C62

METHODOLOGY OF CREATION OF MEAT-BASED PRODUCTS, INCREASING RESISTANCE OF HUMAN ORGANISM TO RADIOLOGICAL INFLUENCES

N.N. LIPATOV, A.B. LISITSYN, T.A. RUDINTSEVA, G.A. SAFRONOVA
All-Russian Meat Research Institute, Talalikhina 26, 109316 Moscow, Russia

Key words: special nutrition, radioresistant factors, quality evaluation criteria, mathematical substantiation of formulations

Consequences of ecological catastrophe associated with Chernobyl disaster have been posing for many years a challenge of preservation of physiological, intellectual, and spiritial gene pool of population at vast areas of the Ukraine, Byelorussia, and Russia falling into the zone of radiological influence.

Leading specialists in biology and medicine are joining their efforts to solve this problem. Scientific Research Institutes and Medicinal Centres work at this problem. One should not underestimate a complicated character of its solution. It is generally recognized that by means of special nutrition it is possible to increase the efficiency of medicinal, physical and chemotherapy curing and preventive measures of consequences of weak (less than 2 Gray = 200 rems) and moderate (2 ... 4 Gray) of radioactive irradiation doses of people.

The presence in products protein of indispensable and dispensable amino acids responsible for rational metabolism, approaching their mutual balance to optimum to meet the degree of radiological affection of immune, blood-forming and other functions of the organism, the availability of lipoproteide cellular membranes and hormones of polyunsaturated fatty acids, necessary for biosynthesis, amounts and ratios of hydrolyzed carbohydrates, vitamins and other nutrients, sufficient for effective compensation of energy consumption - all this contributes to significant improvement of general status of the organism and increase its resistance, as far as prolonged action of endogenic and exogenic radiological factors are concerned.

Purposeful incorporation in formulations of food products of bioorganic and mineral components, forming unassimilable complexes with radioactive isotopes and their compounds with potentially transported products of catabolism contributes to effective clearing the organism of strontium-90, cesium-137 and other radioactive elements.

The above-mentioned served as a logic basis for generalization and systematization of the results of 3 year investigations in the field of theoretical and experimental development of formulations, technological processes and parameters of their implementation, and on the whole providing possibility of commercial production of meat-based foodstuffs, contributing to increasing the resistance of human organism to the effects of radiological factors. Fig. 1 shows the scheme - classification of radioresistant factors of nutrition, largely dividing them into synthetic, modified and natural ones. The next level of this scheme subdivides them into 4 directions: removing radionuclides, antioxidant, blood forming and generally tonic. The first direction implies usage of 5 classes of food substances which bind radioisotopes, radioactive substances and compounds physically, physico-chemically, chemo-physically and chemically and evacuating them from the organism. The second direction uses two classes of substances; the third - four and the fourth - two.

It is interesting to note that according to numerous literature data, such class of foodstuffs as vitamins, belonging to micronutrients, possess high efficiency with regards to three directions: antioxidant, blood-forming and generally tonic. Based on above classification, general and special requirements to ingredients of radioresistant food product have been formulated (Fig. 2). The scheme, as proposed by the authors of this paper (Fig.3), of developing special foodstuffs, and terminating with the organization of commercial production, provides for implementation of 20 stages, ranged in 8 hierarchical levels. In this scheme a great deal of attention is given to choice of preferential ingredients for compu-

ter designing of formulations as based on a priori information about their biological and energy value, digestibility and potential radioresistant properties. Computer designing of formulations of multi-component meat products of radioresistant profile, which are adequate with regards to biological, energy and food value, are based on previously presented methods (1-4). The primary design formulae used in recurrent-cyclic algorithms of computer simulation of the influence of main macronutrients ratio on indices of biological, food and energy value of multi-component mixtures, are presented in Fig 4. The next stages of development of specialized products concerning the assessment of their radioresistant efficiency, will include complex investigation of their biological value in vitro and in vivo with subsequent studying radioresistant properties in vivo on animals and on volunteers. After these steps, the intergrated quantitative assessment of food and special properties of the developed products can be carried out on the basis of experimental data by multiplicative mathematical criterion, developed by the author and presented in Fig. 5.
The results of utilization of a number of approaches described in this paper, are presented in a published work of workers of VNIIMP "Multicomponent products of radioresistant profile" which is proposed to your attention.

References:

1. Lipatov N.N. Methods of quantity evaluation and modelling of amino acid mutual balance of meat industry products: XXXI European Congress of Meat Research Workers, Sofia, 1985, pp. 158-161
2. Lipatov N.N., Rogov I.A. Deterministic approaches to designing biological and energy values of meat products and rations containing them. XXXIII European Congress of Meat Reseach Workers, Helsinki, 1987. Vol. 1, pp. 239-242.
3. Lipatov N.N. Some aspects of modelling of amino acid balance of food products// Pischevaya i pererabatyvayuschaya promyshlennost. - M. 1986, N°. 3, pp. 66-77.

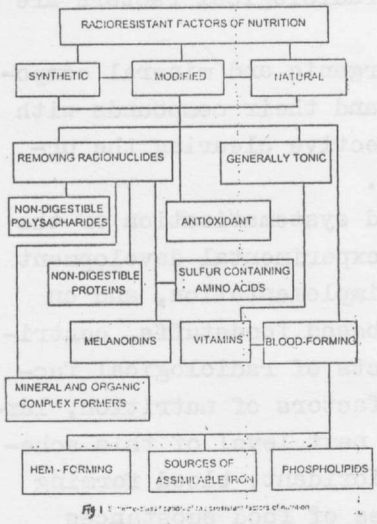

Fig 1

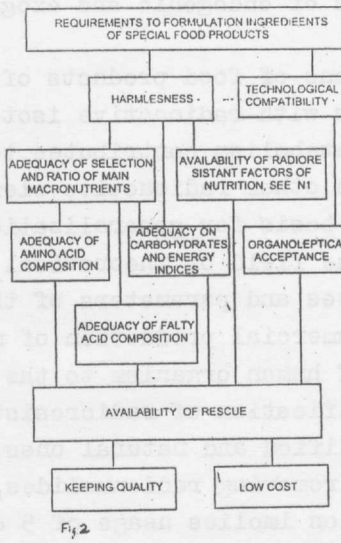

Fig 2

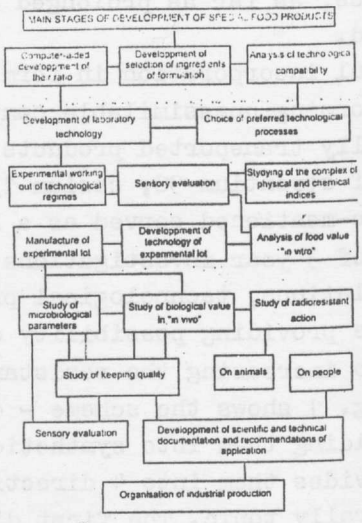

Fig.3

FORMULAE FOR DEVELOPMENT FORMULATIONS

$$P\Sigma = \sum_{i=1}^{n} X_i P_i \quad L\Sigma = \sum_{i=1}^{n} X_i L_i \quad C\Sigma = \sum_{i=1}^{n} X_i C_i$$

$$Q = 4P\Sigma + PL\Sigma + 4C\Sigma$$

$$A_j = \frac{\sum_{i=1}^{n} X_i P_i A_{ij}}{\sum_{i=1}^{n} X_i P_i} \qquad L_j = \frac{\sum_{i=1}^{n} X_i L_i L_{ij}}{\sum_{i=1}^{n} X_i L_i}$$

$P\Sigma$ - mass fraction of protein in formulation mixture
$L\Sigma$ - mass fraction fat, %
$C\Sigma$ - mass fraction of carbohydrates, %
A_j - mass fraction j-indispensable amino acid in total"
C_j - mass fraction of-fatty acid in formulation mixture, %
X_i - mass fraction of i-ingredient in formulation mixture, %
P_i, L_i, C_i - mass fraction of protein, fat, carbohydrates in j-th ingredient, respectively, %
A_{ij}, L_{ij} - mass fraction j-indispensable amino acid or fatty acid, respectively in protein (fat) at formulation mixture, %
Q - energy value, Kcal/100 g
4,9,4 - coefficients Kcal/100(g·)

Fig 4

CRITERION OF COMPARATIVE EVALUATION OF SPECIAL FOOD PRODUCTS

$$K = \frac{KK_6 \cdot БК_6 \cdot tM_6 \cdot \prod_{i=1}^{n} ЭР_{i6} \cdot СЛ_6 \cdot AO_6 \cdot \pi_6 \cdot R_6^P \cdot R_6^L \cdot \prod_{i=1}^{m} БИ_{i6}}{KK_c \cdot БК_c \cdot tM_c \cdot \prod_{i=1}^{n} ЭР_{ic} \cdot СЛ_c \cdot AO_c \cdot \pi_c \cdot R_c^P \cdot R_c^L \cdot \prod_{i=1}^{m} БИ_{ic}}^{\left(\frac{1}{n+m+4}\right)}$$

KK_6, KK_c - index of increase of red cell forming, % of basis (compared) special products, %;
$БК_6, БК_c$ - index of increase of white cell forming, %;
tM_6, tM_c - period of stabilisation of body weigth, days;
$ЭР_{i6}, ЭР_{ic}$ - efficiency of evacuation of radioactive substance of i - kind, %;
$СЛ_6, СЛ_c$ - efficiency of totality;
AO_6, AO_c - antioxidation efficiency, %;
π_6, π_c - digestibility of protein "in vitro", % to initial tyrosine;
R_6^P, R_c^P - index of rationality of amino acid composition, fr. Un., %;
$БИ_{i6}, БИ_{ic}$ - i-th index of biological value of protein in experiments "in vivo", fr. un., %;
$\prod$ - product of i-th indices;
R_6^L, R_c^L - index of rationality of amino acid composition, fr. Un., %;

Fig 5