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RESEARCH OF THE INFLUENCE OF SOYBEAN GERMINATION ON CHANGES IN THE AMINO ACID COMPOSITION AND THE CONTENT OF PHYTIC ACID

Забезпечення населення екологічно чистими білковими харчовими продуктами рослинного походження є важливим завданням державного значення будь-якої країни. Проте нативне використання бобів сої на сьогодні обмежене через наявність у них антипоживних речовин, а саме вмістом фітинової кислоти, яка здатна підвищувати утворення кишкового газу. Знизити вміст фітинової кислоти в бобових можливо під час процесу пророщення. Рослинний білок, який є основною складовою бобових культур, має здатність до акумуляції неорганічних мікроелементів, трансформуючи їх в органічні форми під час замочування у процесі пророщення. Об'єктом дослідження обрано ранньостиглий сорт сої «Алмаз» з вмістом білка 43,88 % врожаю 2018 року з колекційного розсадника «Агротек» (м. Київ, Україна). Характеристика розчинів для замочування була із концентрацією йодиду калію 38 г/1000 см^3 H_2O, що відповідає вмісту йоду в розчинах 41 мкг/г і задовольняє 1/3 % добової потреби в йоді. Зерно замочували на 48 годин. В ході дослідження використовували метод іонообмінної хроматографії, амінокислотний аналізатор ААА Т-339М (Чехія) та хроматограф ТМ Shimadzu LC-20 (Японія). Вміст фітинової кислоти визначали методом Лата. Встановлено, що загальний вміст амінокислот у нативному зерні у пророщеному в водних розчинах та пророщеному в розчині із вмістом йодиду калію (KI) збільшується від 288,8 до 443,6 та до 562,6 мкг/г сухих речовин, відповідно. Вивчено вміст фітинової кислоти та встановлено, що її вміст у нативному зерні становить 29,3 г/кг, пророщеному у водних розчинах – 8,6 г/кг, пророщеному у розчині KI – 3,2 г/кг. З проведеного експерименту можливо зробити висновок, що процес пророщення зерен сої у розчинах KI впливає на збільшення вмісту амінокислот майже на 50 %. Завдяки високій гідрофільності білка у 2 рази збільшується маса пророщених зерен. Припускаємо, що розчин із KI є синергістом інактивації фітинової кислоти. Проведений комплекс дослідження є науковою основою для використання зазначеної сировини в технології м'ясних виробів для осіб із хронічними колітами та йододефіцитними станами.

Ключові слова: *білкові харчові продукти, зерна сої, процес пророщення, акумульований йод, йод-дефіцитні стани.*

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1. Introduction

Providing the population with ecologically pure protein products of plant origin is an important task of national importance in any country [1]. However, the native use of soybeans today is limited due to the presence of antinutritional substances in them, namely the content of phytic acid. It stops the fermentation of the oligosaccharides of raffinose and stachiosis, which, getting into the intestine, are absorbed with the release of gases [2]. In a healthy adult, the stomach and intestines contain about 1 liter of gas, while consuming legumes, the volume of gas removed can reach three or more liters. The accumulation of gases is affected by the quantitative content of phytic acid [3]. Phytic acid is an antinutrient that binds nutrients in the digestive tract, reducing their absorption and removing them from the body as waste. It is possible to reduce the phytic acid content in legumes during germination [4], during which the phytate content decreases by 30–50 % [5]. Plant protein, which is the main component of legumes, has the ability to accumulate inorganic trace elements, transforming them into organic forms during soaking during germination [6, 7]. The aforementioned question is of particular relevance given the prevalence of iodine deficiency states [8]. A method of producing germinated soybean grain in an aqueous extract of kelp Laminaria japonica or Laminaria saccharina is well-known, which includes hydromechanical processing of grain and grinding [9]. The proposed method allows to obtain a product with iodine content, but the disadvantage of this method is the low iodine content. Also, scientists have not studied how the process of germination affects the change in the amino acid composition of grain. Therefore, *the aim of this work* is to study the effect of various conditions of soybean germination on the change in amino acid composition, and the content of phytic acid. This is relevant and timely, and will solve the problem of iodine deficiency diseases and chronic colitis. This study is of particular importance given the possible use of these raw materials in the technology of meat products.

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So, *the object of research* is selected «Diamond» early ripe soybean variety with a protein content of 43.88 %, 2018 harvest from the Agrotek collection nursery (Kyiv, Ukraine).

2. Methods of research

The characteristics of the soaking solutions are as follows: the concentration of potassium iodide in the soaking solution is 38 g/1000 cm^3 H_2O, which corresponds to the iodine content in the solutions of 41 µg/g and satisfies 1/3 % of the daily iodine requirement. The grain is soaked for 48 hours. Analysis of the amino acid composition of the studied samples is carried out by ion exchange chromatography on an AAA T-339m amino acid analyzer (Czech Republic) and a Shimadzu LC-20 chromatograph (Japan). Samples weighing 0.3 g are poured into 10 cm^3 of distilled water and 10 cm^3 of concentrated hydrochloric acid. Samples are placed in a dry oven with a temperature of 130 °C for 8 hours. After that, they are filtered through a filter and washed with distilled water. The resulting solution is transferred to a porcelain cup and evaporated on an electric stove to a volume of 0.5–1.0 ml pH (optimal 2.2±0.02 units) is measured. The resulting sample is passed through a 0.45 µm diameter membrane filter. They are introduced into the chromatographic ion-exchange column of the AAA T-339m analyzer. Further, the analysis is carried out automatically and lasted 115 minutes. After the analysis is completed, the obtained chromatograms are decrypted and the peak areas of each amino acid are calculated. Tryptophan during acid hydrolysis of the protein almost completely decomposes, therefore, its determination is carried out on a Shimadzu LC-20 TM liquid chromatograph. The sample is subjected to alkaline hydrolysis (NaOH) at 100 °C, 16–18 hours in the presence of 5 % tin chloride). The hydrolyzate after neutralization with a mixture of citric and hydrochloric acids (for the prevention of drag) is analyzed on an amino acid analyzer. The phytic acid content is determined by the Lott method, which is based on the discoloration of phytic acid with a solution of the complex anion of iron disulfosalicylate to brown [10].

3. Research results and discussion

The influence of various conditions of germination on the change in the amino acid composition of soybean is investigated. The research results are shown in Table 1.

From the experiment it is possible to conclude that the process of germination affects the change in amino acid composition in the direction of its increase. The total content of essential amino acids, such as valine, isoleucine, tyrosine+phenylalanine, lysine, methionine, threonine tryptophan, arginine, histidine increases from 148 (in native grain) to 238.7 (in sprouted in aqueous solutions) and to 289.7 (germinated in solution with a content of KI) µ/g of dry matter. The total amino acid content increases from 288.8 to 443.6 and to 562.6 µg/g dry matter, respectively. Obviously, the process of soybean germination in KI solutions affects the increase in amino acid content by almost 50 %. Due to the high hydrophilicity of the protein, the mass of germinated grains increases by 2 times, which is an important factor in the manufacture of sausages.

Table 1

Investigation of the influence of various conditions of soybean germination on the change in amino acid composition

No.	Amino acids	The content in grains of soybeans, mcg/g of dry matter		
Essential amino acids:		Native grain	Germinated in aqueous solution	Germinated in KI solution
1	valine	15.7	26.2	31.9
2	isoleucine	13.6	21.6	26.4
3	leucine	22.3	38.1	42.0
4	tyrosine+phenylalanine	24.7	45.9	47.1
5	lysine	26.3	37.3	52.8
6	methionine	3.4	5.0	6.8
7	threonine	9.1	14.7	18.4
8	tryptophan	4.3	6.6	8.2
9	arginine	21.1	29.5	41.0
10	histidine	7.9	13.8	15.1
Essential amino acids content		148.4	238.7	289.7
Nonessential amino acid:				
11	cystine	2.1	3.1	4.1
12	alanine	12.9	18.0	22.2
13	aspartic acid+asparagine	33.3	59.1	67.6
14	glycine	10.8	13.2	20.0
15	glutamic acid+glutamine	63.0	90.9	122.1
16	serine	18.1	20.6	36.9
Total amino acids content		288.6	443.6	562.6

The content of phytic acid in native soybean grain was studied, which amounted to 29.3 g/kg. In the sprouted in aqueous solution – 8.6 g/kg. In the sprouted in KI solution – 3.2 g/kg. Let's assume that the process of soybean germination affects the reduction of phytic acid due to the launch of enzymatic processes that occur during shoot germination, and KI solutions are synergists of this process.

4. Conclusions

Having studied the effect of various conditions of soybean germination on the change in amino acid composition, it is found that the total content of essential amino acids increases from 148 (in native grain) to 238.7 (in sprouted in aqueous solutions) and to 289.7 (sprouted in a solution with KI content) µg/g of dry matters. The total amino acid content increases from 288.8 to 443.6 and to 562.6 µg/g of dry matter, respectively. Having studied the influence of various conditions of germination on the phytic acid content, it is found that native soybean grain contains 29.3 g/kg, 8.6 g/kg germinated in aqueous solutions, and 3.2 g/kg germinated in a KI solution.

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