BASICS OF ANIMAL PRODUCTION UNDER CONDITIONS OF RADIOACTIVE CONTAMINATION

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Abstract

The paper examines the effectiveness of countermeasures implemented in the agricultural sector in Belarus after the Chernobyl nuclear power plant disaster in order to ensure compliance of animal products with the national standards for permissible radionuclide concentrations in foods.

1. INTRODUCTION

The accident at the Chernobyl nuclear power plant occurred on 26 April 1986, on the border between the Ukraine and Belarus. After the decay of short lived radionuclides, the main radioactive contaminants are still caesium isotopes and 90Sr in some areas. Long term compliance with the guidelines and recommendations developed by scientists resulted in a gradual lowering of the national standards for radionuclide concentration levels in major foodstuffs. Although national permissible levels were revised six times, they have always been stricter than the national standards of other affected countries.

2. RESULTS OF THE STUDY

Agricultural practices have shown that with the use of agro-melioration and agro-technical countermeasures it is possible to produce crop and animal products that comply with the permissible levels of 137Cs and 90Sr content in foods and raw materials. Countermeasures can be implemented at different production stages and in different key segments of radionuclide transfer in ‘soil–plant’, ‘feed–animal’, or ‘raw material–end product’ chains. The contribution of cow’s milk, the most critical food product in terms of 137Cs contamination, to internal doses of radiation received by the population can reach 40–80%. In order to reduce internal exposures to the population, it is necessary to apply countermeasures that reduce the transfer of radionuclides into animal fodder. The most effective in terms of dose reduction are countermeasures implemented on pastures and grasslands that are used for meat and milk production (e.g. core improvement of natural grasslands, renovation of cultivated pastures) [1].

Disc harrowing and tillage of grasslands on mineral soils together with the application of mineral fertilizers leads to a factor of 3–5 times reduction of 137Cs and 90Sr uptake by grasses. Core improvement of cultivated meadows also reduces 137Cs transfer grasses, though this approach is

less effective in relation to 90Sr. Over the course of time, however, increased concentration levels of radionuclides in forage and hay may occur due to degradation of cultivated grass stands. Therefore, it is important to ensure renovation of forage lands every 3–6 years, depending on the type of grassland and soil characteristics. At the first stage (i.e. during 1986–1990), half-life periods (T1/2) of 137Cs transfer to field crops were between several months and 1.5 years (T1/2 1.0-1.8 years for grain crops and 0.8–1.2 years for potatoes). During the second stage (1991–1998), T1/2 was from 5 to 13 years. Application of agricultural countermeasures in the first years after the Chernobyl disaster (1986-1992) had resulted in reductions of 3–8 times of 137Cs transfer to crop yields. Several years after the accident (1992–2010), the contribution of natural processes (caesium fixation by clay minerals and radioactive decay) prevailed over the effect of caesium reducing countermeasures, which dropped down to the average of 50–80%. Nowadays, the major contributor to the reduction of 137Cs concentrations in agricultural produce is radioactive decay. In some cases it is very hard, or even impossible, to implement core improvement of pastures. This is why special drugs are introduced into animal diets to prevent absorption of radiocaesium in the gastrointestinal tract and, therefore, limit its transfer to meat and milk products and subsequently into the food supply and humans. The most widely known and used drugs are caesium binding sorbents such as Prussian blue, ferrocynes, Giese salt and Nigrovitch salt. The introduction of these drugs has proved to be a reliable countermeasure with sustainable effects, resulting in a 2–5 fold reduction of 137Cs concentrations in milk and muscle tissues of dairy and beef cattle [2–4]. One of the most popular protective measures in Belarus agriculture in the first months after the accident was feeding cattle ‘clean’ forage at the final fattening stage. Due to this countermeasure, production of contaminated meat was rapidly reduced to insignificant figures [5]. Replacing contaminated milk in the human diet with its processed derivates is an effective protective measure that can achieve a reduction of more than ten times of radionuclide intake into the human body. A reduction of 8–10 times of 137Cs and 90Sr concentrations in the end products can be reached by processing whole milk into butter and rennet cheese. Whole milk processing for cream, sour cream and cottage cheese leads to a reduction of 4–6 times. In cases when contaminated land make it impossible to produce crops in compliance with the established standards, or when consumption of animal products contributes to high doses of internal radiation of the population, an effective countermeasure would be to change the production purposes of a farm enterprise. For instance, a collective dose due to strontium and caesium contribution would be 28 times less, when contaminated feeds are used for the purposes of meat production instead of dairy purposes. Thus, by changing the purpose of the usage of grown farm crops it is possible to lower the levels of exposure to the population by 20–30 times [6].

REFERENCES

[1] AVERIN, V., “Countermeasures in agricultural sector as a basis for recovery and substantial development of contaminated territories of the Republic of Belarus affected in the result of the Chernobyl NPP disaster”, Combating Radionuclide Contamination in Agro-Soil Environment (Proc. Int. Symp. Tokyo, 2012), Tokyo (2012) 259–265.

[2] STRAND, P., HOWARD, B.J., AVERIN, V., Transfer of Radionuclides to Animals, Their Comparative Importance Under Different Agricultural Ecosystems and Appropriate Countermeasures, Experimental Collaboration Project No. 9, final scientific report, Luxembourg (1996).

[3] HOWARD, B.J., et al., “A fluxes of radiocaesium to milk and appropriate countermeasures”, The Radiological Consequence of the Chernobyl Accident (Proc. Int. Conf. Minsk, 1996), Minsk (1996) 349–362.
[4] INTERNATIONAL ATOMIC ENERGY AGENCY, The Use of Prussian Blue to Reduce Radiocaesium Contamination of Milk and Meat Produced on Territories Affected by the Chernobyl Accident, (Special Russian edition), IAEA-TECDOC-926/R, IAEA, Vienna (1997).
[5] AVERIN, V.S., Radioecological Justification of the System of Measures for Reducing Radiation Burdens on Population from Consumption of Contaminated Animal Products, RIRAE, Obninsk (1999) (in Russian).
[6] ANNENKOV, B.N., AVERIN, V.S., Farming in Contaminated Areas (Radionuclides in Food), Propilei, Minsk (2003).