FUNCTIONAL HIGH-PROTEIN CRISPBREADS

[1]N. DAUTKANOV, [2]D. DAUTKANOVA, [3]ZH. USSEMBAYEVA, [4]A. KAZHYMURAT, [5]DAUTKAN NURGISSA

[1,2,3]Kazakh Research Institute of Food Processing and Food Industry
[4]Almaty Technology University
[5]Kazakh-Russian Medicine University
E-mail: ndautkhanov@gmail.com

Abstract - The growing global population is driving the production of high-quality plant proteins with functional properties. Fermentation of plant proteins with proteolytic microorganisms increases the activity and bioavailability of peptides. This study presents a technology for producing gluten-free, functional crispbreads with a high protein content. The composite mixture included corn (30%), buckwheat (30%), soy protein isolate (SPI) (30%), and psyllium (10%). SPI was hydrolyzed with ENZECO® Bromelain Concentrate and ENZECO® FICIN 50K enzymes. The organoleptic and physicochemical properties of the finished products were determined. The developed crispbreads are characterized by crispness, developed porosity, and a distinctive flavor.

Keywords - Soy Protein Isolate, Protein Hydrolysis, Protein Intake, High-Protein Gluten-Free Breads.

1. INTODUCTION

To meet the growing global population's living conditions, greater attention must be paid to the production of high-quality protein foods [1]. Protein plays a dominant role in human nutrition. Plant-based protein production is less resource-intensive and more environmentally friendly [2].

Hye Ran Lee writes in her work that high-protein foods are evolving from simple protein supplements to complete diets with balanced nutrition and multiple functions, including antioxidant properties [3].

Fermentation of food proteins to produce biopeptides using proteolytic microorganisms offers promising opportunities, including increasing the bioactivity and bioavailability of fermented bioactive peptides. [4].
The field of alternative protein production continues to grow exponentially [5].

This aspect of nutrition is particularly relevant for Kazakhstan, as ingrained centuries-old traditions emphasize the consumption of large quantities of animal meat. However, with the changing dietary patterns of Kazakhstanis (including the influence of global players in the food industry), a trend toward a balanced diet rich in plant proteins is emerging. The most effective and functionally sound approach is the use of enzymatically hydrolyzed protein isolates.
According to the UN Food and Agriculture Organization (FAO), the average per capita protein consumption worldwide in 2022 (Fig. 1) was 52.95 and 37.73 grams of plant and animal protein per day. However, according to Reiko Urade, the physiological functions of soy protein isolate include the ability to reduce the risk of cardiovascular disease in humans by lowering serum cholesterol levels. [6]

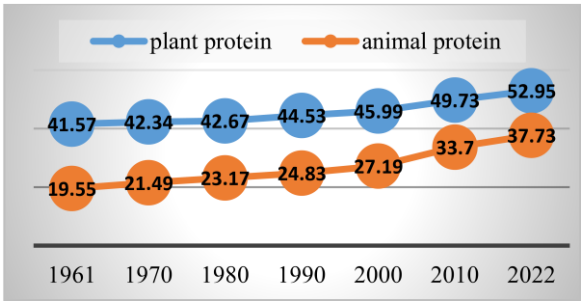


Figure 1. Comparative dynamics of protein consumption worldwide [7]

This figure shows the daily consumption of plant and animal proteins, with cultivated proteins predominating. For Kazakhstan (Figure 2), the situation is the opposite of the global average, as animal meat has traditionally been a part of the diet.

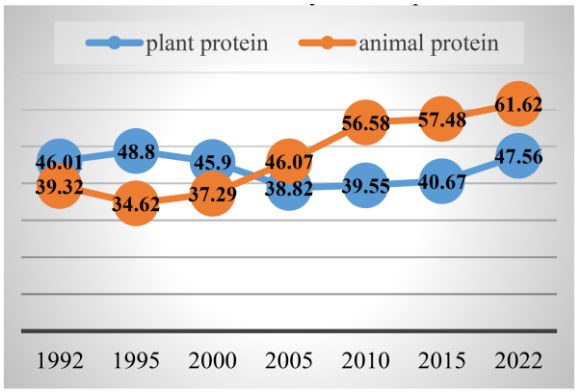


Figure 2. Dynamics of protein consumption in Kazakhstan [8]

II. DETAILS EXPERIMENTAL

2.1 Materials and Research Methods
The subjects of the study were: native soy protein isolate, enzyme preparations, wheat flour, salt, water, and high-protein bakery products. The resulting fermented SPI was used as an ingredient in a popular

snack – crispbread. Functional, wheat-gluten-free crispbreads were prepared as follows: dough was mixed using a straight-dough method from a composite mixture, vegetable oil, table salt, and baking soda, the dough was rested and divided, the dough pieces were pricked, and the products were baked. According to the utility model, the composite mixture was prepared by mixing 30% corn flour, 30% buckwheat flour, 30% SPI, and 10% psyllium. The dough was prepared using a straight-dough method. 45-50% of the composite mixture, 5% vegetable oil, and 1.0% psyllium were added to the dough mixer. Table salt, 0.5% baking soda based on the total weight of the dough ingredients, and water at 30-35°C, calculated to yield a final moisture content of 48%. Mix for 10-12 minutes and let rest for 60 minutes at 25-30°C. Roll out into a layer ≥2 mm thick, cut into 10x4 cm sheets, prick, and bake for 8-10 minutes at 200°C until golden brown.

Name of recipe component	Ratio of ingredients, %
Corn flour	30
Buckwheat flour	30
SPI	30
Psyllium husk	10

Table 1. Gluten-free bread recipe

Organoleptic and physicochemical properties were determined according to standards 21094, 5669, and 5670. The structural and mechanical properties of the gluten-free crispbread dough were analyzed using an AP-2 structurometer.

2.2 Experimental Part

Hydrolysis conditions (temperature, pH, enzyme concentration time) were experimentally selected, and model systems were used to measure the kinetics of enzymatic hydrolysis. The degree of hydrolysis, peptide composition, amino acid profile, and functional properties (solubility) were used as technology evaluation criteria. Soy protein isolate samples were analyzed for organoleptic properties according to ISO 21569-2009. Hydrolysis was performed using ENZECO® Bromelain Concentrate (sample #1) and ENZECO® FICIN 50K (sample #2) enzymes. Soy protein isolate was hydrolyzed by adding 0.1%-0.2% of the enzyme preparation to the dry protein mass at once, followed by a 10–30-minute incubation at 50-55°C.

III. RESULTS AND DISCUSSION

The results of this research include the development of gluten-free crispbread technologies (Figure 3). Renata Różyło and colleagues added lyophilized blackberry powder (5%) as a functional additive and natural colorant to gluten-free, sugar-free crispbreads. [9].



Figure 3. High-protein gluten-free crispbreads

Name of the indicato	Characteristic		
	According to the requirements of regulatory documentation	Sample1	Sample2
Appearance:			
Shape	Rectangular tiles; individual tiles with broken corners or cracks are permitted.	Rectangular tiles; individual tiles with broken corners or cracks are permitted.	Round,5-7cmindiameter
Surface	Top: rough with ridges and texture; slight flouriness, grooves, small blisters, and individual crumb inclusions and marks from the oven grid are permitted.	Top: rough with ridges and texture; slight flouriness, grooves, small blisters, and individual crumb inclusions and marks from the oven mesh Are permitted.	Crispy, uniform in color, free of foreign inclusions with small swellings
Color	From light gray to light brown with a darker color on the underside for rye breads; from light yellow to light brown with a darker color on the underside for breads made from wheat flour or a mixture of rye and Wheat flours.	Rectangulartilesmeasuring4x10 cm.	Light brown with a darker color on the underside
a g	Brittle, easily breakable	Brittle, easily breakable	Brittle, easily breakable
ur e Ap	Well-loosened, with developed porosity, baked and dried, without signs of under mixing	well-loosened, with developed porosity, baked and dried, without signs of under mixing	well-loosened, with developed porosity, baked and dried, without signs of under mixing
Taste	Characteristic of the product type, without foreign taste	Characteristic of this type of bread, without foreign flavors	Characteristic of this type of bread, without foreign flavors
Smell	Characteristic of the product type, without foreign odor	Characteristic of this type of bread, without foreign odors	Characteristic of this type of bread, without foreign odors

Table 2. Organoleptic properties of crispbreads

Jelena Tomić has shown in her research that a combination of chickpea flour and pumpkin seed cake can be successfully used in the production of gluten- free crackers without the use of traditional gluten-free ingredients rich in starch. [10].

IV. CONCLUSIONS

1. For SPI hydrolysis using ENZECO® Bromelain Concentrate and ENZECO® FICIN 50K enzymes, conditions were selected (temperature 50-55°C, enzyme concentration 0.1-0.2%, holding time 10-30 minutes).
2. A gluten-free crispbread recipe using 30% SPI was experimentally validated, allowing for an increased vegetable protein content in the finished product.
3. In terms of organoleptic properties, crispbreads made according to the developed recipe meet expected requirements, namely: regular shape, crisp structure, developed porosity, and the absence of foreign tastes and odors.
4. The developed technology can be recommended and replicated by small and medium-sized businesses for the production of functional products that promote balanced nutrition and reduce animal protein consumption, which is especially important for the population of Kazakhstan, with its meat-eating traditions.

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