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Reducing the risk of hazards when working with radioactive substances and ionizing radiation

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Abstract. The paper presents a product designed to feed people working with radioactive substances and ionizing radiation. The effectiveness of the proposed composition is characterized by the anti-radiation properties of the ingredients included in the composition in the optimal amount and ratio. This product can be recommended as an additional component of dietary and therapeutic nutrition for radiation damage and free radical oxidation of the human body. The presence of a sulfur-containing amino acid - cysteine determines the radiation protective properties of the product and provides an antitumor effect. Cereal bar is proposed for feeding workers who work with radioactive substances and ionising radiation, which includes oat bran, light or dark raisins, dried dates, bee honey, coarse wheat fibre, buckwheat flour, dried apricots, pumpkin seeds, sesame seeds, black currant berries, green apple, butter, dried sea cabbage, crushed fresh beets and dried chokeberry fruits. Invention provides the preparation of cereal bars intended for feeding workers working with radioactive substances and ionising radiation, with radioprotective effect, which accelerate the excretion of radioactive substances from the body.

1. Introduction

People working in difficult industrial conditions need increased support for their health, as the body is subjected to enormous loads. The risk of getting an occupational disease, weakening of the immune system, and general state of health is increasing. The legislator and doctors have developed a special set of measures to support the health of specialists. One such protective measure is special nutrition and special benefits. After all, it is the food that a person consumes that affects his metabolism and state of health [1,2].

The rules and conditions for the free issuance of healthful and dietary nutrition or other equivalent food products are approved in the manner established by the Government of the Russian Federation. Working conditions are recognized as dangerous after a special assessment of jobs or on the basis of certification, if it took place before 1.01.2014 (the results are valid for 5 years). This innovation is aimed at improving the control of the situation by the state. In accordance with Federal Law No. 426



of December 28, 2013, a special assessment of working conditions is carried out by independent experts: laboratories accredited by the Ministry of Labor.

Healthful and dietary nutrition is provided under harmful (dangerous) working conditions for those employees of the enterprise whose professions (positions) are listed in order No. 46n of 16.02.2009, and who perform work in such conditions for at least half of the working day (shift). In addition, healthful and dietary nutrition is issued: to workers who perform various repair, start-up and other types of work in buildings, where working conditions have an increased risk to humans; employees who are on sick leave due to a professional illness (outside the hospital) or have received disability while working in dangerous conditions; workers temporarily transferred from premises with dangerous conditions to other types of work for health reasons. For those employees who were transferred to another job due to occupational disease or received disability in hazardous work, additional meals are required for a period not exceeding 1 year [3-5].

2. Relevance

Currently, urgent issues are protection from radioactive radiation and search for their sources. Radiation is an invisible and especially insidious enemy. People who have been living in infected areas for decades may not be aware of the danger. The effect of radiation on the body gradually manifests itself in the form of heart rhythm failures and the appearance of cancer. The cause of such pathologies, as a rule, is considered stress, smoking, a disordered lifestyle, and poor heredity. Usually no one thinks about the fact that somewhere nearby there is a source of radioactive infection.

The imperceptible effects of radiation last for years. Radiation protection may be necessary for everyone. Blood taken for analysis makes it possible to establish the status - "irradiated" or "injured". These terms describe the degree of damage to everyone who came in contact with radiation. Radiation does not always affect the body immediately. Some effects of exposure to radiation reveal themselves only after a few years. In this case, it is important to have documentary evidence of "irradiated" status. The natural radiation background should be 0.10-0.20 mSv/h. But if the dosimeter shows 0.3 mSv/h or more, it should be perceived as a cause for alarm.

Studies have shown that people who have professional contact with ionizing radiation (radiation) can develop leukemia and various undesirable biological effects. A large dose causes certain (deterministic) symptoms, which in general are called radiation sickness. Small doses of radiation lead to various random (stochastic) changes in the human body, which can occur in both short and long periods (genetic, oncological and other diseases) [6].

3. Problem Statement

With radiation sickness in the human body, the functioning of physiological systems is disrupted, and certain cellular structures are destroyed. This disease manifests itself in a multicomponent and multilevel state. There is acute and chronic radiation sickness caused by external and internal radiation, the accumulation of radionuclides in various tissues.

The radiation dose that can cause acute radiation sickness can only be obtained in radiation accidents at nuclear reactors or in the zone of use of nuclear weapons. So, with uniform one-off event exposure, the threshold dose for the occurrence of acute radiation sickness is 1 Sievert. The first symptoms of acute radiation sickness are nausea, vomiting, lethargy, apathy, lack of desire to move (adynamy). This condition is also called primary radiation reaction. The early symptoms that occur immediately after exposure depend on the dose received by the person. The higher the radiation dose, the first sign occurs earlier and the more pronounced and prolonged it is. This is followed by a period of imaginary well-being and the height of the disease, when the main symptoms of radiation sickness are associated with a violation of the cellular structures of the body [7-9].

TINRO-center experts recommend simple and affordable ways to prevent radioactive contamination. The best sorbents and iodine-containing products are provided by the sea.

4. Results

The first remedy that the Japanese began to use is dried seaweed powder. In the fight against radiation, seaweed is useful as a dietary supplement, in the Far East salad or in dried form. Algae contain iodine and the most important trace elements, moreover, in the form in which radioactive isotopes are displaced, trying to integrate into human metabolism. The sorbing properties of algae bind and remove toxins. At the same time, the substances of seaweed work gently, starting to remove dangerous cesium and strontium first. And algae iodine does not accumulate in the body to dangerous conditions - the thyroid receives exactly as much as it needs.

In addition, pectin contained in all domestic fruits and berries (gooseberries, currants) also effectively removes isotopes from the body. The Order of the Ministry of Health of the Russian Federation No. 20 dated January 24, 2000 "On the implementation of the guidelines for the organization of sanitary and hygienic and healthful and dietary measures for large-scale radiation accidents" outlines measures for the use of iodine prevention by the population. Iodine prophylaxis protects the thyroid gland from the negative effects of radioactive isotopes, preventing deterministic and reducing stochastic effects.

According to the order No. 46n of the Ministry of Health and Social Development of the Russian Federation dated February 16, 2009, the Institute of Nutrition RAMS proposed a healthful and dietary meals No. 1 intended for those working with radioactive substances and ionizing radiation involved in the production of radioactive salts of uranium, thorium, etc. The diet is radiation protective and enriched with proteins of high biological value. The chemical composition of the proposed diet should include 59 g. proteins, 51 gr. fat, 159 gr. carbohydrates, the energy value should be 1380 kcal [10].

5. Conclusion

In view of the foregoing, the authors of the article proposed a cereal bar for feeding those people who work with radioactive substances and ionizing radiation, for which the Russian Federation patent No. 2 649 875 was obtained (published on April 5, 2018, bull. No. 10). The table 1 shows the ingredient composition and energy values of this product [11].

The composition of the proposed food product is enriched with ingredients that block the ionization of atoms and molecules of tissues with the formation of free radicals when exposed to radiation on the human body. As a result, a radiation protective effect and acceleration of the removal of radioactive substances from the body through the intestine is ensured. The cooking process includes the alternate combination of grain ingredients (oat bran, wheat fiber, buckwheat flour, sesame seeds, and pumpkin seeds), chopped dried apricots and raisins with fruit and vegetable mass and butter-honey component. The resulting composition is baked in a special form at a temperature of 180 degrees for 15-20 minutes. Then, the ready-made cereal cake is cooled and cut into bars of the appropriate weight [12-13].

6. Conclusion

Thus, the composition of this product includes radiation protective components of food, proteins of high biological value, ingredients enriched with sulfur-containing amino acids, dietary fiber that can bind and effectively remove radionuclides from the body.

A food product can be an additional source of necessary food components with a high content of grain (cereal) dimension and provide a lack of energy value in the nutrition of individuals when working with radioactive substances and ionizing radiation [14-20].

Table 1. The composition of the cereal product for nutrition people working with radioactive substances and ionizing radiation.

Ingredients	Weight, g	Composition, g			Energy value, kcal
		proteins	fats	carbohydrates	
Oat bran	250	33	11.5	120.3	756.35
Wheat fiber, large	70	11.2	16.45	2.66	130.4
Buckwheat flour	80	7.6	1.52	57.8	260.8
Sesame seeds	30	5.82	14.61	3.66	169.5
Pumpkin seeds	35	10.61	17.17	3.75	195.65
Dried apricots	100	5.2	-	65.9	272
Dried dates	100	2.5	-	72.1	281
Dark or light raisins	50	0.75	-	36.5	146
Fresh chopped beet	100	1.7	-	10.8	48
Dried fruits of aronia	65	0.975	-	7.8	35.1
Dried seaweed	100	0.9	0.2	3	5
Blackcurrant berries	300	3	1.2	21.9	132
Green apple	150	0.6	-	16.95	69
Butter	70	0.42	57.75	0.63	523.6
Honey	70	0.56	0	56.21	215.6
Total	1570	84.84	120.4	479.96	3240
Total	100	5.4	7.7	30.57	206.4
Total	30	1.62	2.31	9.17	61.92

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