

THERAPEUTIC & PROPHYLACTIC PRODUCTS FOR INCREASING AN ORGANISM'S IRRADIATION-RESISTANCE

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Disastrous ecological effects after Chernobyl accident have raised for years a very serious problem of the preservation of physiological, intellectual and spiritual genetic resources of the population in radiation affected areas of the former Soviet Union.

For this population and "liquidators" in the present-day situation to reduce a carcinogenesis risk from the radioactive irradiation to have taken place is of very great importance as these people have already received the greater portion of the radiation dose. However, for some groups of the population a problem of reducing dose loads doesn't lose its actuality in connection with problems of a rehabilitation of affected areas, inhabitants' home-returning, a possibility to obtain a "pure, ecologically safe agricultural produce" as well as in case of a new radiation accident.

At present for the protection of a human organism from contamination with the main dose-generating radionuclides a number of radioprotectors of a therapeutic/prophylactic type is offered, e.g. ferrocin, alginates, etc. However, these are in general preparations of short-term use for the limited contingent of persons, but rather frequently in spite of their positive influence on radionuclides removal it is impossible to except their injurious effect, since together with radionuclides a sorption of essential minerals from an organism can take place.

In this connection, natural substances (dietary components) whose innocuous properties are confirmed by the centuries-old human experience of their consumption are of the highest interest. They are inexpensive and suitable for a long-term use by large groups of the population. Such components can be designated by a term "common preventive products".

VNIIMP (All-Russian Research Institute of Meat Industry) carries out studies aimed at the development of a high-quality range of meat products of biological full value promoting an increase of organism's resistance against radiological influences.

Composition of the products (canned meats) to be created was modelled on the basis of principles (developed by Institute of Nutrition of the Russian Academy of Medical Sciences) of formulating diets for the population to be exposed to irradiation in Chernobyl nuclear power station as well as physiological standard requirements of an organism to be exposed in nutrients. Medico-biological requirements to the quality of meat products of a prophylactic type were also taken into consideration.

A production process for the manufacture of such canned meats provides an inclusion of some biologically active substances such as radioprotectors (vitamins, alginates, dietary fibers, protein additives) in their formulations besides traditionally used meat and auxiliary raw materials.

The quality of experimental samples was estimated on criteria which determine their nutritional and biological values; their antiradiation effectiveness at chronic internal contamination of an animal organism with radioisotopes Sr-90 and Cs-137 was also studied. It was stated that the protein mass content of canned meats was 13%, this one of lipids - 11,8% - 15,7%. Energy value of canned meat-vegetable products varied in the range from 184 to 212 kcal/100 g. These products didn't contain amino acids limiting their biological value; their lipid composition was characterized by the ratio of saturated, mono- and polyunsaturated fatty acids similar to the required formula.

Inclusion of vitamins and ingredients with a high minerals content into recipes of canned products allowed to satisfy in full measure the higher physiological requirements of an organism in these nutrients. Studies carried out in Moscow Medical Academy showed that new products developed had a high biological value: protein efficiency ratios and protein digestibility ones were equal to 2,63-2,76 and 94,2-95,6, respectively.

The antiradiation effectiveness was studied in radiation-ecological laboratory of Institute of Biophysics on the body weight dynamics parameters of rats and on the state of their circulatory system, the latter being determined by radiometry of their bone tissues on the Sr-90 content as well as by measurements of the Cs-137 content in organs and tissues of animals carried out in their life-time. During experiments rats were irradiated with radioactive isotopes of Sr-90 and Cs-137 (radionuclide solutions were probed). Experiments' time-limits caused a speeding-up of chronic absorption of Sr-90 isotopes on a level of 1,8, Cs-137 - 0,3 Gy.

It was stated that the introduction of canned products developed in rations of animals under experiment and feeding them for 20 days before the internal irradiation with radionuclides exerted a roborant effect what was expressed in increasing the weight of animals and improving haemolysis parameters ($P < 0,05$). Decreasing the weight of animals as a result of their chronic internal irradiation was less expressed and its normalization occurred in more earlier time than in animals of the control group.

The maintenance of irradiated animals under experiment on the concentrated canned diet

had a wholesome effect on their blood formation system. Thus, the quantity of the main formed elements of white blood formation in rats under experiment at Sr-90 irradiation was truly higher than in control animals ($P < 0,05$). Feeding animals with canned products developed at Cs-137 irradiation promoted to the renewal of leucocytary formula in more early stage of exposure as well as cell elements of red blood almost to standard levels. Sr-isotope accumulation in the skeleton of experiment animals was truly ($P < 0,01$) reduced 2-fold and even more as compared with the control group. The efficiency of prevention from Sr-90 at feeding animals with canned meat-vegetable products was 53%, in case of meat products - 44-56%.

Results of radiometric measurements carried out in life-time of animals showed that the Cs-137 concentration in organs and tissues of experiment animals was truly ($P < 0,01$) lower than in animals of the control group. The efficiency of reducing the Cs-content as a result of feeding with meat-vegetable canned products was 58-62%. Thus, the introduction of specialized canned products contacting with ionizing radiation in rations increases the resistance of an organism and reduces an accumulation level of the most injurious isotopes of Cs-137 and Sr-90 and, hence, decreases a dose load.

MATERIALS AND METHODS

Meats and organs. Meats and organs used for experiments were prepared from cattle, swine and chicken which were slaughtered at National Institute of Animal Industry. After fat and connective tissue were removed, each of the materials was cut into small pieces. They were homogenized with an equal weight of water and centrifuged at 1000 g for 15 min. The supernatant was then freeze-dried. Ten water extracts containing macrophage stimulants were dialyzed against distilled water to obtain their non-diffusible fractions. Each of the fractions was then freeze-dried.

Cells and medium. A macrophage cell line (RAW 264.7) was obtained from the American Type Culture Collection. The cells were grown in Dulbecco's modified Eagle medium supplemented with 10% fetal calf serum (Bocknek Laboratories) at 37°C in a humidified incubator containing 5% CO₂ and 95% air.

Nitrite formation assay. The freeze-dried samples were each dispersed in the supplemented MEM (Hiras et al., 1989) and stirred for 30 min. After centrifugation, the supernatant was sterilized by passage through a 0.22 µm filter. The cultured macrophage was removed from the dishes by vigorous pipetting and resuspended at a concentration of 1×10^6 cells/ml. Cells were plated at 500 µl/well allowed to adhere for 30 min, and then the medium was changed to the sample in the supplemented MEM. After 48 h of incubation, nitrite concentration in the culture supernatant was determined by a colorimetric method (Hiras et al., 1989). Data were each expressed as an average of three independent measurements.

RESULTS AND DISCUSSION

Table 1 shows macrophage stimulation activity of meats and organs in beef and cattle organs. Only reticulumen and cerebrum (50.0 and 5.0 mg/ml) stimulated macrophages to produce nitrite. Water extracts per se did not contain nitrite. The nitrite production by lipopolysaccharide (LPS) was 66 nmol/10⁶ cells in the control and saline organ. The water extracts had the activity. Among the six stomach and tongue had high activity. They stimulated macrophages at a concentration more than 5.0 mg/ml. Table 1 also shows that chicken gizzards had the highest macrophage stimulation activity. Chicken had the highest activity among the 18 materials investigated in this experiment and the nitrite production was 11.4 nmol/10⁶ cells at a concentration of 0.5 mg/ml. In this experiment, we found that ten water extracts from three kinds of meats and 35 organs had macrophage stimulating activity. These ten extracts containing macrophage stimulants were dialyzed against distilled water. Some of them lost the activity by dialysis and the others contained non-diffusible stimulants. The non-diffusible stimulants in swine cerebrum, swine cerebellum and chicken, chicken gizzards had higher activity than the activity before dialysis.