METHODOLOGY FOR QUANTITATIVE EVALUTATION OF FOOD ADEQUACY OF MEAT RAW MATERIALS AND FINISHED PRODUCTS

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A methodology and related individual methods of the quantitative calculation of food adequacy of meat raw materials and foods as products from them are discussed in the paper. A multiplicative function as known from qualimetry interrelating differential indicators characterizing the composition and properties of evaluated meat products is used as a basic model.

A systems analysis of information about these indicators allowed to limit their number and to propose a convenient for computer calculation mathematical dependences.

The "food adequacy" of meat raw materials and components is their predisposition to acquire during the technological process the safety, the cumulative capacity of the finished product to ensure a material and energetic balance of the organism, taking into account physiological and and psychological characteristics of particular groups of consumers according to their age, region of living and profession.

According to the above notion of "food adequacy" it is possible to use the known from qualimetry formula for quantitative evaluation of the quality of foods:

$$K=\left(K_1^{\alpha_1} * \ldots * K_n^{\alpha_n}\right)^{0,5/n} * \left(K_{min}^{\alpha_{min}}\right)^{0,5} \qquad (1)$$

where K_i - numerical value of i-th differential characteristic of quality, frac. un., $(0 \le K_i \le 1)$;

α_i - index of significance of quality of the i-th parameter frac. unit $(0 \le \alpha_i \le 1)$;

K_{min} - minimum from the values of numerical differential characteristics of quality of all the parameters of the object, frac.unit;

α_{min} - index of significance, corresponding $K_{min.}$, frac. un.;

n - number of parameters of quality evaluation.

In this work 21 hypothetical differential characteristics of quality K_i are identified with real quantitatively measured characteristics of meat raw materials or products.

These are as follows:

$K_1 = \pi$ - digestibility of protein "in vitro", fract. unit from initial tyrosine;

$K_2 = C_{min}$ - minimum amino acid score, fract. unit (if $C_{min} > 1$ $K_2 = 1$);

$K_3 = R_c$ - coefficient of rationality of amino acid composition, fract. unit;

$K_4 = F\left(\frac{R_{jx}}{R_{jo}}\right)$ - correspondence of fractional composition of protein (in the evaluation of food adequacy of breast milk substitutes or other special products), fract. unit;

$K_5 = \Sigma$ НЖК / 0.3; $K_6 = \Sigma$ МНЖК / 0.6; $K_7 = \Sigma$ ПНЖК / 0.1; НЖК, МНЖК, ПНЖК - respectively saturated, monounsaturated fatty acids, fract. units to mass fraction of fat in the object;

$K_8 = P_x / P_э$ - ratio of mass fractions of protein in the compared and reference objects, fract. unit;

$K_9 = L_x / L_э$ - ratio of mass fractions of fat in the compared and reference objects, fract. unit;

$K_{10} \ldots K_{14} = Q_i$ - relative organoleptical indicators (for prepared foods), fract. unit;

$K_{15} \ldots K_{18}$ - ratio of values of structural-mechanical characteristics, fract. unit;

$K_{19} = \left(1 - \prod_j \frac{МБ_j}{МБ_{пдк_j}}\right)$ - multiplicative ratio of j-th indicators of microbiological contamination of the investigated object, fract. unit;

$K_{20} = \left(1 - \prod_к \frac{ТБ_к}{ТБ_{пдк_к}}\right)$ -multiplicative ratio of k-th indicators of contamination of compared objects with toxic substances, fract. units;

$K_{21} = \left(1 - \prod_m \frac{РБ_m}{РБ_{пдк_m}}\right)$ - multiplicative ratio of m-th indicators of radioactive contamination of compared objects, fract. units;

Taking into account the above, the formula (1) can be transformed into:

$$A_п = \left\{\prod_i^n K_i^{\alpha_i}\right\}^{0.5/n} * \left(K_{min}^{\alpha_{min}}\right)^{0.5} \qquad (2)$$

where $A_п$ - indicator of food adequacy, fract. units.

Taking into account the limitations as imposed on K_i and a_i, it can be concluded that the positive numbers not exceeding the unit should be the exponential complexes $K_i^{a_i}$ of the formula 2. To comply with this condition as applied to numerical values of differential characteristics of quality K_i, as identified by the indices i = 4, ...9; 15-18, it is necessary to introduce the following relationship:

$$\alpha_i = \beta_i \ \mathbf{sign}\ (\mathbf{зн}_i - \mathbf{чс}_i) \qquad (3)$$

where sign - a function of sign,

зн - denominator of differential characteristic of quality K_i,

чс - numerator of differential characteristic of quality K_i.

The recommended in this work numerical values of the indices of significance α_i are the averaged values of analytical expert evaluations of the scientists and experts invited by the former Ministry of Meat and Dairy Industry of the USSR to make a forecast of the developmentof the industry up to 2010:

$$\alpha_{1,3,10,...,14,21} = 1;\ \beta_4 = 1;\ \alpha_{2,20} = 0{,}75;\ \beta_{5...8} = 0{,}75;\ \alpha_{19} = 0{,}5;\ \beta_{9,15...18} = 0{,}5$$

In case, when if only one of the numerators of the quotients entering the multiplicative component $K_{19} \dots K_{21}$ becomes equal or exceeds MPC (maximum permissible concentratration), $\alpha_{i,j(k,m)}$ corresponding to it, is taken as equal to $-\infty$, and therefore the criterion as calculated by the formula (2) automatically transforms into zero.

To demonstrate the possibility of the formula (2) for numerical evaluation of the food adequacy of the meat raw materials or ready products, as well as for the visual analysis of the influence of differential characteristics of quality K_i with the indices of significance α_i equal to 1; 0,75; 0,5 on the change $A_п$, in the figures 1a; 1b; 1c; 1d are presented the graphical dependences plotted with the aid of the computer.

When plotting these graphs the numerical values were assigned to differential characteristics K_i, corresponding to real situations, as selected on the basis of our own investigations or from literature.

In all the four cases of graphs plotting the characteristics of quality K_i with the index i=3, ..., 7, 9, 15, ..., 18, 20, 21 did not change and were taken as: K_3=0.85, K_4=0.75, K_5=1.73, K_6=0.75, K_7=0.3, K_9=0.54, $K_{15,...,18}$=0.8, K_{20}=0.85, K_{21}=0.7.

The ranges of variation of the indices K_1, K_2, K_8, $K_{10...14}$ and K_{19} are shown at the corresponding graphs.

In conclusion of this presentation about formalization of notins of the food adequacy of meat raw materials and products one should pay attention to the fact that, though the formula (2) doesn't contain as arguments the numerical values of such differential quality characteristics as mass fractions of: water- and fat- soluble vitamins, physiologically important macro- and microelements etc, their inclusion into this formula will not change its structure and will not complicate the procedure of computer calculations. However, it should be noted that in the complex food substances the traditional sources of which are meat and meat products, these food components account for the amounts which are 2-5 orders less.

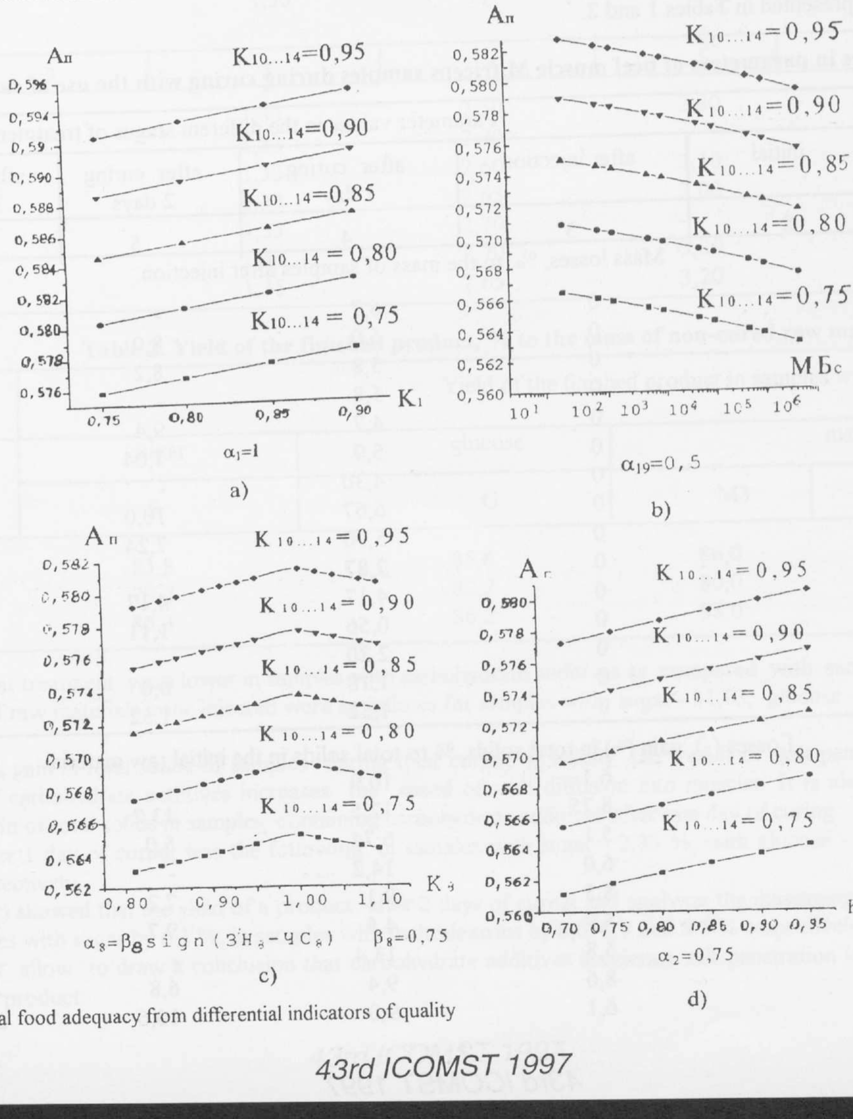

Fig.1. Dependence of integral food adequacy from differential indicators of quality