

Functional nutrition and psycho-intellectual possibilities of man: things in common

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According to the 1996 WHO Report, the world is heading for a major crisis in public health as outbreaks of new and re-emerging infectious diseases are striking at increasing frequencies within the past 10 to 15 years. The given information is true not only for an infection. On the other side eventually a food of the persons considerably changes. The urgent question which needs to be addressed is the nutrition modification and optimization for public health improvement.

Key words: functional nutrition, psychological status, intellect.

Considering the marked negative tendency which has appeared at the turn of 20-21-st centuries, in the form of increasing early mortality and disability of the population resulting from cardiovascular, oncologic, gastroenterological diseases, high frequency of infectious pathology, the mankind has faced the necessity besides developing new medical products which are in some cases palliative and have serious by-effects, to make changes to nutrition. One of the effective possibilities to reduce the quota of chemical medicinal compounds for treatment of human diseases is nutrition modification and optimization.

Thereupon it is necessary to notice that, both character of modern man nutrition, and functions of interaction of appreciable number of factors in the society and the nature, have considerably changed, especially for the last 100 years. In a modern civilized society sharp (2-3-fold) decrease of quantity of food consumed by man has occurred because of change of life-style and reduction of energy expense. This as well as the change of quality of the foodstuff consumed resulted in deficiency of some biologically important nutritive components (bioflavonoids, isothiocyanates, phytosterols, cadmium, lithium, chrome, vanadium, nickel, selenium and many others) the enough quantity of which is in the amount of food equivalent, approximately, to 5-6 thousand kcal, consumed by an ancient man, versus 2-2.5 thousand kcal in the food of a modern man [10, 17].

Thus, the appeared dilemma, i.e. reduction of food consumption because of energy expenditure decrease and receptions of all the necessary set of nutrients can be solved only by the use of various biologically active additives (BAA) in food, capable to fill in the given shortage [10].

For example, it is well known, that physiological norm of consumption of the essential phospholipids as part of a daily ration developed during evolution is 3.000-6.000 mg lecithin and 500-1000 mg choline. Unfortunately, lately these figures tend to decrease in the developed countries because of keeping hypocholesteric diet by the population, and consumption of the essential phospholipids with food becomes inadequate to physiological requirements of the human body. Choline in food occurs mainly in the structure of lecithin complex, but it can also be in a free form or a component of others phospholipids. Thus the richest natural sources of lecithin and choline are in fat food with high content of cholesterol [29]. Consumption of fat food, and, hence, essential phospholipids, steadily decreases thanks to realization of national programs on atherosclerosis prevention [40, 42]. In the USA consumption of eggs has decreased by 20 %, red meat by 48 % for last 20 years [41].

It is obvious, that in conditions of keeping hypocholesteric diet, deficient in essential phospholipids, by an appreciable part of the population all over, the only possible and real way is the enrichment with lecithin and choline of rations poor in animal facts in a form of food additives or capsules with medicinal compounds.

Thus, last years witnessed the development of a new scientific field, the so-called functional nutrition. The treatment of some diseases with diet became quite promising, and literature again and again mentions such terms as "functional nutrition", "nutrition-metabolic therapy" etc. [10, 27, 28]. The concept of functional nutrition was formulated for the first time in Japan in the late nineties of the 20-th century. Now this field intensively develops in England, Germany, the USA, Japan and many other countries [36, 37].

The term "functional nutrition" means including in a ration of a person of such products or substances of a natural origin which produce certain regulating influence on the body in a whole or its certain systems, normalizing their functions [6, 28].

Primarily Japanese scientists suggested using lactic-acid bacteria and Bifidobacteria, oligosaccharides, alimentary fibers and polyunsaturated fatty acids as products of functional nutrition. Now this list has extended and the main categories of functional nutrients include probiotic microorganisms, amino acids, oligosaccharides, mineral substances, vegetative fibers, polyunsaturated fatty acids, vitamins, organic acids, antioxidants, etc. It is necessary to note that difference between probiotic preparations and products of functional nutrition consists only in a different form of release, i.e. liquid, tableted, capsular etc. [28].

According to the Russian and foreign scientists, development of the industry of functional nutrition is the most promising direction in the food-processing industry now, since it mostly corresponds to the needs of consumers.

Numerous researchers showed, that regular consumption of probiotic products with food leads to quick restoration of normal intestinal flora, promotes treatment of gastro-intestinal diseases (chronic gastroduodenitis, peptic ulcer, inflammatory bowel diseases, functional disturbances of the digestive system, acute intestinal infections, etc.). These products are especially effective for the prevention of different gastro-intestinal diseases [12, 39]. It is necessary also to note the importance of probiotics for cardiovascular diseases, metabolic disturbances, endocrine diseases, etc.

At the same time more and more researchers address to the association of the main determinants of development of internal organ diseases and psychological functioning of man. In the modern world psychological deadadaptation arises due to stresses, urbanization, etc. It is no wonder that by 2020 steady growth of depressive disorders which can compete on frequency of their occurrence with cardiovascular diseases [11] is expected. On the other hand, according to the data of domestic and foreign scientists, disorders of microbiocenosis of the alimentary system correlate with anxiety-depressive disorders in the macroorganism. It should be supposed, that aggravation of disturbances of the psychological status of patients at intestinal dysbiosis development can be associated with the activity of neurotransmitters of bacterial origin, which influence not only intestinal physiological functions, but can also promote the development of changes in psychic sphere. In their fundamental work "Microbial endocrinology and biopoly" the most active and consistent researchers of the given scientific problem in Russia A.V.Oleskin and co-authors (1998) [7] summaries data of different authors and their own researches on the synthesis of signal substances in higher animals by microorganisms (table).

Table Synthesis of the signal substances in higher animals (hormones, neurotransmitters) by microorganisms

Signal substances	Microorganisms
1. Amines	
Serotonin	<i>Escherichia coli</i> , <i>Rhodospirillum rubrum</i> , <i>Streptococcus faecalis</i> , <i>Candida guilliermondii</i> , <i>Bacillus cereus</i> , <i>Bacillus subtilis</i> , <i>Staphylococcus aureus</i> , <i>Enterococcus faecalis</i>
Noradrenaline (norepinephrine)	Pathogenic strains <i>Escherichia coli</i> (EHEC 0157:H7 et al.), <i>Saccharomyces cerevisiae</i> , <i>Penicillium chrysogenum</i> , <i>Bacillus subtilis</i> , <i>Proteus vulgaris</i>
Dopamine	<i>Bacillus cereus</i> , <i>Bacillus subtilis</i> , <i>Staphylococcus aureus</i> , <i>Escherichia coli</i> , <i>Proteus vulgaris</i>
Histamine	Intestinal symbiotic microflora
Tyramine	Intestinal symbiotic microflora
Amphetomine	<i>Clostridium perfringens</i> , <i>Clostridium difficile</i> , <i>Peptostreptococcus anaerobius</i> , <i>Eubacterium limosum</i> and other components of intestinal symbiotic microflora
2. Amino acids	
Aspartic acid	<i>Escherichia coli</i> and other components of human intestinal symbiotic microflora
Glutamic acid	Intestinal symbiotic microflora
γ -Aminobutyric acid	Intestinal symbiotic microflora, <i>Escherichia coli</i> , <i>Bacillus fragilis</i>
β -Alanine	Intestinal symbiotic microflora
3. Peptides	
Insulin	<i>Escherichia coli</i> , fungus <i>Neurospora crassa</i> , <i>Tetrahymena</i> sp.

Calcitonin	Infusoria <i>Tetrahymena pyriformis</i>
β -Endorphine	<i>Tetrahymena pyriformis</i> , <i>Amoeba proteus</i>
Glucagon	<i>Neurospora crassa</i>
Gonadotropin	<i>Pseudomonas maltophilia</i>
Gonadotropin-releasing hormone (α -factor)	Yeast <i>Saccharomyces cerevisiae</i>
Relaxin	Infusoria <i>Tetrahymena pyriformis</i>
Somatostatin	<i>Tetrahymena pyriformis</i> , <i>Plasmodium falciparum</i> , <i>Escherichia coli</i> , <i>Bacillus subtilis</i>
Thymosin α 1	<i>Tetrahymena pyriformis</i> , <i>Mycobacterium</i> sp.
Thyrotropin	<i>Clostridium perfringens</i> , <i>Yersinia autolytica</i>
4. Steroids	
Estradiol	<i>Saccharomyces cerevisiae</i> , intestinal symbiotic microflora
Progesterone	Yeast <i>Candida albicans</i> , <i>Coccidioides imrnitis</i> , fungus <i>Trychophyton mentagrophytes</i>
Metabolized derivatives of bile acids	Intestinal symbiotic microflora
5. Inorganic compounds	
Nitric oxide	<i>Pseudomonas stutzeri</i> , <i>Pseudomonas aureofaciens</i> , <i>Thiobacillus denitrificans</i> , fungi <i>Fusarium oxysporum</i> , <i>Dictyostellium discoideum</i> , <i>Escherichia coli</i>

[according to: McMurrey, 1980; Hsu S.C. et al., 1986; Strakhovskaya M.G. et al., 1993; Lenard J., 1992; Lyte M., 1993; Zumft W.G., 1993; Babin V.N. et al., 1994; Budrene E.O., Berg H., 1995; Lyte M. et al., 1996; Oleskin A.V. et al., 1998, Oleskin A.V., 2001; Shenderov B.A., 1998].

Thus GABA and glutamate are produced by a wide range of bacteria both facultative and strictly anaerobic (*B.fragilis*, *E.coli*). Abnormalities in GABA-besodiazepin receptor complex, which form a part of the main inhibiting system of the brain neurotransmitters, are thought to play an important role in the occurrence of alarm-phobic disorders. It was also shown that GABA concentration decrease results in the development of irritable bowel syndrome. It is possible to suggest the existence of stress-suppressing mechanism in the form of stimulation by the body of GABA production of the corresponding bacterial population.

These discoveries stimulated the interest for studying interrelations between the higher mammals and procaryotes and separate microorganisms, through endocrinology prism (mutual influence at the expense of action of hormones, hormone-like substances). Besides, the table shows that many hormone-like active substances are produced by representatives of human intestinal symbiotic microflora. This fact is of great importance from the medical point of view in estimating the possibility of influence of a macroorganism and its microflora on each other at the expense of the effects of hormones and hormone-like substances, in particular in the question of pathogenesis of various diseases (infectious diseases, therapeutic infections, etc.), in change of vital activity of man and character of some functions of microorganisms.

In turn psychoemotional stress causes change of intestinal microbiocenosis, influencing both the obligatory and facultative microflora. Thus, study of interrelations of the psychoemotional status of patients and condition of intestinal microbiocenosis is important now.

Besides, problems of interrelation of intestinal microflora state with social behavior of man are widely discussed now. Level of biologically active compounds produced by microorganisms, undoubtedly, influences behavior of

macroorganism. It is enough to say that depression of immunity as a result of termination of synthesis of microbial immunostimulators in conditions of disbiosis not only threatens with the development of somatopathies, but also can result in social and political passivity, apathy, disabilities to cope with stresses.

The other important fact of the problem especially important both theoretically and practically is association study between intestinal microbiota state and intellectual possibilities of man. According to definition in Webster's dictionary, intelligence is an ability to estimate interrelation of perceived events and facts, to direct the activities on achievement of the planned purpose. Complexity of the given concept is stressed by a number of more or less successful attempts to structure intelligence on parts and rubrics. According to D. Cattell (1965), the intelligence is subdivided into crystalline, demanding erudition and special knowledge, and liquid, reflecting natural feature of man which does not demand erudition and special knowledge. In 1982 J. Guilford suggested a three-dimensional spatial structural model of intelligence; on one axis there were the divergent and convergent thinking, memory and knowledge, on the other - products of mental operations, associations, systems, transformations and consequences, on the third - figural, symbolic or behavioral content of the task. According to the literature intelligence is 70 % biologically conditioned (genetically determined) and 30 % is defined by cumulative influence of the factors reflecting a role of environment.

G. Aisenk, who for many years was engaged in studying of population intelligence, was the first to say that attempts of IQ rising by purposeful training, improvement of living conditions, formation of special classes has appeared ineffective. His other not less important postulate was the following: "There is one exception from the general rule that is little possible to make for IQ improvement: many children eat too much sweet food, not enough vegetables and fruits but if they begin to receive a necessary dose of vitamins and mineral substances, their IQ considerably increases". This really pioneer statement has been made by the scientist, who has never specially been practically engaged in the study of the problems of nutrition! According to G. Aisenk optimization of diets in childhood may significantly influence the rise of intellect and the younger the child the more the influence. Thus the rise of intelligence of children and teenagers, whose mental development actively proceeds, can reach 10-20 % from the initial level (the intelligence is predetermined by all environmental factors no more than by 30 %) [10, 22].

Unfortunately, in a modern society there is a tendency of nation intellectual potential falling at the expense of increasing number of persons with average and low level of intellectual possibilities. The reasons of the given changes are social and economic, ideological, imbalance of nutritive rations, annual immigration of intellectual elite, etc. In other words such tendency is observed under conditions of different unfavorable factors for human life, e.g. genetic, ecological (deterioration of quality and regime of nutrition, ecological situation, growth of alcoholization of the population, smoking, narcomania etc.), social and economic (political instability, degradation in the field of education, "brain drain", worsening of health services etc.), psychological factors (stresses, intrapersonal and interpersonal conflicts, lack of faith in future etc.) [23]. Under conditions of the modern reality "struggle" for an intellectual resource of the population gets nation-wide importance, going far beyond the frameworks of the scientific theory.

Now within the limits of the given problem which is far beyond the framework of the proper medical science, influence of optimization of nutritive rations, including products of functional nutrition (pre-, pro-, sim- and sinbiotics) on intelligence [10] is proved. The first pilot data show that microbiota disturbance correction may result in essential purposeful positive influence on intellectual characteristics of man. The described approach seems to be of special importance because it is regarded in the world as of strategic importance, the fact confirmed by guardianship and home nursing which are realized by such influential international organization as UNESCO [22].

Interrelation revealing between disturbance of intestinal microecology on the one hand and changes in the psychological status, social functioning and intellectual possibilities of man on the other opens essentially new possibilities of therapy of the given changes by means of leveling of the disturbances of intestinal microbiocenosis, that is provided by the use of means correcting intestinal microflora state (pre-, pro-, sim- and sinbiotics, use of products of functional nutrition, food biologically active additives, products of special therapeutic nutrition. The results are quite predictable since interrelations of more phylogenetically ancient prokaryotes (microorganisms) and eukaryotes (macroorganisms) are equipotential as macroorganism influences macroorganism and microorganism in its turn influences macroorganism.

We quite understand that the problem raised in this article is just an invitation for further discussion and cooperation. For its further development consolidation of efforts of specialists working in the field of clinical nutrition, neurophysiology, pediatricians, public health services organization, and scientific councils and organization is necessary.

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