COMPUTER-AIDED ANALYSIS OF FOOD ADEQUACY OF ANIMAL RAW MATERIALS AS USED FOR PRODUCTION OF POLYCOMPONENT FOODS FOR CHILD NUTRITION

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Background

The present paper is devoted to computer-aided evaluation of food adequacy of the two main macronutrients – proteins and fats, the carriers of which are the animal and plant ingredients of polycomponent meat-based foods for child nutrition. As far as the food adequacy of the protein components is concerned, a statistically processed information is considered regarding their total mass fraction in individual raw materials sources, amino-acid composition of the protein and its digestion by acid and alkaline proteases of gastro-intestinal tract. As far as the food adequacy of the fat components - the information about their mass fraction in the individual ingredient, the set and mass fractions of forming them saturated, monounsaturated and polyunsaturated fatty acids. The values of similar indices corresponding to mature woman's milk were used as the reference values of the above mentioned indices of food adequacy of protein and fat components.

To evaluate the most important component of food adequacy of the protein components of the raw materials (and also of final products) – their biological value- the following indices and criteria as offered by academicians of RASKHN Rogov I.A. and Lipatov N.N. (jun.) are used:

Coefficient of utility of the j[th]-essential amino-acid - α_j characterizing a potential efficiency of its use - $\alpha_j = \frac{C\min}{C_j}$; coefficient of rationality of amino acid composition – R_C numerically characterizes the balance of essential amino-acids in relation to physiologically required standard (reference). In the case when Cmin ≤ 1, the coefficient of rationality of the amino-acid composition can be calculated from the following formula: $Rc = \frac{\sum_{j=1}^{n}\left(\alpha_j A_j\right)}{\sum_{j=1}^{n} A_j}$; index of "comparable redundancy" of the content of essential amino acids – σ, characterizing a total mass of essential amino acids not used for anabolic needs in such amount of the protein of the evaluated product, that is equivalent by their potentially utilized content to 100 g of the protein of the reference : $\sigma = \frac{\sum_{j=1}^{n}\left(A_j - C\min \cdot A_{\ni j}\right)}{C\min}$. The following designations are adopted in the formula: Cj – score of the jth essential acid of the assessed protein as related to physiological standard (reference), fract.units; Cmin – minimum score of essential amino-acids of the assessed protein as related to physiological standard (reference), fract. units; Aj – mass fraction of the jth essential acid in the raw materials, g/100 g of raw materials; Aэj – mass fraction of the jth essential acid, corresponding to physiologically needed standard (reference), g/100 g of protein.

The fatty acid balance of potential fat-containing ingredients of the formulations of special meat-based products for child nutrition can be assessed with the help of the following formulae which are a specific interpretation of the general criterion of alimentary adequacy:

$R_L = \left(\prod_{i=1}^{m} d_{Li}\right)^{\frac{1}{m}}$, in this case $d_{Li} = \frac{L_i}{L_{\ni i}}$, if $L_i \leq L_{\ni i}$ and $d_{Li} = \left(\frac{L_i}{L_{\ni i}}\right)^{-1}$ if $L_i > L_{\ni i}$, where R_L – coefficient of fatty acid compliance, fraction units; L_i – mass fraction of the i-th fatty acid in the raw materials. g/100 g of fat; $L_{\ni i}$ - mass fraction of the i th fatty acid, corresponding to physiological standard (reference), g/100 g of fat; i = 1 corresponds to Σ SFA, i = 2 – Σ MUSFA = i = 3 – Σ PUSFA, i = 4 – linoleic, i = 5 – linolenic, i = 6 – arachidonic.

Objectives The purpose of this article is the analysis of nutrient adequacy of raw materials ingredients of animal origin and their ranging acording to the criteria presented.

Methods. Methods of computer-aided statistical processing and ranging of data, computer-aided evaluation of nutrient adequacy of raw materials ingredients of polycomponent food systems.

Results and discussion. Computer-aided analysis of amino-acid balance of protein of products of processed products from cattle and pigs allows to make a conclusion that the protein of these kinds of raw materials ingredients, including by-products and anatomically isolated muscles are limiting by one or several amino-acids as compared to the protein of mature woman's milk. Using the above indices of aminoacid balance – minimum score – C min, coefficient of rationality of amino-acid balance Rp and the coefficient of comparable redundancy –σ, one can make a conclusion that as the individual protein-containing ingredients of products for additional feeding of babies and children of early age, the metabolically advantageous potentials gave: beef heart (Cmin = 85.17, Rp = 0.851, σ = 6.85), higher grade beef (C min = 80.92, Rp = 0.851, ρ= 6.47) and a muscle-fat fraction of mechanically trimmed beef of 2[nd] grade (Cmin = 74.67, Rp = 0.844, σ = 6.32). Among anatomically isolated muscles of the cattle the preference can be given to Semimembranosus (Cmin = 83.33, Rp = 0.852, σ = 6.64), quadriceps (Cmin = 77.45, Rp = 0.874, σ = 5.13) and Semitendinosus (Cmin = 76.01, Rp = 0.846, σ= 6.36)

From functional and technological point of view a connective tissue fraction of mechanically deboned beef of second grade (Cmin = 36.96, Rp = 0.751, σ = 5.62 .may present large interest. Because of a very low score on isoleucin the mass fraction of this component (in terms of protein) in the formulations of products being developed for feeding children of early age shouldn't exceed 5%, however, such amount of connective tissue protein with rational use of its possibilities as water-binding and plastifying substance may be quite sufficient for purposeful change of consistency characteristics of child nutrition products actually without decrease of biological value and digestion of total protein of these products.

Analyzing the data on amino acid composition of proteins of pig products the priorities of their use as the individual raw materials in formulations for child nutrition foods can be ranked as follows: pork heart (C min = 89.22, Rp = 0.899,σ = 5.12), fat pork (C min = 82.76, Rp = 0.860, σ = 6.20) and pork tongue (Cmin = 78.83, Rp = 0.844, σ = 6.70).

Computer-aided analysis of amino-acid balance of proteins of unconventional meat raw materials, poultry products and milk

The data about amino-acid balance of protein of unconventional meat materials for the manufacture of products for feeding of children – lambs meat, horsemeat and deer meat allow to state that these materials are a very promising object for industrial processing. With the aim of quality increase of the products for feeding children of early age from the point of view of acid balance of the protein, the highest potentials has deer meat (Cmin = 79.53, Rp =0.870, σ = 5.43), then lambs meat (Cmin = 78.06, Rp = 0.845, σ = 6.58) and horse meat (Cmin = 78.18, Rp= 0.838, σ= 6.95).

Analyzing the meat materials obtained as a result of processing of chickens one can conclude that the most preferred component of formulations of products for children of early age in terms of balance of aminoacid composition of protein are the leg muscles of male chicks (Cmin= 81.05, Rp = 0.856, σ = 6.24), meat of manual deboning of second grade chickens (C min = 76.84, Rp = 0.846 σ = 6.40) and leg muscles of female chickens (Cmin = 74.50, Rp = 0.844, σ = 6.33).

The thoracic muscles of female chickens and especially of male chicks, as well as the mechanically deboned meat of chickens of second grade on such parameters of aminoacid balance of protein, as Rp and σ are markedly inferior compared to the above-mentioned kinds of raw materials.

Among the egg products the sequence of potential raw materials for the manufacture of products as an additional foods for babies and for children of early age on the parameters of aminoacid balance of the protein is as follows: egg yolk (Cmin = 86.99, Rp =0.857, σ = 6.65), dried yolk of egg (Cmin = 86.32, Rp= 0.847, σ = 7.17) and the whole egg (Cmin = 86.86, Rp = 0.841, σ = 6.55).

Among the dairy products the most advantageous potentials in terms of aminoacid balance of protein are such kinds of materials as dried serum (Cmin = 88.27, Rp =0.892, σ = 4.91) and dried demineralized serum (Cmin = 85.46, Rp = 0.875, σ = 5.59).

Computer-aided analysis of fatty acid balance of animal fats and vegetable oils. At the present time it is generally accepted that fatty acid composition of foods for additional feeding of babies and feeding of children of early age is the next significant complex index after amino-acid balance with the help of which it is possible to evaluate qualitatively and quantitatively functional-metabolic adequacy of these products to the purposes of regular and special nutrition for children. While in the development of milk-based foods the high level of amino acid balance of their total protein component may be achieved through the trivial provision of the ratio "milk casein, serum proteins of milk" at the level 0.4 : 0.6, the more or less satisfactory approach to the fatty acid composition of the products being developed to a similar index corresponding to mature woman's milk, there are up to 5 (not less than 3) of fat –containing components, primarily of vegetable origin (and this is not justified) used. But the authors of this article in their works clearly demonstrated that with the help of the methods of computer designing a very high degree of adequacy to the mature woman's milk of the fatty acid composition of polycomponent products for child nutrition can be achieved through the use of one kind of animal fat and one kind of vegetable oil together with the milk fat (or without it).

As an information support for the convenience of the computer-aided optimization of fatty acid composition of meat-based foods for additional feeding of babies and feeding of children of early age a systematization of experimental data on the fatty acid composition of fat of potential recipe ingredients of animal and vegetable origin presented in different literature sources was carried out.

The analysis of data and calculated on their base coefficients of fatty acid balance leads to the following conclusions.

The highest adequacy as compared to the fat of mature woman's milk that was evaluated by the coefficient of the fatty acid balance taking into account the ratios of sums of saturated, monounsaturated and polyunsaturated fatty acids possess (in descending order) : lard, back fat, side fat, fat pork, pork semi-fat, whole chicken egg and dried whole egg. In case when the coefficient of fatty acid balance is calculated not only with the consideration of the ratio of sums of saturated, monosaturated and polyunsaturated fatty acids but also of linoleic, linolenic and arachidonic polyunsaturated fatty acids, the highest balance have the fat of the whole chicken egg and the whole dried egg.

In the case when the coefficient of fatty acid balance was calculated not only with the consideration of the ratio of the sum of saturated, monounsaturated and polyunsaturated fatty acids. but the ratio of linoleic, linolenic and arachidonic polyunsaturated fatty acid the highest balance had the fat of the whole chicken egg and of the yolk of the whole egg. Then goes lard, semi-fat pork, fat pork, dried whole chicken egg, backfat and side fat. From vegetable oils the best balance by the ratio of sums of saturated, monounsaturated and polyunsaturated fatty acids had the refined olive oil. Taking into consideration that the following vegetable oils: copra, corn,sunflower, rape-seed, olive and soya don't containing arachidonic acid their complex balance is zero.

Conclusions. A ranged information about food adequacy of raw materials components of animal origin, as sub-groups, obtained on the basis of computer-aided evaluation of their protein and lipid contents according to the p given criteria is presented.