

## INSTANT PORRIDGE COMPOSITION OF THE FUNCTIONAL PURPOSE: TECHNOLOGICAL ASPECTS

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**Annotation.** The objective of the research is to develop compositions and technology of dry compositional mixtures with gluten inclusion for producing instant porridges of functional purpose. The method of mathematical modeling was applied to develop compositional mixtures.

The alkaline hydrolysis method was used to obtain collagen preparation (glutin) from the fish industry derivative products. To establish the biological value of the developed instant porridges ion-exchange chromatography (Hitachi 835) was used.

It is shown, that the inclusion of glutin in developed mixtures contributes to the biological value of culinary products and provides additional functional properties. The biological full-value of developed instant porridges is determined. It is established that the degree of the daily requirement satisfaction of essential amino acids is 30 %, when consumed the recommended servings of food. Examined organoleptic, rheological and physicochemical characteristics of developed products confirm the usefulness of the proposed technology.

**Keywords:** instant porridges, collagen preparation, glutin, compositional mixtures, mathematical modeling, extrusion.

## КОМПОЗИЦІЯ КАШ ФУНКЦІОНАЛЬНОГО ПРИЗНАЧЕННЯ: ТЕХНОЛОГІЧНІ АСПЕКТИ

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**Анотація.** Розроблено композиції та технології сухих композиційних сумішей з включенням глютину для інстантних каш функціонального призначення із застосуванням методу математичного моделювання рецептурних композицій із заданою харчовою цінністю.

Глютин отримували лужним гідролізом вторинної рибної сировини. Показано, що введення до рецептур глютину сприяє підвищенню біологічної цінності та надає стравам функціональних властивостей. Визначено біологічну цінність розроблених інстантних каш методом іонно-обмінної хроматографії та встановлено, що ступінь задоволення добової потреби в незамінних амінокислотах при споживанні порції страви складає 30 %. Досліджено органолептичні, реологічні та фізико-хімічні характеристики розроблених продуктів, що підтверджують доцільність застосування запропонованої технології.

**Ключові слова:** інстантні каші, колагеновий препарат, глютин, композиційні суміші, математичне моделювання, екструзія.

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### Introduction

The food structure analysis of the population in every country of the world at the present stage shows that the ordinary person diet is characterized by deficiency of protein at the rate of about 10 – 26 % from requirement. It is known that owing to deficiency of this nutrient the proteinaceous insufficiency appears in a human body, being accompanied by violations of synthesis of enzymes, pancreas and intestine functions, negative nitrogenous balance, atony of muscles, decrease in organism resilience to causative agents of diseases. Development of the biologically full value food products with a number of functional properties will promote the solution of an ex-

isting food problem in the world. Today, a promising area of research and technological developments in the food industry is production of food that meets the requirements of instant and healthy nutrition. Thus, the development of multicomponent recipes that combine plant and animal raw materials will increase their biological value by combining proteins with different amino acid composition.

**Problem statement.** It is known that collagen plays a significant role in the human body as a specific protein. The collagen preparation (glutin) with inherent complex of physico-chemical properties can be used as a universal functional component in the production of food products. Fish waste is a source of collagen and its hydrolysis

products, which can be widely used in the food industry. Recently the interest to fish collagen has considerably grown. This is due to the fact that spongiform encephalopathy (cattle rabies) has become a major issue so that the use of animal collagen is dangerous. In addition, fish collagen is hypoallergenic (96 % identical to the human protein).

Cereals play a special role in the human diet. There are a number of technologies that provide producing of these products with maximum preservation of beneficial properties of raw materials. In this case, the question of balance and biological completeness of instant products on the grain basis remains unresolved.

### Literature review

It is known that dishes with optimal protein content are the basis of normal metabolic processes [1-2]. It should be noted that the condition of a proteinaceous exchange in a human body depends on a shortcoming or lack of essential amino acids to a large extent. Liebig's law [3] suggests that the lack of at least one essential amino acid in the diet leads to limitation of absorption of other ones. People should consume all the essential amino acids with food for normal life. Shortage of animal protein can be eliminated in the diet by replacing it with the vegetable proteins, however, provided that amino acid composition is balanced [4]. High quality functional properties of animal proteins occur in their water-holding capacity. Functional and technological quality of animal proteins (water-retaining, emulsifying ability, thermal stability, etc.) allows to use them for different target areas [5,13]. To make collagen digested it has to be hydrolysed [14,15]. The using of animal protein from raw materials containing collagen can enrich products with detoxifiers, significantly improve rheological quality and consistency of developed food and has health benefit for consumers [17-20].

### Development of instant porridge compositions of the functional purpose

Collagen preparation (glutin) was obtained using this method. Fish scales should be nonfatten by 3 – 5 % solution of NaOH (hydromodulus is 1:(2 – 5), T = 2 – 6 °C) for 24 hours. Then the fish scales (after degreasing) are washed under flowing water and hydrolysis is performed by two-fold process. The first stage assumes filling the fish scales with 5 – 7 % solution of NaOH, (hydromodulus is 1:(2 – 5), T = 10 – 12 °C) and keeping for 24 hours. Then the fish scales are washed with flowing water, filled with 6 – 8 % solution of NaOH and kept for 12 hours at 20 °C. The solution should be decanted, and thus obtained precipitate washed with water, filled with 2 % solution of acetic acid and kept for 5 – 10 minutes. The resulting collagen preparation is washed with flowing water until the pH = 7.0. Ready collagen preparation is dried at a temperature of (70 ± 5) °C prior to reaching the moisture content 5 – 8 %. The resulting

dry collagen preparation is crushed in the mill to the particle size 0,8 – 1 mm.

The development of the polycomponent recipes was accomplished with the method of mathematical modeling implying the add-in "Search solutions" of MS Excel. It allowed to develop the recipes of compositional mixtures for producing instant porridges with inclusion of the collagen preparation.

Preparation of the extruded cereal mixtures was based on the extrusion technology. Technological processing of grain raw materials included extrusion (T = 110 – 130 °C, P = 2 MPa, τ = 4 – 6 sec), crushing in the hammer mill and sieving (sieve 1x1 mm). Crushed and sifted extruded grain was mixed.

To establish the biological value of instant porridges with inclusion of the collagen preparation amino acid composition of the developed recipes was determined by applying of ion-exchange chromatograph Hitachi 835 (Japan).

Data were analysed by using one-way analysis of variance (ANOVA). To establish the significance of differences among samples at 95 % significance level the Tukey's test was used.

**Objectives of the article.** The objective of the research is to develop a cereal composition of functional properties with including of easily digestible collagen.

The major tasks are:

- rationale for choosing raw materials for the instant porridge production;
- development of the recipes with different content of collagen preparation;
- determination of basic physicochemical, rheological and organoleptic properties of developed food;
- establishment of biological usefulness of the products.

**Results.** The recipes of compositional mixtures for producing instant porridges with inclusion of the collagen preparation were developed. Three of them are demonstrated in table 1. Such raw materials as wheat, maize, rice, rye, oats and buckwheat were considered as recipe components. The mass fraction of essential amino acids limiting in selected raw materials (lysine, tryptophan and methionine) and the mass fraction of recipe components, including collagen product in the mixture, were reflected in the limitation of the "Search solutions" add-in. Mass fraction of collagen preparation was 5 %, 10 % and 15 % in developed recipes.

**Table 1 – Recipes of instant porridges with the collagen preparation obtained by computer designing**

Ingredients	Recipe № 1	Recipe № 2	Recipe № 3
	Mass fraction, %		
Extruded rice	46.0	44.0	41.0
Extruded wheat	24.0	23.5	22.0
Extruded corn	24.0	21.0	20.0
Collagen preparation	5.0	10.0	15.0
Licorice of root	1.0	1.5	2.0

The instant compositional mixtures were prepared according to the developed recipes. The technological process included operations of mixing extruded cereal mixtures, gluten and chopped licorice root with further stirring [6]. It was determined that the shelf life of the collagen preparation added to the recipes is 6 months (relative humidity is 60...70 %, temperature is 18... 20 °C). Amino acid composition of the developed collagen preparation is demonstrated in the Table 2.

**Table 2 – Amino acid composition of the collagen preparation [11]**

Amino acid	g/100 g	Amino acid	g/100 g
Lysine	2.60	Alanine	10.93
Histidine	0.42	Valine	2.02
Arginyn	4.45	Metionyn	0.61
Asparticacid	4.90	Isoleucine	1.36
Threonine	1.87	Leucine	2.66
Serine	3.87	Tirozyn	0.52
Glutamicacid	7.19	Phenylalanine	1.31
Proline	11.82	Hydroxyproline	9.21
Glycine	33.50	Hydroxylysine	0.76

To evaluate the quality characteristics of instant porridges with the collagen preparation several physicochemical and rheological parameters such as fluidity, swelling, and water-retaining capacity at different hydraulic were investigated. These characteristic values confirm the ability of the developed product to bind water, to be dissolved in it and the changing of its consumer properties. In addition, studies have revealed the recommended mass fraction of the collagen product in the mixture.

To establish rational hydromodulus (HM) for the water restoring of dry cereal mixtures with collagen

**Table 4- Daily requirement satisfaction of essential amino acids**

Aminoacid	Recipe № 1, %	Recipe № 2, %	Recipe № 3, %	Grainmixture, %	The daily requirement, g / day (FAO / WHO)
Valine	12.7	13.5	14.0	11.5	4
Isoleucine	9.0	9.4	9.7	8.0	5
Leucine	15.9	16.3	16.7	14.6	4
Lysine	8.0	9.3	10.5	6.4	3
Methionine	7.0	7.2	7.3	6.5	3
Threonine	10.5	11.6	12.6	9.0	3
Tryptophan	13.0	15.2	17.2	10.0	1
Phenylalanine	14.5	14.9	15.1	13.3	4

**Discussion.** Traditionally, grain-crops are the main raw materials for porridge production [7,8]. Whole grains contain to 17 % protein and 7 % fat, of which only 10 % are saturated. Relatively high fat content is typical for the grain of millet (up 4 %), oats (up 7 %) and corn (5 %) [9]. Due to the significant carbohydrate content (60 %) grains have a high energy value.

preparation their flowability was determined at different water dilution ( $T = 75\text{ }^{\circ}\text{C}$ ,  $\tau = 180\text{ s}$ ). It was found that optimal HM was 1:4. When HM was 1:3 the consistency of porridges with different content of collagen preparation was too thick and rheological parameters were not acceptable. With an increase of more than the recommended HM the flowability of mixtures significantly increased, which is characteristic for products with liquid consistency (table 3).

**Table3 – Physicochemical and rheological parameters of dry mixtures**

Index name	Units of measurement	Samples		
		Recipe № 1	Recipe № 2	Recipe № 3
Humidity	%	5.8	5.8	5.7
Active acidity	pH units	7.3	7.4	7.5
Swelling	%	292	286	279
Flowability of restored mixture (GM = 1:4)	Bostwick units	5.5	6.8	7.9

The establishing of the biological value of instant porridges showed that the degree of the daily requirement satisfaction of essential amino acids compared with recommended standards (FAO/WHO) for consumption of 100 g of porridge was on average 12 % (table 4), and when consumed the recommended servings of food (250 g) – 30 %, which corresponds to almost one-third of the daily requirement.

adjoining limiting amino acids or combination of components with its high content. The combination of grain-based mixture and collagen preparation allows to produce a product with the recommended ratio of amino acids.

Amino acid composition of obtained collagen preparation (table 2) is rich in glycine (33,5 g/100 g), proline (11,82 g/100 g) and hydroxyproline (9,21 g/100 g), indicating that the resulting substance is a product of collagen hydrolysis [10,11]. Low content of methionine and tryptophan in the hydrolyzate indicates a high degree of purification of ballast raw materials containing collagen protein fractions. It should be noted that the hydrolyzate contains 0,23 % of fat. Hydroxyproline and hydroxylysine are specific amino acids that are found only in collagen structures. The presence of these amino acids in the hydrolyzate shows a high biological role of the collagen preparation (gluten). It is known, that gluten is well digested in human body [5].

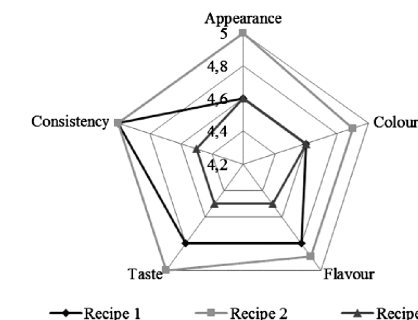
Because the collagen preparation was obtained using partially alkaline hydrolysis, it is a natural ion exchanger. The presence of free amino groups and carboxyl groups of collagen causes the ability of the drug to bind heavy metal ions to form insoluble complexes that are excreted from the human body. Based on the physiological effects, some researchers refer to the collagen fiber [12]. Products of the collagen hydrolysis (gluten, gelatin, etc.) actively stimulate secretory and motor functions of the stomach and intestine, they are beneficial to the state and function of the beneficial intestinal microflora. The ability of the starting materials and gluten to sorption of cholic acids and heavy metals was determined. The data showed that gluten absorbs cholic acid and the  $\text{Pb}^{2+}$  ions in an amount of 4,8 mg/g and 27,4 mg/g respectively. It was established that gluten has high ability of heavy metals and cholic acids sorption, so it can be used as enterosorbent to detoxify the human body.

Inclusion of the collagen preparation to the grain-based instant porridge adjusts amino acid composition and enhances biological value of the product. Additionally, the technological processing of grain raw materials by extruding accelerates the assimilation of nutrients and retains their nutritional value. Extrusion increases the digestibility of nutrients (due to starch gelatinization and denaturation of proteins) and reduces the term of heat cooking.

Studies showed a change of rheological properties of compositional mixtures with different content of collagen preparation for the same values of HM, temperature and duration of recovery. It was observed (table 3) that flowability of porridges increased in mixtures with a higher content of collagen preparation due to limited ability of collagen preparation to swell. Collagen binds water to 220 % due to hydration of functional groups of protein peptide

bonds as the result of formation of hydrogen bonds in the interaction of OH-, CO-, COOH- and NH-groups with water molecules. The determined humidity and pH of the developed instant porridges differ slightly and comply with the standards established for this type of food.

Organoleptic evaluation (pic. 1) of the developed instant porridges showed the following results: the color (cream yellowish color), taste and flavour (which correspond to the original grain raw materials) had satisfactory consumer properties.



**Fig. 1. Organoleptic evaluation of instant porridges with different content of collagen preparation**

It was noted that the inclusion of 15 % collagen preparation (recipe № 3) to the grain mixture results in less homogeneous consistency of the restored porridge. Thus, degustation evaluation of instant porridges with different content of collagen preparation showed that products on the basis of extruded crops with inclusion of 10 % of collagen preparation obtained by the developed method had the best performance.

## Conclusions

The technology of producing instant porridges with inclusion of collagen preparation is recommended. Developing of the grain compositional mixture with collagen preparation added in the recommended amount can balance the amino acid composition of foods. Applied extrusion technology for processing grain raw materials enhances the bioavailability of major food components and accelerates cooking time. The rational restoration conditions of dry mixtures are established, basic physical and chemical properties of the developed instant porridges are determined. The developed product contains polymers-detoxifiers, which have a positive effect on cleansing the body of xenobiotics such as heavy metals, free radicals, etc.

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## КОМПОЗИЦИИ КАШ ФУНКЦИОНАЛЬНОГО НАЗНАЧЕНИЯ: ТЕХНОЛОГИЧЕСКИЕ АСПЕКТЫ

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**Аннотация.** Разработаны композиции и технологии сухих композиционных смесей с включением глютена для инстантных каш функционального назначения с применением метода математического моделирования рецептурных композиций с заданной пищевой ценностью.

Глютин получали щелочным гидролизом вторичной рыбной сырья. Показано, что введение в рецептуры глютена, способствует повышению биологической ценности и придает блюдам функциональных свойств. Определена биологическая ценность разработанных инстантных каш методом ионно-обменной хроматографии и установлено, что степень удовлетворения суточной потребности в незаменимых аминокислотах при потреблении порции блюда составляет 30 %. Исследованы органолептические, реологические и физико-химические характеристики разработанных продуктов, подтверждающие целесообразность применения предложенной технологии.

**Ключевые слова:** инстантные каши, коллагеновый препарат, глютин, композиционные смеси, математическое моделирование, экструдирование.

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