is to improve the methodology for assessing the quality and safety of food products and raw materials based on the principles of traceability for accumulation of toxic substances [2].

II. MATERIALS AND METHODS

The principles of traceability are used to build the design for monitoring of heavy metal content of natural and anthropogenic origin in organs and tissues of farm animals (Fig. 1).

In accordance with the presented design, farms breeding the farm animals for meat production were selected as objects for monitoring while area and anthropogenic influence were simultaneously assessed [3]. Observing system included such indicators of anthropogenic load, as pollution of air, drinking water, soil, animal organs and tissues.

In order to identify potentially hazardous chemicals the most complete list of all chemicals that could affect the human in the studied area was compiled.

Then, when assessing the study area, the main existing (or existed in the past) sources of pollution were establishes, including facilities in adjacent areas potentially able to influence the studied animals relative to the possibility of the spatial distribution of toxic compounds. One should also consider the possibility of cross-media transition and accumulation of chemicals in the secondary polluted media.

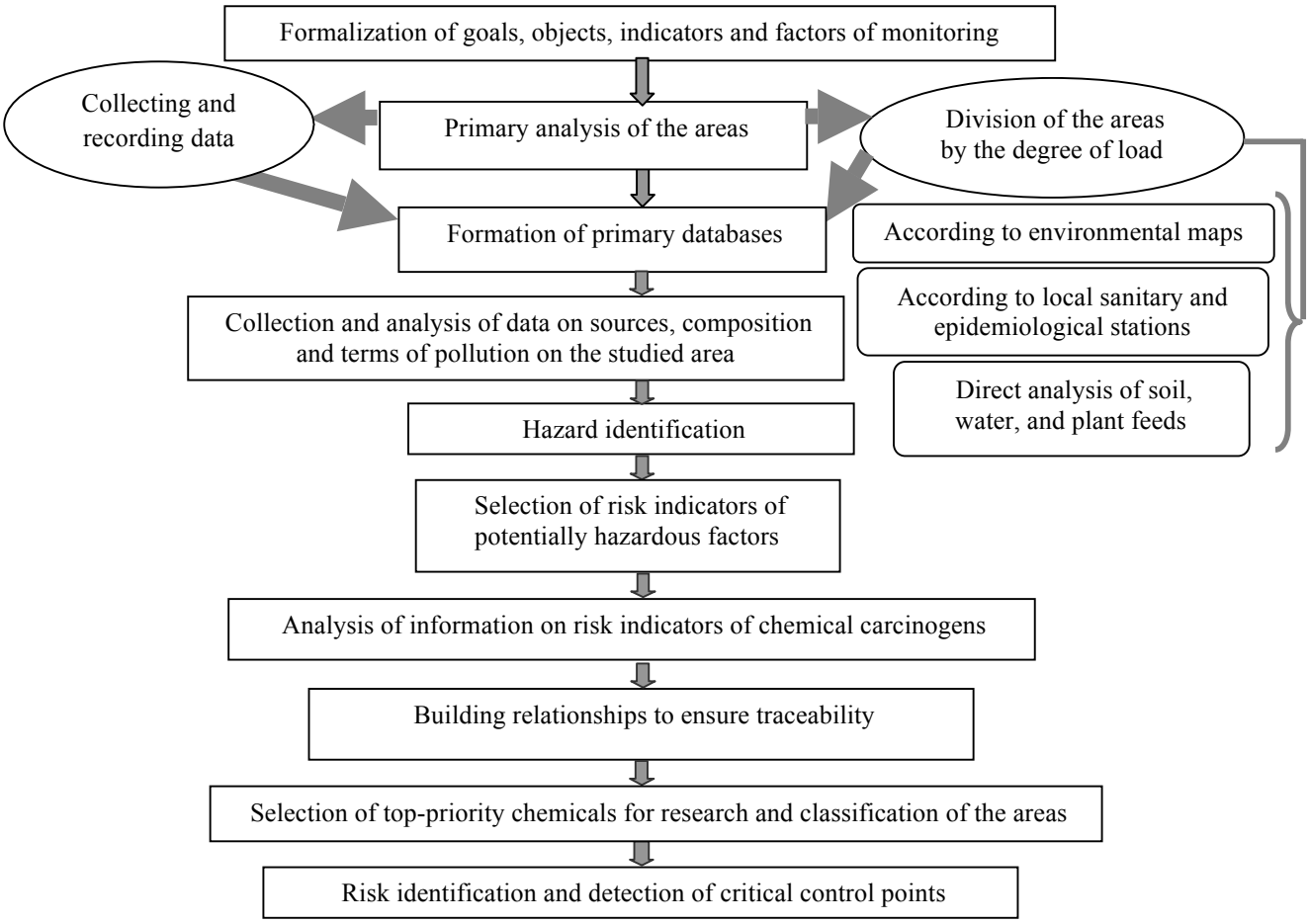

Fig.1 Design of work

The collected data were grouped taking into account the objects of the environment and the sampling sites. The analysis included not only resulting statistical parameters, but also all the measured concentrations with indication of sampling date, which is particularly important when assessing the risk of acute effects of chemical compounds.

When selecting risk indicators necessary to solve specific problems of risk, assessment preliminary design was formed and the exposure pathways of the chemicals were identified. These pathways were subsequently updated in the evaluation of exposure. Hazard identification was carried out both for parent compounds and for toxic products of their transformations in the environment and in the body.

When analysing the list of most dangerous substances, the groups presumably entering the body at the same time were marked. For these compounds, critical organs (systems) were analysed based on the available literature while the type of their simultaneous (combined and complex) action were assumed by analogy with structurally similar substances. Assessment of combined effect of non-carcinogens intended the additive effects of substances on the same organs or body systems.

Determination of social-hygiene priorities for the areas was carried out by identification of correlation for environmental factors with health characteristics of population. Such correlation was determined by the experts or by means of computer processing.

The experts separated the areas with the worst indicators of animal health (morbidity, mortality, physical development, pregnancy and calving pathologies, etc.) and analysed sanitary and hygienic parameters of the environment (air, water sources, soil, feeds) recorded in these areas. Based on this analysis, environmental factors strongly associated with indicators of healthy animals were empirically established.

At the final stage, the risk identification and critical control points (CCP) detection were carried out.

Research on the accumulation of residual quantities of toxic substances in the organs and tissues of slaughtered animals (in accordance with the above design) conducted at the Institute on the basis on the traceability principles allowed to estimate the degree of anthropogenic load on trophological chain. According to these results, the degree of pollution in the area and, consequently, in production was identified.

III. RESULTS AND DISCUSSION

The dynamics and characteristics of the accumulation of residual biogenic elements (copper, zinc, iron, magnesium, manganese, cobalt, sodium, potassium, calcium), including toxic ones (lead and cadmium), were determined in organs and tissues of animals (pigs, cattle) and poultry under effects of feeds, water, and environmental conditions.

For example, the dynamics of zinc accumulation in the organs of broiler chickens had the following tendency: soil (1.84) - feeds (1.41) - skin (1.53) - liver (1.34) - stomach (1.25) - white meat (1.15) - red meat (1.1) - heart (1.01), with a maximum accumulation in skin.

As a result, the CCPs of accumulation of toxic compounds in the organs and tissues of pigs (suet, liver, and kidney), poultry (skin), and cattle (kidney) were identified [3].

Based on these researches, the recommendations were developed for the use of raw meat derived from slaughtered animals grown in the areas with high environmental load. The recommendations will help to make the right decision when choosing supplier and using raw meat. Information received will further be collected in a database and used to develop a national program for monitoring of residual toxic substances in food products.

According to the developed recommendations, the input control should establish the origin of animals, including the growing area and the origin of feeds (local or imported) based on supporting documents. Hazard analysis and identification of the CCPs for the incoming raw materials should also be performed.

During the processing of raw meat with high content of heavy metals and essential elements derived from slaughtered animals grown in the areas subjected to anthropogenic pollution, animal carcasses should be well bled.

According to the recommendations, it is necessary to take steps to reduce the heavy metal content in final food products to acceptable levels by mechanical removal of critical organs and tissues, as well as to dilute the contaminated raw materials with clean ones not more than 15% of total amount of raw materials intended for manufacturing the batch of product. It is also required to boil the contaminated raw meat before using and to pour out the broth. Given the particular toxicity of heavy metals, the foods produced from raw materials with high content of heavy metals cannot be sold to the people.

IV. CONCLUSION

The development of integrated monitoring system and databank on the content of residual toxic substances during animal breeding and slaughtering based on the traceability principles will ensure stable raw material quality and safety of the final products.

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