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Food security assessment in Ukraine

Abstract

The transformation of food security concept according to individual food preferences is considered. The issue of nutrition as a complex problem of rational balanced nutrition is distinguished. The importance of nutrition in the context of food security has been investigated. The relationship between the terms "food security" and "nutrition" has been analyzed.

The concept of functional nutrition for the development of a new model of food production is investigated. Three aspects of nutrition research for the development of agricultural sector and food industry are highlighted.

The analysis of nutrition, its caloric content and balanced diet by major macronutrients and micronutrients is conducted. Correlation between the level of nutrition and life expectancy of a person is determined.

Keywords: food security, nutrition, food safety.

In international food safety research, the approach to the concept of food security is transformed according to individual food preferences. In the Rome Declaration on World Food Security (1996), food security implies not only the physical and economic accessibility of food in accordance with rational consumption norms, but also the food provision of the population due to their growing needs. This approach deals with the definition of food security, which was defined as physical and economic availability of food for any individual in accordance with his/her dietary needs and preferences, taking into account the peculiarities of nutrition.

Nutrition is a complex problem which requires thorough knowledge and skills in different areas of science and practice. This is due to the fact that life at all levels is associated with the consumption of nutrients and energy. Thus, the first necessary condition for the prolonged existence of biological systems of any hierarchical level and the development of life in general is receiving of nutrients (Kundieieva, 2014). Process of supplying and assimilation of nutrients include: foods absorption; foods processing (digestion); transportation of nutrients into human cells. Absorption of food means the process of production, preservation, supply and consumption of food products.

Nutrition provides the growth of the younger generation; assures an excellent health; restores productivity; increases longevity; reduces the level of diseases; guarantee the protection of the population from the influence of unfavorable production and environmental impacts. In the "Methodical recommendations for general practitioners of family medicine on counseling

patients about the basic principles of healthy eating" is noted that the priority directions of modern nutrition science include: rational balanced nutrition; prophylaxis of diseases of protein and micronutrients deficiency, other essential nutrients; raising public awareness about healthy eating (Order of the Ministry of Health of Ukraine, 2013).

According to the importance of nutrition for human health, the nutrition study is vital in the context of food security. It is necessary to determine the meaning of such definitions as "food security" and "nutrition". Using the historical research method, the question of the emergence, development and interconnection of these definitions are considered (FAO).

In 1966, the United Nations adopted “The International Covenant on Economic, Social and Cultural Rights”, which proclaimed the right to adequate food (Article eleven, part three) and the right to be free from hunger (paragraph 2 of the aforementioned article) (FAO). It is emphasized the obligation of states to take measures for improving methods of production, conservation and distribution of food by making full use of technical and scientific knowledge, by disseminating information of the principles of nutrition. Thus, the state should organize the availability of information for people, and therefore, on our point of view, it is necessary to develop full educational potential.

The Administrative Committee on Coordination (ACC) recommended the establishment of the Subcommittee on Nutrition in 1974. The primary aim of the organization is to ensure access to a balanced nutrition at the global level, the possibility for each person to receive the main nutritional components necessary for a healthy and active life. Multilevel nutrition planning was proposed as an entirely new approach to combating malnutrition.

According to this approach, the right to have adequate food is a matter of public policy and should be taken into account in planning the economy at the national level and in planning measures to improve nutrition as a main component of planning for the overall development of the country. However,

this question is not taken into account in domestic documents of the strategic development of Ukraine. The proposed document "Nutrition Planning" outlines proposals for society development planning, taking into account nutrition issues (FAO). It is emphasized that malnutrition is not just a problem of food accessibility, it is a manifestation of poverty and injustice. Nutrition planning is the main task of comprehensive planning of society development, because the primary goal should be reducing malnutrition at scale.

In the eighties of the last century, much attention was paid to such definitions as hunger and malnutrition. In 1990, “Conceptual framework for malnutrition” was adopted by UNICEF. This document identifies the factors which determine the adequate (deficiency) of food:

- direct factors (malnutrition, illnesses) influence on the individual level;
- structural factors (adequate food security and childcare, which are especially important for children's nutrition, healthy environment and access to medical services) at the household level;
- basic factors (socio-economic and political conditions and potential resources) - at subnational, national and regional levels (UNICEF, 1990, p. 9).

This conceptual framework was further developed at the International Conference on Nutrition (ICN) in 1992. This conference became the first intergovernmental meeting on nutrition where the World Declaration and Plan of Action for Nutrition were adopted (FAO).

Since 1995, the term "food safety" has been used, according to which nutrition security can be defined as adequate food including the adequate amount of proteins, calories, vitamins and minerals for all members of the household at any time (Kisambung et al.,1995). Food and health experts advocated a broader understanding of key determinants of nutrition.

In 2006, O. Shakir in his research "Major issues for Nutrition development" emphasized the importance of food security combination with the sanitary conditions, the appropriate level of health care and adequate food. According to the above, it can be argued that the food safety includes not only the qualitative and quantitative components of food products, but also the diet, the implementation of which is person's responsible attitude to his own health.

Since 2009, the term "food and nutrition security" is considered to be a standard for all FAO documents and is used by FAO as one of the corporate strategic objectives to increase food security and improve nutrition.

In 2012, a document "Unified Understanding of the Definitions" was adopted. Various interpretation of the definitions "food safety", "food safety and nutrition", "food safety and security " were analyzed. FAO experts have proposed the following definition: "nutrition security" is achieved when secure access to an appropriately nutritious diet is coupled with a sanitary environment, adequate health services and care, to ensure a healthy and active life for all household members.

The definition emphasizes the attention to such aspects of food security as: the accessibility of food, the stability of its supplies. In addition, dietary regimens are considered. Measures of food security should ensure a stable access to adequate and safe food to all households and access to information on nutritional value of food. The inclusion of the words "food safety" in the term "food security" emphasizes the importance of nutrition improvement.

To emphasize attention to nutrition issues, UNICEF proposed the following definition: "Food security is achieved when adequate food (by quantity, quality, socio-cultural acceptability) is accessible to all people at all times and consumed by them for healthy and active life (FAO, 2012).

Another document (Updated Comprehensive Framework for Action) proposes the following definition: "food security" exists when all people, at all times, have physical, social and economic access to sufficient, safe and

nutritious food that meets their food preferences and diet needs for an active and healthy life. Food insecurity exists when people do not have the appropriate physical, social and economic access to enough food (FAO). Thus, this term covers availability, access, stability, food consumption and emphasizes the need to meet the human needs of energy, proteins and nutrients for active life.

The term "food and nutrition security " is used more often to identify actions at the global, national, local, household and individual levels. It is necessary to take into account the importance of investing money in food security measures. The term "food security and food safety" on our point of view defines the conditions of achieving the strategic goal of social development - human health and long active life, because food security is a necessary condition, and food safety is a sufficient condition for achieving this goal.

Food security includes not only food production, distribution, exchange, but also food consumption. "Food Security and Food Safety" is becoming more widespread definition, covering the availability, stability of supply and the rational consumption of food in constraints of financial resources.

To sum up all the above, it is needed to take into account, that there is no consensus about the use of the combined term "food and nutrition security". The term "food security" includes the aspect of nutrition, but we emphasize the importance of studying food security like a combination of nutrition structure and diet modes. Thus, food security, according to the proposed definition, is, first of all, a balanced, healthy nutrition in accordance with the regime, and not just the quality of food.

This clarification allows to make broader the definition of food security based on nutrition: "food safety and food security" exists when all people at all times have physical, social and economic access to food of sufficient quantity and quality, meet their dietary needs in accordance with the physiological norms of consumption, have a safe nutrition (balanced by structure and modes).

Nutrition and food security issues remain topical for FAO and WHO, which jointly organized the Second International Conference on Nutrition in November 2014. The Rome Declaration on Nutrition and Framework for Action were adopted. In September 2015, Member States adopted the 2030 Agenda for Sustainable Development committing to achieve a comprehensive, far-reaching and people-centered set of universal and transformative Sustainable Development Goals (SDGs) and targets, indispensable requirements for sustainable development. They placed high priority on addressing malnutrition by committing to all the SDGs , in particular under SDG 2 to "End hunger, achieve food security and improved nutrition and promote sustainable agriculture". The General Assembly proclaimed the United Nations Decade of Action on Nutrition, 2016-2025. The main tasks are to eliminate hunger, provide food security and food safety. The Nutrition Decade has been adopted as part of an inclusive, continuous process.

The purpose of the Decade of Action on Nutrition is to establish a clear-cut and time-bound plan of actions designed to ensure compliance with the commitments which were adopted at the Second International Conference on Nutrition and 2030 Agenda for Sustainable Development.

Action during the Nutrition Decade is centered on six cross-cutting, integrative areas for impact:

(1) Sustainable, resilient food systems for healthy diets;

(2) Aligned health systems providing universal coverage of essential nutrition actions;

(3) Social protection and nutrition education;

(4) Trade and investment for improved nutrition;

(5) Safe and supportive environments for nutrition at all ages; and

(6) Strengthened governance and accountability for nutrition.

The Nutrition Decade opens up opportunities for these actions and accelerates progress towards global nutrition goals.

We conducted an analysis of existing scientific theories of nutrition, food functions, and micro- and macro-nutrients (Kundieieva, 2010). The study of the nutrition development theory has allowed us to determine the transition from hunting and harvesting to plowing the land, industrial production and the design of special quality of food products.

Each theory of nutrition has both advantages and disadvantages, that opens up new perspectives for the further development of the nutrition science. The relevance of further research are proved because are links between food technology development and certain food production methods. However, it is necessary to take into account the technologies development of the creation of raw materials for the food industry: traditional agrotechnologies, agro-biotechnologies, organic production and technologies for food production.

One of the important tasks to improve the nutritional structure of the society is to increase the volume of food production. Modern nutrition should satisfy the physiological needs of the human body in biologically active nutrients and energies, support preventive and therapeutic functions. The concept of positive (healthy, functional) nutrition appeared in the early 80's of the twentieth century in Japan, where so-called functional foods had become very popular (abbreviated as "physiological functional foods"). By this term, we mean food products that have a potentially positive effects on health (contain ingredients that are beneficial for human health, enhance the immunity, improve many physical processes in the human body). These products can be used regularly for a wide range of consumers. In Japan, functional nutrition was recognized at the state level as an alternative to drug therapy and identified as Food for Specific Health Use (FOSHU).

During 1995-1998, the "Scientific Concepts of Functions Food in Europe" was adopted. European experts presented their views on the issue of functional nutrition, including terminological, technological aspects, prospects for the development (Mardar and Sukhanova, 2011). It is noted that functional food

may be defined as any food that has a positive impact on an individual's health, physical performance, or state of mind, in addition to its nutritious value.

According to many researchers, functional foods provide the human body with the necessary ingredients that can not be obtained in sufficient amount from traditional diet (Mardar and Sukhanova, 2011, p. 149; Egorov and Mardar, 2009).

A functional food is a food claimed to have an additional function (often one related to health-promotion or disease prevention) by adding new ingredients or more of existing ingredients. Functional foods may be designed to have physiological benefits and/or reduce the risk of chronic disease beyond basic nutritional functions, and may be similar in appearance to conventional food and consumed as part of a regular diet.

The Academy of Nutrition and Dietetics defines functional foods as "whole foods along with fortified, enriched or enhanced foods that have a potentially beneficial effect on health when consumed as part of a varied diet on regular basis at effective levels based on significant standards of evidence."

Literature analysis allows us to determine functional foods as products of high nutritional value that meet the following requirements:

1. it is a food (not a capsule, tablet, or powder) derived from natural ingredients;
2. it can and should be consumed as part of the daily diet;
3. it has a particular function when eaten, serving to regulate a particular body process, such as:

- enhancement of biological defense mechanisms;
- prevention of specific diseases;
- recovery from specific diseases;
- control of physical and mental disorders;

- slowing of the aging process (Lucchinger-Heershe, 2000; Peresichnii, 2008; Syrokhman and Zavgorodnya, 2009).

D. Potter has identified seven main types of functional ingredients that provide nutritional products with positive functional properties: edible fibers (soluble and insoluble); vitamins (A, group B, D, etc.); mineral substances (such as calcium, iron); polyunsaturated fats (vegetable oils, fish oil, omega-3 fatty acids); antioxidants: beta-carotene and vitamins (ascorbic acid - vitamin C and alpha-tocopherol - vitamin E); oligosaccharides (as a substrate for beneficial bacteria); a group that includes microelements, lactobacilli, bifidobacteria, etc. (Syrokhman and Zavgorodnya, 2009).

The main categories of functional foods are natural products:

- which naturally contain the required amount of functional ingredient;
- which are additionally enriched by some functional ingredient or a group of ingredients;
- in which the potential functional ingredients are modified in such way that they begin to develop their biological or physiological activity or this activity is enhanced;
- in which the digestibility of functional ingredients increases as a result of certain modifications;
- in which a combination of the above-mentioned technological techniques acquires the ability to preserve and improve human health and / or reduce the risk of diseases (Roberfroid, 2002).

Technologies of functional food products at the present stage is the modification of traditional products with growing number of ingredients that correlates with the physiological norms (10-50% of daily needs). According to G. Simakhina (2013) it is possible to create a wide range of innovative products: functional foods based on raw materials containing high concentration of functional ingredients (oats, barley, soy beans, bran, flax seeds, spirulina, natural juices, etc.); functional foods with reduced salt, sugar, animal fats; functional

foods based on cereals (bakery, confectionery, pasta); dairy, meat, canned; products enriched with vitamins, food fibers, mineral compounds, polyunsaturated fatty acids, probiotics and prebiotics, phospholipids, amino acids, etc.

L. Kaprelyants and G. Khomich (2012) draw attention to the fact that there are efforts to differentiate functional and traditional food products for consumer properties. Functional foods have three characteristics: nutritional value, taste properties, physiological effects on human body, whereas traditional products are characterized only by the first two features.

Based on the importance of nutrition for human health, we believe that nutrition research should include:

- the biological aspect of nutrition to determine the perspective of development of agro-sector and food industry;

- economic aspect of food as a factor of economic development of the country;

- the social aspect of nutrition as the basis of the socially oriented economy of the country (Kundieieva, 2014).

Such a multi-dimensional analysis of nutrition becomes the basis for the study of food security of Ukraine, especially food safety.

Based on the biological aspect, we analyzed the nutrition, especially caloric content and the balance of main macro- and micronutrients, and the determination of the relationship between the level of nutrition and the life expectancy of a person. Dynamics of calories of daily average consumption of food products in Ukraine during 2000-2017 per capita is presented in table 1.

Table 1

Dynamics of caloric content of daily average consumption of food products during 2000-2017 in Ukraine (per capita) *

Indicators	Products calories limit	Years															
		2000	2001	2002	2003	2004	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017

caloric content of animal origin products, cal	1375	611	619	673	690	719	733	805	796	809	807	844	868	849	791	790	781
% to the limit		44	45	49	50	52	53	59	58	59	59	61	63	61,7	57,5	57,5	56,8
caloric content of vegetable products, cal	1125	2050	2139	2127	2108	2191	2183	2193	2150	2124	2144	2110	2101	2090	2008	1952	1926
% to the limit		182	190	189	187	195	194	195	191	189	191	188	187	185,8	178,5	173,5	171,1
caloricity of daily average consumption of foodstuffs, cal	2500	2661	2800	2798	2798	2910	2916	2998	2946	2933	2951	2954	2969	2939	2799	2742	2707
% to the limit		106,4	112	111,9	111,9	116,4	116,6	119,9	117,8	117,3	118	118,2	118,8	117,56	111,96	109,68	108,28
share of caloric content of animal origin products in calories of daily average consumption of food products,%		23,0	22,1	24,1	24,7	24,7	25,1	26,9	27,0	27,6	27,3	28,6	29,2	28,9	28,3	28,8	28,9

* Calculated by authors based on (State Statistics Service of Ukraine)

The analysis shows that during the studied period, the dietary intake per capita exceeds the recommended norm, primarily due to the consumption of vegetative products, and the caloric content of animal origin products does not exceed 30% of the actual daily calories intake per person. The recommended fat content in a human diet is 90-100 g per day, where 1/3 should be vegetable oils and 2/3 – animal fats. Deficiency of fats, as well as their excess, in the human diet leads to deterioration of health and non-infectious diseases, such as: obesity; atherosclerosis; cardiovascular diseases; neoplasms; cholelithiasis; disturbance of secretory activity of the liver and pancreas. The largest share in domestic consumption is vegetable fats. In 2000, the calories intake exceeded the norm by 6,4%, and in 2017 - more than 8%. Also, there was a decrease in the calorifies of vegetable products, which exceeded the norm in 2000 by 182%, and in 2017 - by 171,1%. During 2001-2013, there was an increase in the caloric content of products of animal origin, but during 2014-2017, the reduction was almost to level of year 2009.

To study the relationship between the life expectancy of a person (persons of both sexes) (y), the calories of the diet (x1) and the calories of animal origin diet, we used a regression analysis. To detect the power of the relationship in MS Excel, the pairwise linear correlation coefficient is calculated: for the first dependence is 0,577, and for the second - 0,79. According to Chaddock Scale, a high direct relationship has been evaluated between the person's life expectancy (both sexes) and the caloric content of the animal origin diet. The relationship between life expectancy (both sexes) and the caloric content of the daily diet is considered to be significant. The regression analysis of this dependence shows that the linear model is the most adequate (Fig.1).

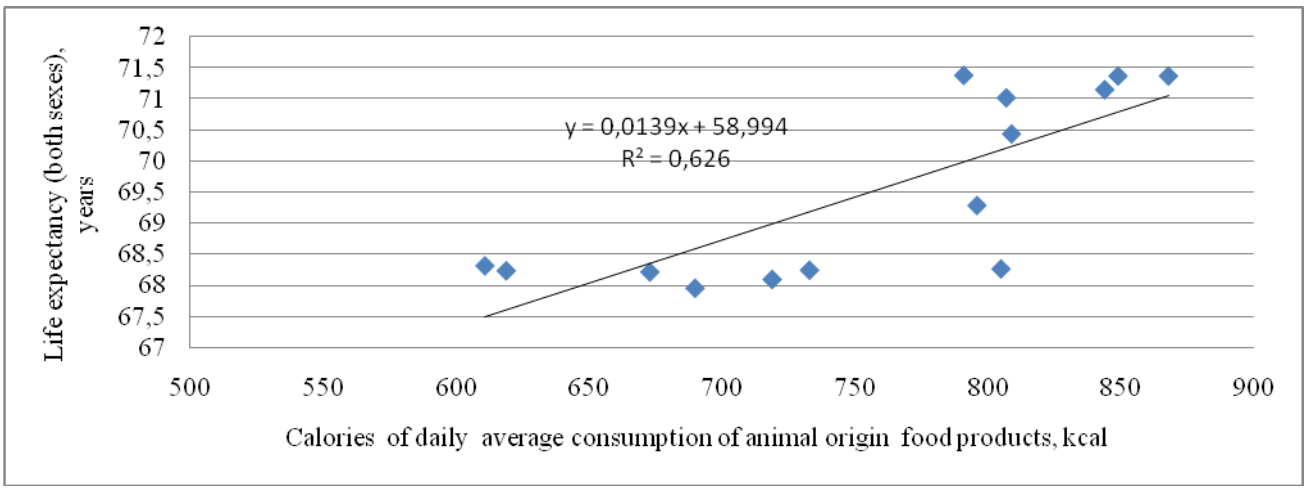

Fig.1. Model of linear dependence of human life expectancy (both sexes) in accordance with calories of daily average consumption of animal origin food products, kcal *

* Developed by authors based on data (State Statistics Service of Ukraine)

The obtained equation $Y = 58.99 + 0.01389x_1$ (x_1 - the amount of calories of animal origin products consumption) explains the effect of caloric content of animal origin food products on life expectancy, which is approximately 63%. According to the obtained equation, if a person will be able to consume the physiological norm of calories, then the predicted life expectancy is expected to reach 78,1 years.

Body's protein needs are dependent upon age, gender, climate of the region and labor activity. Optimal amount of protein is considered to be at a rate of not less than 1 g per 1 kg of body weight. Protein needs for an adult are about 70-110 g per day, the protein needs for children – 1,5-4 g per 1 kg of weight. Proteins of animal and vegetative origin should be in the ratio of 1:1.

Protein is the main part of the diet and should be at least 12% of daily caloric content (Krupa, 2014). Deficiency of protein, as well as its excess in the food intake, affects negative on the human body.

The analysis of protein consumption showed that only in 1990 and during 2013-2017 the ratio between animal and vegetable proteins was almost 50%:50%. During a longer analyzed period, there was a significant shortage of animal proteins, which can be explained by the fact that animal production is 5-10 times more expensive than crop production.

A similar trend is observed in the consumption of fats (108 g /per day in 1990, a decrease to 71,7 g / per day in 2000, an increase to 153 g / per day in 2011 and a decline during 2012-2017 to 134 g / per day). Consumption of carbohydrates varied: in 1990, consumption was at 386 g / per day, in 2000 - 369 g / per day, and during 2001-2008 growth was observed up to 434 g / per day. Since 2012 there has been a tendency to reduce carbohydrate consumption to 367 g /per day in 2016, but in 2017 consumption increased to 370 g / per day. It should be noted that the main role of carbohydrates is energy, providing almost 60% of the daily energy of the food intake.

Analyzing the data in table 2, it is necessary to note that a balanced diet consists of optimal amount of proteins and fats of vegetative and animal origin, carbohydrates. Necessary food caloric content can be provided from different products, but the diet should be optimal and meet the requirements of nutrition. The research of the balance of macronutrient consumption suggests that there is no clearly defined relationship, for example, WHO recommends that a general ratio (%) of proteins:fats: carbohydrates should be 18:16:66.

Table 2

Protein-fat-carbohydrate balance in food consumption in Ukraine during 2000-2017 *

Indicator	Years											
	2000	2005	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Protein, gm	73,4	79,7	95	93	93	93	93	92	90	84	84	85
Fat, gm	71,7	89,7	161	152	153	153	151	151	146	136	135	134
Carbohydrate, gm	369	386	434	420	409	414	412	402	398	374	367	370
Ratio (%) of proteins:fats: carbohydrates	1:0,98 :5,0	1:1,12 :4,8	1:1,7: 4,6	1:1, 6:4, 5	1:1,6: 4,4	1:1,6: 4,5	1:1, 6:4, 3	1:1,6: 4,4	1:1, 6:4, 4	1:1,6: 4,5	1:1,6 :4,4	1:1,6 :4,4

* Calculated by authors based on (State Statistics Service of Ukraine)

This ratio is 13:13:75 or 1: 1,2: 4,6 in Ukraine (Shvets, 2012). In 1990, the ratio of proteins: fats: carbohydrates did not reach the normative indicator and was 1:0.98:3.5. The following years, this indicator exceeded the normative indicator.

In Ukraine, two documents determine the food intake. A set of food products should determine the amount of products consumed over a certain period of time (day, month, year). At this time, person should get all the nutrients. In Ukraine, the "Norms of physiological needs of the population of Ukraine in basic nutrients and energy" ("Norms-99") was approved (Order of the Ministry of Health of Ukraine, 1999). This document defines a physiological daily amount of food that meets the needs of the child and adult population in proteins, fats and carbohydrates, energy, minerals, vitamins etc.

Consumer baskets have been formed in Ukraine for 13 group of population: 5 for children and adolescents (under 3 years of age, 4-6 years, 7-10 years, 11-13 years, 14-17 years), 4 – for persons of working age (18-29 years for both sexes, 30-54 years for women, 30-59 years for men), 4 for persons of retirement age (55-74 years for women, 60-74 years for men, 75 years and older for both sexes). Ministry of Health of Ukraine will determine the recommended rational norms for consumption of main food products per capita and re-approval of the consumer basket every five years. However, indicators of

physiological nutrition norms were revised in October 2016.

Based on two acts that regulate nutrition of the Ukrainian population, we performed a comparative analysis (table 3).

Table 3

Comparison of physiological norms of food consumption and consumer basket *

Food products	Physiological consumption norms, kg /per year	Consumer basket, kg / per year	Deviation of physiological norms of consumption from the consumer basket	
			absolute	relative,%
Bread and bakery products	101	123,4	-22,4	-22,18
Potatoes	124	95	29	23,39
Vegetables and melons	161	110	51	31,68
Fruit, berries, grapes	90	64	26	28,89
Sugar, confectionery	38	36,5	1,5	3,95
Vegetable oils	13	7,1	5,9	45,38
Meat and meat products	80	53	27	33,75
Fish and fish products	20	13	7	35
Milk and dairy products	380	348	32	10,92
Eggs, pcs	290	220	70	24,14

* Calculated by authors based on (Smolyar, 2012; Bankovskaya, 2008)

The result gives us an opportunity to make the following conclusions: the largest difference in indicators is observed in food groups that provide the human body with proteins and fats. Moreover, the physiological norms recommended by the Ukrainian Research Institute of Food of the Ministry of Health are approximately 20% lower than actual consumption of food in developed countries.

The biological aspect of nutrition analysis requires to conduct research of vitamins consumption. The dynamic of vitamins consumption by Ukrainians during the years of independence is given in table 4.

Table 4

Daily intake of the main vitamins by the population of Ukraine during 2000-2016 *

Main vitamins	Years														Recommended norms for adults
	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	
Retinol, mcg	1004	1156	1204	1158	1112	1109	1088	1088	1135	1165	1164	1093	1086	1044	1
Beta-carotene, mcg	1472	1735	1824	1711	1848	1952	2035	2290	2304	2306	2300	2260	2298	2241	–
Thiamin, mlg	1,81	1,9	1,9	1,87	1,89	1,87	1,88	1,91	1,93	1,92	1,92	1,83	1,82	1,81	1,5–2,0
Riboflavin, mlg	2,27	2,51	2,6	2,57	2,57	2,56	2,55	2,57	2,66	2,71	2,7	2,56	2,55	2,49	2,0–3,0
Niacin, mlg	16,8	17,9	18,1	18,1	18,8	18,6	18,8	19,1	19,3	19,3	19,2	18,4	18,6	18,6	10–18
Ascorbic acid, mlg	100	111	111	110	115	119	121	133	133	133	133	130	132	133	60–100

* Calculated by authors based on (State Statistics Service of Ukraine)

The data indicate that the human body during this period did not receive enough fat-soluble vitamin A, only the content of vitamin C in the nutrition was sufficient. Micronutrients are very important for human body, but domestic statistics identifies only two elements - iron and calcium. Scientific and special literature analysis (Smolyar, 2012; Bankovskaya, 2008; Smolyar, 2013) shows insufficient amount of magnesium and zinc in the daily nutrition, the amount of iron is insufficient for women, physiological norm for which is 18 mg / per day.

To sum up, we can assert that the nutrition of the Ukrainian population is irrational and unbalanced. The question arises: is this the consequence of consumed food "poverty" (food quality)? During the 1990's a sharp decline in consumption of meat and meat products by the population of the country occurred despite the fact that the Ukrainian culture has a rich food intake in meat dishes.

In 1990, the actual consumption of meat and meat products was 68 kg per capita per year, or 131% of the minimum norm and 81,9% of the physiological

norm of consumption. In 2000, the consumption decreased almost twice, only 33 kg (63,5% of the minimum and 39,8% of the physiological norm of consumption). This was due to a sharp decline in supply of this type of food, rising prices and, consequently, the economic inaccessibility of these products.

The following decades are marked by the tendency of annual growth of personal consumption of meat and meat products (56 kg in 2013, 107,7% of the minimum and 70% of the physiological norm of consumption) and a decrease in consumption to 51,7 kg (99,4% of the minimum and 64,6% of the physiological norms of consumption) in 2017. There were transformations in consumption structure of meat and meat products: in 80's pork and beef were more popular in consumption, in the 90's poultry meat took the first place. Since 2000, the supply of poultry meat has rapidly increased in the country. However, poultry meat in Ukraine is consumed 2 times less than in the United States (Fig 2), and beef consumption is less than the world level.

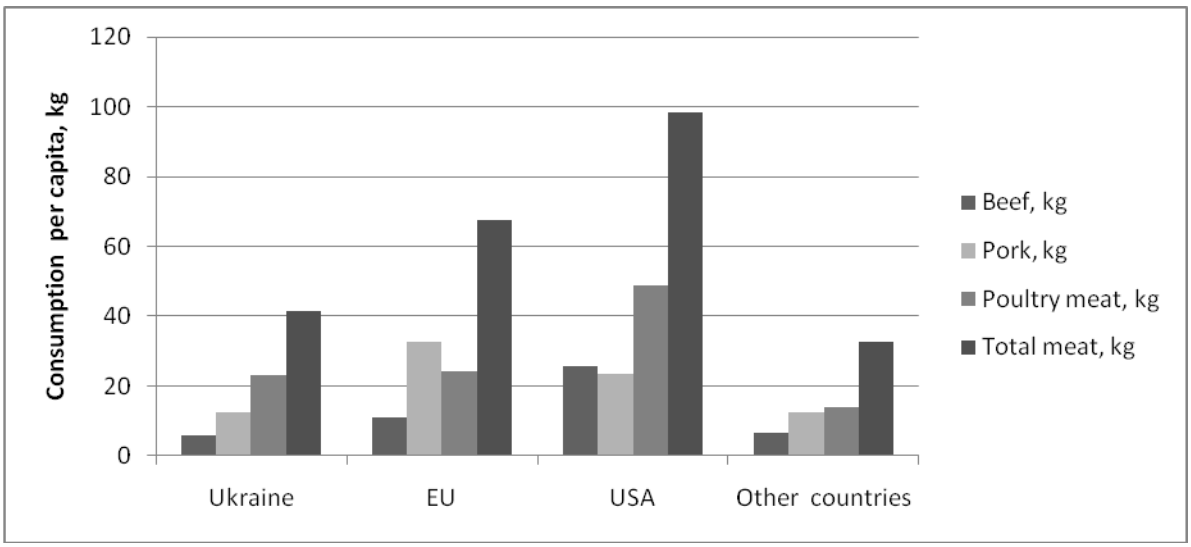

Fig. 2 Meat consumption structure in Ukraine and other countries in 2017 (kg per capita) *

* Calculated by authors based on (OECD)

In general, the consumption of meat by Ukrainian exceeds the world level by 25%, but is at 60% of the European and 42% of American consumption. The

dynamic research of consumption of such food groups as eggs, milk and dairy products, fish and fish products suggests that egg consumption in 2017 was almost 6% less than the physiological norm of consumption; the consumption of fish in 2017 did not reach the indicators of 1990 and was 54% of the physiological norm of consumption. The increasing of milk and dairy products accessibility was observed during 2005-2006 and 2012-2014, but in 2017 the consumption of milk and dairy products was significantly lower than in 1990 - by almost 50%.

Potatoes consumption during this period exceeded the minimum consumption norm. In 2017, actual consumption was 149%, however, in relation to physiological norm it was almost 115%. Sugar consumption had a decline more than 66% in 2017 in comparison with 1990. According to V. Smolyar (2013, p. 6): volumes of sugar consumption are overestimated; and it is necessary to take into account that a considerable part of sugar (about 50%) is spent on the production of home-made alcoholic beverages.

Bread and bakery products consumption decreased in recent years, but in 2017 the actual consumption was 101 kg per person, which corresponds to the physiological norm of consumption. The dynamics of vegetable oil consumption indicates a decrease in volumes until 1995, but in 2009, the actual consumption of vegetable oil doubled the minimum consumption norm. Since 2010, there has been a tendency of reducing the vegetable oil consumption, in 2017, its consumption exceeded the minimum norm by 46,3%. However, according to physiological norm, consumption of vegetable oil was lower than the required norm by 10%.

The tendency of vegetables, fruits and berries consumption during the 1990's was identical to consumption of other food products: decline and then slow growth. In 2017, consumption of vegetables was 55% higher than in 1990 and was 160 kg – approximately equal to physiological norm of consumption. Fruits, berries and grapes consumption had some fluctuations, the largest

consumption of this food group was during 2012-2013 (56 kg); during 2014-2016, the reduction was observed to almost 50 kg, but in 2017 actual consumption was 53 kg (59% of physiological norm of consumption). Thus, compared with physiological norms of consumption in 2017, every citizen of Ukraine consumed less: milk and dairy products - by 48%; meat and meat products – by 35,4%; fish and fish products - by 46%; fruits and berries - by 41%.

We investigated the relationship between life expectancy (both sexes) and the amount of actual food consumption. The results of correlation analysis are given in table 5. The data indicate the existence of a direct and inverse relationship between life expectancy (both sexes) and the consumption of the basic food groups.

Table 5

Relationship between life expectancy (both sexes) and consumption of basic food groups *

Foods	Correlation coefficient
Bread and bakery products	-0,9158
Meat and meat products	0,92464
Milk and dairy products	-0,6305
Fish and fish products	-0,5104
Eggs, pcs	0,9558
Vegetables and melons	0,96399
Fruits, berries and grapes	0,95665
Potatoes	0,60402
Sugar	-0,7876
Vegetable oil	-0,51866

* Calculated by authors

Based on correlation analysis data, we performed a regression analysis of the effect of meat consumption (x_1) on Y - life expectancy of a person (both

sexes).

The determination coefficient (R^2) equals 0,85. This coefficient indicates a functional relationship between life expectancy (both sexes) and the chosen factor. The equation $Y = 57,85 + 0,245x_1$ explains this factor. This model can be used to predict human life expectancy. Thus, if a person will consume of the physiological norm of meat and meat products (83 kg), then life expectancy is expected to reach 78,22 years, and in case of the minimum norm of consumption approved in the consumer basket (52 kg), life expectancy will be 70,6 years.

We performed a regression analysis of the influence of fruits, berries and grapes (x_1) consumption on life expectancy (both sexes) - Y. In this case, R^2 equals 0,83. The obtained equation $Y = 64,09 + 0,12x_1$ has high reliability and explains the investigated factor. This model of predicting the human life expectancy allows us to determine that if a person will consume of the physiological norm of fruits, berries and grapes (90 kg), then life expectancy is expected to reach 75,21 years, and in case of the minimum norm of consumption (68 kg), life expectancy will be 72,5 years.

To determine the impact of the nutrition on the quality of human development, we used the method of main components. This method is most widely used from all multidimensional methods and has a number of advantages; it does not require to check the data to normality. It differs from the method of main factors by a simpler logical expression. It is possible to form a simpler and at the same time the most informative system for describing the object of the study, to estimate the relationship between the factors and the selected main components, to investigate the possible factors changes (Kalinina and Soloviev, 2003; Kendyukhov and Tolkachov, 2013).

The mathematical model for determining the aggregated indicator can be described as a linear combination of features:

$$Y_i = a_1X_1 + \ldots + a_nX_n , \quad (1)$$

where Yi is the resulting integral indicator;

Xi - factors influencing the resulting indicator Yi (main components of the model);

a - weight of i-th factor.

Two criteria can be used to determine the optimal number of the model components. According to the first criterion, the number of factors equals to the number of components whose value is bigger than one. The second criterion is a graph of own components of "scree plot" (Kendyukhov and Tolkachov, 2013; Mokeev and Pluzhnikov, 2011).

We used a package of applications "Statistica 10.0", the method "Principal components". The optimal number of main components is determined graphically using the "Scree plot" (Fig. 3). The percentage of the first component in the total variation is 52,8%, the second component – 23,7%, the third- 12,4%, and the fourth – 5,3%. The components explain 94,1% of the total variation. The variance should be at least 70%. That's why, two components can be used to analyze the impact of food status on human life.

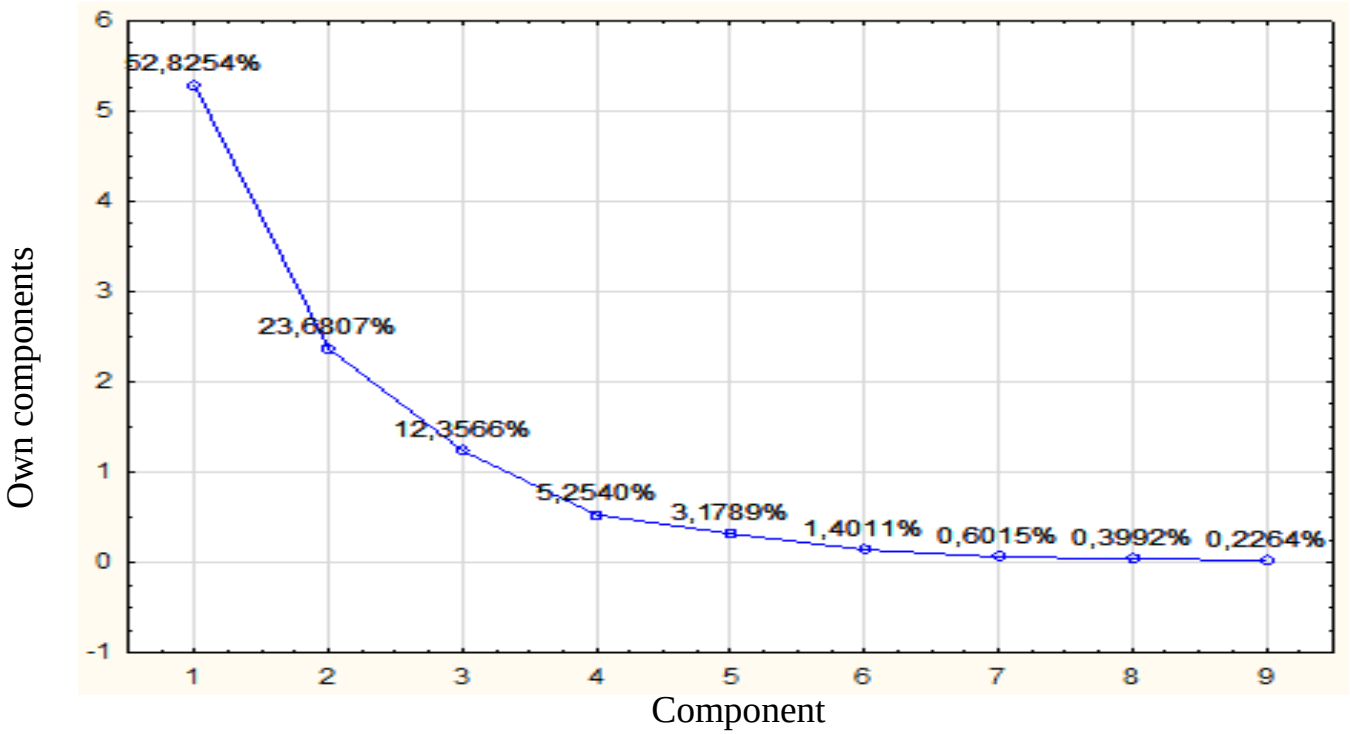

Fig. 3. The optimal number of main components by the criterion of "Scree plot" *

* Developed by authors

The percentage of each indicator and individual components are given in table 6.

Table 6

Matrix (number of components equals 4) *

Variable (X)	Number of variable	Component 1	Component 2	Component 3	Component 4
Meat and meat products	1	0,86215	-0,376	-0,2612	-0,1213
Milk and dairy products	2	0,43176	0,63623	-0,2605	0,5464
Eggs	3	0,888	-0,2401	0,34186	0,10325
Bread and bakery products	4	-0,8275	0,43181	0,21177	0,08021
Potatoes	5	-0,6381	-0,4678	0,52239	0,28071
Vegetables and melons	6	0,63468	-0,6167	0,42941	0,03152
Fruits,berries and grapes	7	0,76356	-0,3595	-0,2386	0,25207
Fish and fish products	8	0,71704	0,62356	0,10463	-0,2251
Sugar	9	0,42464	0,59742	0,63053	-0,0248
Vegetable oil	10	0,89001	0,322	0,12307	-0,0203

* Developed by authors

The "main components" method, and first of all, the possibility of step-by-step joining of the components and the use of built-in multiple regression, allowed to determine the impact of nutrition on the life expectancy and mortality of the population (table 7).

Table 7

Results of regression for dependent variables "life expectancy" and "number of dead" *

For the dependent variable "life expectancy"										
	BETA	Statistical error of BETA	B	Statistical error of B	t(16)	p	R	R^2	F	Estimation standard error
							0,939	0,883	30,07	0,577
Free term			68,93	0,126	547,38	0				

Component 1	0,7608	0,0857	0,4986	0,0561	8,8806	0				
Component 2	-0,4812	0,0857	-0,471	0,0839	-5,6171	0				
For the dependent variable "the number of dead"										
Free term			727,19	4,2693	170,3	0	0,9319	0,8667	24,382	18,905
Component 1	-0,5824	0,0956	-11,97	1,9641	-6,095	0				
Component 2	0,65023	0,0944	18,99	2,7559	6,8909	0				

* Developed by authors

We conducted an analysis of scientific works, taking into account the significant influence of certain food products consumption on the human life expectancy and to substantiate the modern balanced nutrition. It gives us an opportunity to determine the basic principles of "healthy" nutrition in Ukraine: the daily eating norm should contain no more than 25-30% of energy-rich foods, including no more than 10% of the diet of energy-rich foods should be saturated fats, more than 60% - complex carbohydrates, and only 10-12% - proteins; the amount of kitchen salt - no more than 6 grams per day, and sugar - no more than 35 grams; fresh fruits and vegetables should be consumed in a wide assortment of at least 400 g per day (146 kg per year) (The Resolution of the Cabinet of Ministers of Ukraine, 2000).

Investigating the food structure, we note that domestic normative documents do not examine the norms of consumption of food fibers. The analysis of nutrition theories and functions of macronutrients and micronutrients in food approved that dietary fiber is one of the components of complex prevention of disorders of fat metabolism, atherosclerosis, diabetes mellitus, and cholelithiasis.

Based on the analysis of the biological (physiological) aspect of the healthy eating concept and food security, it is necessary to form the following directions for the development of food industry, such as the production of products with low- fat, sugar, salt, and cholesterol; prophylactic and dietary

products; development and implementation of technologies for the processing of vegetables and fruits with high contents of food fibers, pectin and micronutrients.

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