# NON-TRADITIONAL IDEAS ABOUT ECOLOGICAL SAFETY AND NUTRITIONAL ADEQUACY OF FOODSTUFFS (INCLUDING MEAT-BASED ONES)

Lipatov N.N., Bashkirov O.I., Gevorgyan A.L.
Scientific Research Institute of Child Nutrition of RASHN, Istra town, Russia

## Background

Analysis of available scientific literature about modern trends and prospects for quantitative evaluation of negative effects of indirect anthropogenic activities on ecology suggests that at the present time there is no appropriate informational-algorithmic support, sufficient for carrying out this evaluation, both on the whole and as applied to separate links of exotrophic chain "production of foods → storage → marketing → consumption → digestion → evacuation of catabolism products → utilization of all wastes".

As applied to foods and food processing, inadequate filling of this scientifically-intensive niche is largely caused by incorrectness, and as a consequence, "discrepancies" in terminology, phenomenological and noumenological notions and definitions, being the base for creation of computer-implemented versions of information-algorithmic support for calculation and analysis of dominant quantitative indices associated with ecology of foods.

## Objectives

To fill this gap we offer herein for food scientists and food industry specialists the terms, definitions and criteria, being essentially our innovations.

## Materials and methods

Terms and definitions

*Ecology** (definition from encyclopedia) – (from Greek oĭkos – house, dwelling, place of living and … logia) science about relations of plant and animal organisms and associations formed by them between each other and the environment.

*Ecology** (interpretation of the authors) – interdisciplinary science studying direct and (or) indirect mutual influence of a human organism in the process of his activities in places of living or location and different forms of existence of being there: animals, plants, micro organisms and organic, mineralorganic, mineral and field objects of natural or anthropogenic origin.

*Ecological safety** - notion as applied to food raw materials, technologies, devices, foodstuffs and their packaging combining necessary and adequate conditions providing absence or minimization of negative effects on the environment during production, processing marketing and use of listed objects.

*Food safety** - a group of indices which quantitatively characterize necessary and adequate conditions, eliminating probability of occurrence of pathological violations of physical, psychical and intellectual status of human organism, caused by components of raw materials and (or) ready products.

*Ecological purity** - (as applied to foodstuffs) = good ecological condition & food safety - is a total property of a particular food or products from the same assortment group characterizing their ability to have minimum effect on the environment during their production, storage, marketing and consumption and provide the absence of substances negatively influencing physical, psychical and intellectual status of a human organism.

*Nutrient (alimentary) adequacy** - a group of indices qualitatively and quantitatively characterizing contents and mutual balance of macro as well as micronutrients and their components in raw materials and final products.

*Metabolic adequacy** - a group of indices characterizing potential efficiency of use by the organism of nutrients as supplied to it by foodstuffs during their consumption, digestion and assimilation.

*Food value (adequacy)** - this is a potential ability, suggesting safety, of foodstuffs or raw materials used in their production to provide in their totality a material and energetic balance of the organism taking into consideration physiological and psychological requirements of the individual consumer or a group of consumers who are combined by their regional, national, age, professional or other signs.

**Results and discussion**

We have created the following set (1-6) of criteria:

*Criterion of* **relative ecological safety** of food processing

$$E_{П} = \left[ \prod_{\alpha} \left( \frac{\Delta \mathrm{Ds}_{\alpha}}{\Delta \mathrm{Ds}_{\alpha 0}} \right) \cdot \prod_{\beta} \left( \frac{\Delta \mathrm{DA}_{\beta}}{\Delta \mathrm{DA}_{\beta 0}} \right) \cdot \frac{m_0}{m} \right]^{\frac{1}{\alpha + \beta + 1}} \qquad (1)$$

Where: $E_{П}$ - relative ecological safety of production of a particular food, units (with regards to base, reference); $_{\Delta}Ds_a$ – difference between high critical limit of the share of α-th contaminant and its actual pre-limit share in production effluents, corresponding to compared complexes of technological processes, % of ПДУ (Limit value, LV); $_{\Delta}DA_{\beta}$ - difference between top critical limit of the share of β-th contaminant and its actual pre-limit share in atmospheric emissions, corresponding to compared complexes of technological processes, % of LV; *m* - mass of unutilized production garbage, as accumulated in equal time periods in the implementation of compared versions of production processes, t. Index $_0$ corresponds to base (reference) version.

*Rated criterion* **of food safety**

$$S_{П} = \prod_{i}^{4} \left( 1 - \prod_{ij} \frac{X_{ij}}{X_{ПДУij}} \right) * \left( 1 - \max \prod_{ij} \frac{X_{ij}}{X_{ПДУij}} \right) \qquad (2)$$

Where: $S_{п}$ – rated food safety, share units; *i* = 1 = corresponds to a group of multiplicative indices of physical contamination of the product, $1 \le j \le k$; *i* =2 – corresponds to a group of multiplicative indices of chemical contamination of the product, $k + 1 \le j \le l$; *i* = 3 – corresponds to a group of multiplicative indices of radiological contamination of the product, $l + 1 \le j \le m$; *i* =4 – corresponds to a group of multiplicative indices of microbiological contamination of the product, $m + 1 \le j \le n$; $X_{ij}$ corresponds to actual value of the unit ij-th index of contamination of the comparable product (corresponding unit of measurement). $X_{ПДУij}$ corresponds to limit value of the ij-th index of contamination. In the case when $S_{п} \le 0$ – the product **is not allowed** for consumption!

*Criterion of* **ecological purity**

$$e_{П} = (E_{П} \& S_{П})^{0,5} \qquad (3)$$

*Rated criterion of* **nutrient adequacy**

$$N_{П} = \left[ \prod_{i=1}^{n} \mathrm{N}_i^{sign(1-N_i)\cdot\alpha_i} \right]^{0,5/n} \cdot \left[ \mathrm{N}_{\min}^{\alpha_{\min}} \right]^{0,5} \qquad (4)$$

Where: $N_{П}$ - rated criterion of nutrient adequacy, share of units; $N_i$ – determined rated *i*-th index of nutrient adequacy, share of units; $N_i = P/P_0$ – correlation of mass fractions of protein in comparable and reference objects; $N_2 = R_p$ - coefficient of rationality of amino acid composition (as $R_{p0} = 1$); $N_3 = L/L_0$ – ratio of mass fractions of fat in comparable and reference objects; $N_4 = \sum SFA/\sum SFA_0$; $N_5 \sum MUFA/\sum MUFA_0$; $N_6 = \sum PUFA/\sum PUFA_0$ -ratios of sums of saturated, monounsaturated and polyunsaturated fatty acids in the

compared and reference objects; $N_7 = C/C_0$ – ratio of mass fractions of carbohydrates in compared and reference objects; $N_8 = macr/macr_0$ – correlation of mass fractions of essential macroelements in compared and reference objects; $N_9 = micr/micr_0$ - ratio of mass fractions of essential microelements in compared and reference objects; $N_{10} = vit_A/vit_{A0}$ - ratio of mass fractions of essential water-soluble vitamins in compared and reference objects; $N_{11} = vit_L/vit_{L0}$ - ratio of mass fractions of essential fat-soluble vitamins in compared and reference objects; *Sign (1-Ni)* – function of sign; *Sign (*1-*Ni)* = +1, if *Ni* ≤*1* and *Sign (*1 – Ni) = -1, if *Ni >1;* $N_{min}$ - index of nutrient adequacy, possessing minimum value; $\alpha_i$ – determined by expertise coefficients of weightiness of the *i th* index of nutrient adequacy, taking the values 0; 25; 0.5, 0.75; 1.0 (the less is the coefficient of weightiness, the less individual influence has the corresponding to it determined index of nutrient adequacy on its multiplicative value); $\alpha_{min}$ - coefficient of weightiness corresponding to $N_{min.}$

*Rated criterion* **of metabolic adequacy**

$$M_{II} = \left[\prod_i^n m_i^{sign(1-m_i)\cdot\beta_i}\right]^{0,5/n} \cdot \left[m_{min}^{\beta_{min}}\right]^{0,5} \quad (5)$$

where: $M_{\Pi}$ – rated criterion of metabolic adequacy, share units; $M_i$ – determined rated *i*-th index of metabolic adequacy; $M_i$ –index of relative fractional adequacy of protein composition, share units; $M_2 = \pi$ – digestibility of protein in vitro, share units from initial tyrosine; $M_3$ …$M_5$ –ratio of: linoleic, linolenic and arachidonic polyunsaturated fatty acids in comparable and reference objects, shares of units; $M_6$ – ratio of assimilation of fat of comparable and reference objects, share of units; $M_7 = C_1/C_{10}$ – ratio of mass shares of metabolically hydrolyzed carbohydrates in comparable and reference objects, share of units; $M_8 = C_2/C_{20}$ - ratio of mass shares of metabolically non-hydrolyzed carbohydrates in comparable and reference objects, shares of units; $M_9 = Q/Q_0$ – ratio of energy value of comparable and reference objects, share of units; $M_{10}$…$M_{14} = S_1$ – relative organoleptic indices, share units; $M_{min}$ - –index of nutrient adequacy, possessing minimum value; $\beta_{min}$ - coefficient of weightiness, corresponding to $M_{min}$; $\beta_i$ – determined by expertise coefficients of weightiness, taking up the values 0; 0.25, 0.5; 0.75; 1.0.

*Criterion of* **food adequacy**

$$K_{II} = (S_{II} \& N_{II} \& M_{II})^{1/3} \leq 1, \text{ share un.} \quad (6)$$

## Conclusions

The authors of this paper hope that the above-stated ideas and criteria will allow to scientists and specialists, involved in the problems connected with ecological aspects of supply of people with high quality products to quantitatively interpret the obtained results.

## References