ANIMAL SCIENCE AND FOOD TECHNOLOGY

Journal homepage: https://animalscience.com.ua/en
Animal Science and Food Technology, 12(2), 5-13
Received: x.xx.20xx Revised: x.xx.20xx Accepted: x.xx.20xx

UDC 664.014/019
DOI: 10.31548/animal2021.02.001

New grain concentrates with increased biological value in the structure of modern nutrition

L. Bal-Prylypko[*1], H. Tolok[1], M. Nikolaienko[1], A. Antonenko[2], T. Brovenko[2]

[1]National University of Life and Environmental Science of Ukraine
03041, 15 Heroiv Oborony Str., Kyiv, Ukraine

[2]Kyiv National University of Culture and Arts
01601, 36 Yevhena Konovaltsia Str., Kyiv, Ukraine

Abstract. Nutrition of modern people is the main controllable factor that determines their state of health, quality of life, efficiency and active longevity. It has been established that excessive consumption of animal fats, simple carbohydrates, table salt and a significant reduction in the diet of vegetables and fruits, which are sources of vitamins, minerals, dietary fibre and minor biologically active substances, results in the development of cardiovascular diseases, metabolic disorders, cancer, etc. Thus, the priority task of scientists and practitioners is to develop products of high biological value as an important factor in preserving human health and disease prevention. The development, introduction into production, and popularisation of such products will optimise the nutritional structure of Ukrainians, overcome the adverse trends in the health of the nation caused by nutritional status disorders, improve the quality of life of the population, and improve the demographic situation in Ukraine. The research substantiates the expediency and necessity of establishing new products with improved properties and provides a list of used additives of natural origin, which are a source of essential nutrients. The results of the conducted tests confirm the optimisation of the chemical composition of new grain concentrates, improvement of their organoleptic properties, and prolongation of shelf life, which indicates the correct choice of prescription components, and their rational ratio. The characteristics of the nutritional and biological value of new grain concentrate Extrapolivitamix enriched with vegetable powders, wheat germ, iodine and raisins are presented. The properties of grain concentrates were explored, and it was proved that they can be included in the group of functional foods due to the correlation of chemical composition. The optimal concentrations of functional ingredients that can be used in new products were determined. New concentrates "Extrapolivitamix" are recommended for industrial production and use in the daily diet

Suggested Citation:
Bal-Prylypko, L., Tolok, H., Nikolaienko, M., Antonenko, A., & Brovenko, T. (2021). New grain concentrates with increased biological value in the structure of modern nutrition. *Animal Science and Food Technology*, 12(2), 5-13.

[*]*Corresponding author*

Keywords: human nutrition, rational nutrition, functional foods, disease prevention, grain concentrates, extrapolivitamix, iodine, vegetable powders, wheat germ, vegetable milk

Introduction

Currently, a significant number of results of comparative analysis of the incidence of chronic non-communicable diseases and diets in many regions of the world have been accumulated. Many nutritional risk factors for cardiovascular diseases, cancer, diabetes mellitus, obesity, and bone and joint damage have been explored, and it has been concluded that the development and progression of most diseases depend on nutrition. Studies conducted by the O.M. Marzeev Institute of Public Health of the National Academy of Medical Sciences of Ukraine state that the diet of the majority of the population of Ukraine is high in calories. The energy value of the diet is satisfied by carbohydrates and fats that come from low-quality foods. Therewith, the countries that have managed to achieve a significant reduction in mortality from cardiovascular diseases over the past 30 years (USA, Australia, Finland), during the development and implementation of prevention programs, placed significant emphasis on changing the nature of nutrition (Bal-Prylypko, Dubina, Baranivskyi, 2012; Danilova, Tkachenko & Vitryak, 2017).

The issue of rational nutrition is complex and large-scale. It – a kind of reflection of the social welfare of the country and the population and is currently not solved in Ukraine, as there is no unified national policy in the field of nutrition. (Antiushko & Bozhko, 2021). The analysis of the nutritional dynamics of different population groups in Ukraine demonstrates significant deviations from the formula of balanced nutrition, primarily in terms of the level of consumption of vitamins, chemical macro- and microelements, biologically valuable nutrients of plant origin and other biologically active substances that are important in maintaining regular metabolism, structure and functions of various organs (Bal-Prylypko, Tolok, Nikolaenko, 2021; Mamenko, 2020). Thus, an unbalanced diet can cause severe disorders in the human body, and the clinical signs of such disorders are individual excess or deficiency of a particular element or compound in the body. Therefore, the prevention and treatment of diseases caused by insufficient intake of necessary biologically active substances – compounds that have a high pharmacological effect in micro quantities are becoming increasingly significant.

The issue of improving the structure of nutrition, quality and safety of food products as the foundation of human life is one of the most crucial nowadays, both within one country and at the international level. The search for alternative ways to solve this extremely important task has brought scientists and practitioners to the idea of the necessity of developing and implementing new, much more advanced technologies of food production, appropriate to the requirements of modern people. The establishment of a new generation of food products and their introduction into the diet of consumers can be performed only based on scientifically sound and proven medical and biological principles, new technologies for processing agricultural and medicinal raw materials into health products and guaranteeing the absolute safety of such products for consumers (Dzyundzya & Burak, 2018).

The issues of healthy nutrition are now dealt with by specialists in numerous scientific fields – technologists, nutritionists, biochemists, microbiologists, etc. A significant contribution to the development of the scientific foundations of the design of food products was provided by domestic and foreign scientists: S.N. Astranov, L.V. Kapreliants, P. Karpenko, V.Korzun, M. Peresichny, O. Cherevko etc.

The problem of developing new functional products is being explored by scientists from the National University of Life and Environmental Sciences of Ukraine, the National University of Food Technologies, the Kyiv National University of Trade and Economics, the Chebotarev Institute of Gerontology of the National Academy of Medical Sciences of Ukraine, the Scientific Center for Preventive Toxicology, Food and Chemical Safety named after Academician L.I. Medved (Nikolaienko & Bal-Prylypko, 2020).

The general conclusion of scientists is that almost all food products consumed by the population can be given functional properties and, thus, make their food into medicine. For this purpose, it is necessary to find natural sources of the most effective functional ingredients, explore the properties of various biologically active components of food (vitamins, mineral elements, polysaccharides, amino acids, fats, etc.) and to develop new technologies for the production of health food products.

The results of observations demonstrate that more than 50% of the population of Ukraine eats poor-quality food. Incomplete quantitative and qualitative composition and unbalanced energy value nutrition contribute to the development of alimentary and alimentary-dependent diseases. The imbalance of modern nutrition and the inability to provide the human body with the necessary amount of essential vitamins and minerals (micronutrients) is a problem that requires the development of new and modernisation of conventional food products with well-defined targeted functional properties. Food technologies of the future – are new raw materials and new properties of conventional raw materials, new ways of converting agricultural raw materials, plant and animal origin into food products, and new food recipes. The development of recipes for new functional products is an urgent and timely issue, as such products provide maximum mobilisation of the adaptive forces of the human body designed to protect against pathological changes under the influence of adverse factors of various origins.

Materials and Methods

Food concentrates are a group of products that have a long shelf life, convenient for transportation, easy to prepare. These are quite conventional products that are popular among a large part of the population, their assortment is a quite limited, and nutritional and biological value often leaves much to be desired. For using them in functional food, it is advisable to improve the recipes by optimising their chemical composition, improving taste characteristics, and extending shelf life. The basic samples were grains – oatmeal, buckwheat, rice and semolina, as conventional for Ukrainian consumers. New grain concentrates for functional food are enriched with several components that have a wide range of useful characteristics.

Thus, it is known that vitamins and minerals are essential components of food, to other components contained in microdoses, but are crucial for human health and longevity. Their deficiency or absence provokes several diseases and pathologies. Thus, it is advisable to additionally enrich new functional products with naturally concentrated compounds that are sources of these

nutrients. In the course of research, discussions and approvals, were identified as enriching recipe components vegetable powders (carrot and pumpkin), wheat germ and raisins.

Vegetable powders are used in therapeutic and prophylactic nutrition due to their active antioxidant and immunomodulatory properties. In addition, wheat germs are becoming popular due to their rich vitamin and mineral composition, they are a source of valuable fats and proteins.

For human health, particularly essential mineral components are a sufficient amount in the diet and optimal absorption of calcium and iodine by the body.

Calcium – is vital for the development of the body, healthy bones and teeth. In the body of an adult, the calcium content is from 1 to 2.2 kg. Approximately 99% of calcium is the base of the human skeleton, while 1% of this mineral circulates in the blood. In addition, calcium is necessary for the contraction of the heart muscles, regulation of the heartbeat and is necessary for the development of blood cells.

The staff of the Nutrition Hygiene Laboratory of the Institute of Gerontology of the National Academy of Medical Sciences of Ukraine established that in different regions of Ukraine, the level of calcium in the diet does not exceed 30-40% of the standard. Lack of calcium results in stimulation of bone resorption. The consequence of long-term calcium deficiency is almost always a decrease in bone mineral density (BMD), which can contribute to an increased risk of osteoporosis in older age.

As a natural calcium enricher of new grain concentrates, in addition to skimmed milk powder, eggshells (pre-processed and ground) are used as a source of calcium carbonate, which is fully absorbed by the body. The chemical composition of the shell is almost identical to that of our bones and teeth. In addition, eggshells stimulate the hematopoietic function of the bone marrow. It contains about 30 other microelements necessary for a person: copper, fluorine, iron, manganese, molybdenum, phosphorus, sulfur, zinc, silicon, etc. Particularly crucial is the significant content of silicon and molybdenum in the shell – without them, the proper course of biochemical reactions in the body is impossible (Watanabe *et al.*, 2019).

One of these biologically active substances is iodine, the lack of which in diets is one of the pathogenic factors of unbalanced nutrition, and endemic goitre and thyroid cancer in adults and children, as its main manifestation, ranks first among non-communicable diseases by regional characteristics and the number of patients living in contaminated areas. Most residents of Ukraine consume only 40...80 μg of iodine per day, while the physiological requirement is 90...300 μg (depending on age, gender, and living conditions) (Motuzka & Koshelnyk, 2019).

In Ukraine and abroad, the problem associated with iodine deficiency in diets was partially solved by iodised salt with potassium iodide. This method appeared to be easy and effective since everyone uses salt in general. However, over time it was understood that using iodised salt does not solve the problem.

Recent studies demonstrate that daily long-term use of iodised salt slightly reduces the incidence of endemic goitre but does not eliminate it. In addition, there are known data on the adverse effects of long-term prophylaxis with iodised salt. For salt iodisation, cheap but volatile iodine compounds are used, which are destroyed during storage and heat treatment (Zheplinska & Mushtruk, 2021).

Attempts to eliminate iodine deficiency by using iodised salt, iodised yeast, starch-iodine complex and other compounds using

chemical iodine have not yielded significant results. In addition, products enriched with inorganic iodine compounds have a pronounced unpleasant taste and smell (Ponomarov, Merzlikina & Gladneva, 2008).

Organic iodine sources are required to eliminate iodine deficiency. Organic iodine – a complex compound of iodine with organic matter (sugar, polysaccharides, amino acids). Organic iodine, unlike mineral iodine, is contained in a bound state and does not enter into most chemical reactions with organic substances in the body.

Iodcasein – iodised milk protein is a yellow powder that is well soluble in water the mass fraction of iodine is 7…9%.

Main properties of iodcasein:

• is based on natural milk protein, which is easily digested;

• provides individual regulation of iodine metabolism in the body;

• iodine is tightly bound to protein and does not degrade during prolonged storage and heat treatment, withstands high temperatures;

• iodine overdose is excluded;

• using as a food additive "Iodcasein" in milk, dairy products, bakery products, etc. does not require material costs for the reconstruction of production due to the scanty amounts of the recommended drug and ease of use (2.5…..5 g/t,);

• using iodcasein does not affect the organoleptic properties of the finished product (Naumenko, Danylenko & Bal-Prylypko, 2020).

The uniqueness of "Iodcasein" is that in case of iodine deficiency, the liver produces enzymes that decompose the milk protein molecule, and iodine enters the human body. When there is enough iodine in the body, the enzymes stop working, and all the remaining iodine is excreted from the body along with protein naturally (Grek, Onopriichuk & Tymchuk, 2019).

Research results

New concentrates of increased biological value "Extrapolivitamix", enriched with wheat germ and dried fruits or vegetables (depending on the recipe) and "Extrapolivitamix-2", additionally enriched with eggshells, are characterised by a high content of vitamins and some minerals.

Grain concentrate "Extrapolivitamix" based on oat or pearl barley flakes "Extra" is characterised by the presence of biologically active ingredients:

- Wheat germ – 15-30%;
- Raisins – 20-30%;
- Vegetable powders – 5-10%.

However, these compositions contain a small amount of iodine (up to 8% of the daily requirement). Therefore, it was decided that some recipes of the developed products of increased biological value should be enriched with iodcasein.

After conducting working tastings of various compositions with using the scoring, the recipes of the concentrate "Extrapolivitamix-2" were obtained (Fig. 1). Therewith, "Extra" oat flakes, wheat germ flakes and raisins were used as the main raw materials.

During the development of new recipes, it was considered that one portion of the finished product enriched with iodine should not exceed 50% of the daily requirement for this trace element, i.e. no more than 60 micrograms for an adult, as a variety of vegetables and fruits, milk, eggs, meat, sea fish, which are based on the diets of the population (including military personnel) contain a specific part of iodine in their composition.

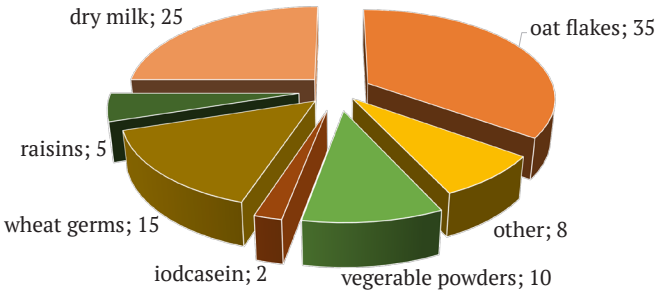

Figure 1. Recipes of "Extrapolivitamix-2" concentrates

Together with the specialists of the Scientific Center for Preventive Toxicology, Food and Chemical Safety named after Academician L.I. Medved, the chemical composition of the new concentrate was explored (Table 1). According to the data in Table 1, the new composition significantly increased the content of such important macronutrients as calcium and potassium in terms of protection of the human body in adverse environmental conditions. The main suppliers of calcium are skimmed milk powder, wheat germ flakes and in some compositions – egg shells. Thus, the calcium content increased almost 7 times (345.2 mg/100g vs 53.25 mg/100g) Potassium content doubled due to the introduction of raisins, dried apricots and partially wheat germ flakes.

Using a new component – iodcasein allowed increasing the iodine content in the new composition by almost 30 times, which is 50% of the daily requirement for this nutrient. Thus, the expediency of using iodcasein in the development of new types of concentrates of dinner dishes of increased biological value for functional purposes has been proved.

Table 1. *Chemical composition of the new concentrate of high biological value*

Indicator name	Oat flakes "Extra"	"Extrapolivitamix-2"
Proteins, %	12.15±0.61	15.52±0.78
Lipids, %	6.24±0.61	5.57±0.28
Carbohydrates Including dietary fibre, %	66.15±3.31 3.56±0.19	51.46±2.57 3.84±0.20
Min. substance, mg/100g Sodium	18.13±0.91	45.80±2.29
Potassium	331.50±16.58	675.2±33.76
Calcium	53.25±2.66	345.2±17.26
Magnesium	128.26±6.41	132.28±6.61
Phosphorus	325.0±16.25	238.8±11.94
Iron	3.65±0.18	4.16±0.20
Iodine	0.04±0.002	1.2±0.06

In addition to micronutrient deficiency, which affects all segments of the population, the results of studies indicating chronic protein deficiency in the diet, in particular, in childhood and the elderly, are alarming (Brovenko & Dzyundzya, 2019). In the new concentrates, skimmed milk powder was introduced into the recipe as the main protein-containing component. However,

considering the rapidly growing interest in the world and Ukraine, in particular, in dairy-free products, the next step of research is planned to use alternative substitutes for cow's milk powder. Among the most important reasons that encourage people to stick to a plant-based diet are the following: caring for animals, improving health, the adverse impact of meat and dairy production on the environment, the safety of such food products, cost, doubts about the reliability of labelling of animal products, etc (Vitorino *et al*., 2020; Kour, Singh & Saxena, 2019).

All varieties of plant milk are low-calorie products that are aqueous emulsions of extracts from nuts, grains, seeds and seedlings of some crops and are positioned as substitutes for natural milk of animal origin for vegans, people with lactose intolerance and simply followers of healthy eating (Bal-Prylypko & Nikolayenko, 2018).

These drinks contain biologically active protein complexes, peptides, free amino acids, lecithin, soluble sugars, dietary fibre, biogenic macro- and microelements, vitamins, phytohormones and other valuable components.

In a study by Pro-Consulting (Gómez-Cortés *et al*. 2019), it is noted that oat and soy milk are the most popular in the Ukrainian vegetable milk market, and local raw materials are used for their production. They are planned to be used as the base for establishing new recipes of grain concentrates for functional purposes.

Conclusions

A healthy diet prevents diseases, increases efficiency and prolongs people's life, while an unbalanced diet, on the contrary, causes many health problems. Therefore, it is timely and expedient to establish new products with improved properties, which both have excellent nutritional properties and have a targeted effect on the functional activity of individual organs, systems and the body in general, stimulating their work with a specific preventive and therapeutic purpose.

New grain concentrates can be included in the group of functional foods due to the correlation of their chemical composition, which allowed compensation for the deficiency of essential macro- and micronutrients necessary for the development, optimal functioning, recovery of the body after diseases and their prevention. The concentrations of functional ingredients used in the new products are close to optimal, physiological ones, thus, such products can be consumed for a long time (ensuring the daily requirement for basic nutrients does not exceed 50%, which allows using the new products in daily nutrition).

Using plant-based milk substitutes will allow the development of new products that, on the one hand, correspond to modern market demands, and on the other hand, will satisfy the body's demand for essential components.

References

[1] Bal-Prylypko, L.V., Dubina, M.I., & Baranivskyi, V.F. (2012) *Humanitarian and resource problems of the national security of Ukraine* Kyiv: VPC Express-Polygraph.

[2] Danilova, K., Tkachenko, L., & Vitryak, O. (2017). The use of extracts of green tea and ginger in the technology of beverages of high biological value. *Food Resources*, 9, 161-166.

[3] Antiushko, D., Bozhko, T., Shapovalova, N., Bodak, M., & Bezruchko, L. (2021). Nutritional Value Of A Dry Soluble Gerodietetic Product For Enteral Nutrition. *Eastern-European Journal of Enterprise Technologiesthis*, 5(11-113), 35-42.

[4] Bal-Prylypko, L., Tolok, G., Nikolaenko, M., Slobodyanyuk, N., Kornienko, V., & Panasyuk, O. (2021). *Scientific basis of creating a complex of technologies of food products for health purposes: A collective monograph.* Kyiv: FOP Yamchinsky.

[5] Mamenko, M. (2020). Iodine deficiency in the world and in Ukraine: The current state of the problem. *Modern Pediatrics. Ukraine*, 7(111), 40-46.

[6] Dzyundzya, O., Burak, V., Averchev, A., Novikova, N., Ryapolova, I., Antonenko, A., Brovenko, T., Kryvoruchko, M., & Tolok, G. (2018). Obtaining the powder-like raw materials with the further research into properties of eggplant powders. *Eastern-European Journal of Enterprise Technologies*, 5(11 (95), 14-20.

[7] Nikolaienko, M., & Bal-Prylypko, L. (2020). Development of an integrated food quality management system. *Potravinarstvo Slovak Journal of Food Sciences*, 14, 862-87.

[8] Watanabe, M., Yamada, C., Maeda, I., Techapun, C., Kuntiya, A., Leksawasdi, N., Seesuriyachan, P., Chaiyaso, T., Takenaka, S., Shiono, T., Nakamura, K., & Endo, S. (2019). Evaluating of quality of rice bran protein concentrate prepared by a combination of isoelectronic precipitation and electrolyzed water treatment. *LWT – Food Science and Technology*, 99, 262-267.

[9] Motuzka, Yu., & Koshelnyk, A. (2019). The market of analogues of dairy products of plant origin: World trends. *Goods and Markets*, 3, 38-49.

[10] Ponomarov, A.N., Merzlikina, A.A., Gladneva, A.A., & Lukin, A.L. (2008). Prospects for the use of antioxidants. *Milk Industry*, 27-30.

[11] Zheplinska, M., Mushtruk, M., Vasyliv, V., Kuts, A., Slobodyanyuk, N., Bal-Prylypko, L., Nikolaenko, M., Kokhan, O., Reznichenko, Y., & Salavor, O. (2021). The micronutrient profile of medicinal plant extracts. *Potravinarstvo Slovak Journal of Food Sciences*, 15, 528-535.

[12] Naumenko, O., Danylenko, S., Bal-Prylypko, L., Gunko, S., & Melnik, I. (2020). *Development of the biotechnology of streptococcus thermophilus bacteria as producers of exopolysaccharidesdevelopment of the biotechnology of streptococcus thermophilus bacteria as producers of exopolysaccharides*. Retrieved from https://journals.ontu.edu.ua/index.php/foodtech/article/view/1787.

[13] Grek, O., Onopriichuk, O., & Tymchuk, A. (2019). Biological value in milk-protein concentrates with malt ingredients. *Ukrainian Food Journal*, 8(3), 571-583.

[14] Brovenko, T., Dzyundzya, O., Burak, V., Ryapova, I., Voivoda N., Shinkaruk, M., Tolok G. (2019). Establishing the effect of eggplant powers on the rheological characteristics of a semi-finished product made from liver pate masses. *Eastern-European Journal of Enterprise Technologies*, 4(11), 56-64.

[15] Vitorino, K., Chambo, A., & Coradini, M.F. (2020). Cereal bars flavored with fish protein concentrate from different species. *Journal of Aquatic Food Product Technology*, 29(1), 65-72.

[16] Bal-Prylypko, L.V., & Nikolayenko, M.S. (2018) Integrated system of management of quality and safety of food products. *Scientific Bulletin of the National University of Bioresources and Nature Management of Ukraine*, 10, 5-6.

[17] Kour, J., Singh, S., & Saxena, D.C. (2019). Effect of nutraceuticals (beta-glucan concentrate, flaxseed lignan concentrate and gamma oryzanol concentrate) on nutritional, textural, pasting, thermal, structural and morphological properties of corn and rice flour blend based RTE extrudates. *Journal of Food Measurement and Characterization*, 13(2), 988-1003.

[18] Belkin, V.G. (2009) Modern trends in the field of development of functional food products *Pacific Medical Journal*, 1, 26-29.