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STUDY OF THE EFFECT OF THE FERMENTATION PROCESS ON THE BIOCHEMICAL CHARACTERISTICS OF VIGNA RADIATA.

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This article provides a comparative assessment of the chemical composition, the content of vitamins, minerals and amino acid composition of ordinary and fermented mung bean seeds, Vigna radiata. The seeds of Vigna radiata of the domestic selection "Zhasyl Dan" are the object of research. In order to increase the biological values of Vigna radiata seeds and improve their biochemical composition, a fermentation process was carried out. The effect of the fermentation process on the biochemical and amino acid composition of Vigna radiata seeds was studied. The fermentation process of mung bean seeds occurs due to the activation of a number of biochemical compounds and enzymes contained in the seed itself. The main substances that participate in and influence fermentation are amylases, proteases, lipases, gibberellins and other phytohormones such as auxins and cytokinins, polyphenols and antioxidants. Fermentation of Vigna radiata seeds was carried out at room temperature 20^0 C for 72 hours. The seeds were placed in a plastic container, then covered with drinking water also at room temperature. The water level was monitored every 12 hours. The research was carried out in the accredited testing laboratory "Regional Testing Laboratory of Engineering profile "Structural and Biochemical Materials" on the basis of M. Auezov South Kazakhstan University, Shymkent. As a result of the study, it was found that fermentation of Vigna radiata seeds leads to an improvement in physico-chemical properties. This is due to the strengthening of the amino acid composition of the Vigna radiata seed, especially the effect of fermentation has a positive effect on essential amino acids. It was found that as a result of fermentation, the level of essential amino acids increased in the following order: valine – by 25.4%, leucine – by 32.8%, phenylalanine – by 27.7%, threonine – by 44.9%. There was also a decrease in the indicators of anti-nutritional substances - in particular, there was a decrease in the amount of oligosaccharides. Due to the activation of the enzyme systems of the seed itself, their nutritional and biological value increases.

Keywords: Vigna radiata, amino acids, fermentation, functional foods.

ИЗУЧЕНИЕ ВЛИЯНИЯ ПРОЦЕССА ФЕРМЕНТАЦИИ НА БИОХИМИЧЕСКИЕ ХАРАКТЕРИСТИКИ VIGNA RADIATA.

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В этой статье представлена сравнительная оценка химического состава, содержание витаминов, минеральных веществ и аминокислотного состава семян обычного и ферментированного бобов Vigna radiata. В качестве объекта исследования выступают семена бобов мунг отечественной селекции «Жасыл Дән». С целью повышения биологических показателей ценности семян Vigna radiata и улучшения их биохимического состава проводили процесс ферментации. Было изучено влияние процесса ферментации на биохимический и аминокислотный состав семян Vigna radiata. Основными веществами, которые участвуют и влияют на ферментацию, являются амилазы, протеазы, липазы, гиббереллины и другие

фитогормоны, такие как ауксины и цитокинины, полифенолы и антиоксиданты. Ферментация семян Vigna radiata проводилась при комнатной температуре 20^{0}С в течение 72 часов. Семена были помещены в пластиковую тару, далее их покрывали питьевой водой также комнатной температуры. Контроль уровня воды производился каждые 12 часов. Исследования были проведены в аккредитованной испытательной лаборатории «Региональная испытательная лаборатория инженерного профиля «Конструкционные и биохимические материалы» на базе Южно-Казахстанского Университета им М. Ауэзова, г. Шымкент. В результате исследования было выяснено, что ферментация семян Vigna radiata приводит к повышению их биологической ценности за счет улучшения сбалансированности общего состава аминокислот, а также росту важнейших пищевых компонентов для технологии пищевых продуктов и питания человека. Так, биологическая ценность семян Vigna radiata до ферментации составляла 60 %, а после ферментации – 51 %. Также было зафиксировано снижение количества антипитательных веществ – произошло уменьшение массовой доли олигосахаридов. За счет активации ферментных систем самого семени повышается их пищевая и биологическая ценность.

Ключевые слова: Vigna radiata, аминокислоты, ферментация, функциональные продукты питания.

ФЕРМЕНТАЦИЯ ПРОЦЕСІНІҢ VIGNA RADIATA ТҰҚЫМДАРЫН БИОХИМИЯЛЫҚ СИПАТТАМАЛАРЫНА ӘСЕРІН ЗЕРТТЕУ.

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Бұл мақалада кәдімгі және ферменттелген Vigna radiata тұқымдарының химиялық құрамы, дәрумендер, минералдар және аминқышқылдарының құрамы, салыстырмалы түрде бағаланады. Зерттеу объектісі ретінде отандық "Жасыл Дән" селекциясының Vigna radiata тұқымдары болып табылады. Vigna radiata тұқымының биологиялық құндылығын арттыру және олардың биохимиялық құрамын жақсарту мақсатында ферментация процесі жүргізілді. Ферментация процесінің Vigna radiata тұқымдарының биохимиялық және аминқышқылдық құрамына әсері зерттелді. Ашытуға қатысатын және әсер ететін негізгі заттар - амилазалар, протеазалар, липазалар, гиббереллиндер және ауксиндер мен цитокининдер, полифенолдар және антиоксиданттар сияқты басқа фитогормондар. Vigna radiata тұқымын ферментация процесі бөлме температурасында 20^0 С 72 сағат ішінде жүргізілді. Тұқымдар пластикалық контейнерлерге орналастырылды, содан кейін бөлме температурасында ауыз сумен жабылды. Су деңгейін бақылау әр 12 сағат сайын жүргізілді. Зерттеулер Шымкент қаласы, М. Әуезов атындағы Оңтүстік Қазақстан университетінің базасында "құрылымдық және биохимиялық материалдар "инженерлік бейіндегі Өңірлік сынақ зертханасында" аккредиттелген сынақ зертханасында жүргізілді. Зерттеу нәтижесінде Vigna radiata тұқымын ферментация процесі физика-химиялық қасиеттерінің жақсаруына әкелетіні анықталды. Бұл Vigna radiata тұқымының аминқышқылдарының құрамының жоғарылауына байланысты, әсіресе ашытудың әсері маңызды аминқышқылдарына оң әсер етеді. Ферментация процесін нәтижесінде маңызды аминқышқылдарының деңгейі келесі ретпен жоғарылағаны анықталды: валин – 25,4%, лейцин – 32,8 %, фенилаланин – 27,7 %, треонин-44,9 %. Сондай-ақ, қоректік заттарға қарсы заттардың төмендегені анықталды-атап айтқанда, олигосахаридтер санының төмендеуі байқалды. Тұқымның ферменттік жүйелерін белсендіру арқылы олардың тағамдық және биологиялық құндылығы артады.

Негізгі сөздер: Vigna radiata, аминқышқылдары, ферментация, функционалды тағамдар.

Indroduction

The global COVID-19 pandemic has revealed the following nutritional problem for society: the increased consumption of ultra-processed products. Ultra-processed products are those that are developed using artificial food additives – flavors, emulsifiers, thickeners and other artificial food ingredients. This has led to a phenomenon in nutrition that results in the so-called "hidden hunger" - a condition characterized by a deficiency of vitamins and minerals [1]. These circumstances have also been accompanied by a decrease in physical activity and a general change in the rhythm of life. As a result of these reasons, there has been an urgent need to change the society's diet towards its functionality and usefulness.

Given the state of the environment, increasing environmental risks, poor nutrition should be considered as a factor directly affecting the health of the body. This can include such elements as decreased immunity and the

occurrence of various diseases associated with human nutrition [2]. In accordance with the UN Sustainable Development Program, in which the Republic of Kazakhstan also actively participates, one of the goals is to eliminate hunger This is consistent with the state policy in the field of food production [3].

The main task of the government of Kazakhstan is to correctly formulate a healthy nutrition culture for the population of the republic. This task includes providing the body with the necessary food components - microelements, macroelements, vitamins, dietary fiber, probiotics and enzymes. The key direction in the field of development of the food industry is the development of modern technologies for the production of functional food products, since such products help to provide rational nutrients and prevent the risks of disease development [4].

In the production of functional foods, the origin of the raw material source, its composition and useful properties are of great importance. In southern Kazakhstan, mung beans (*Vigna radiata*) are widely used in the diet.

Vigna radiata (other names - mung beans, Asian golden beans is an annual plant; a species of the genus Vigna of the legume family (legumes). *Vigna radiata* is widespread among Asian countries such as India, Vietnam, Pakistan, China, Indonesia, Uzbekistan and Tajikistan. Since *Vigna radiata* has a high caloric value and relatively low production costs, it occupies a significant place in the diet of these countries. In Kazakhstan, *Vigna radiata* is consumed mainly in the southern regions of the country [5].

When creating functional food products, the safety indicators of raw material sources are subject to in-depth analysis. As a result, certain limitations arise in the use of chemical methods of fermentation of *Vigna radiata* seeds. The negative aspects of chemical methods of fermentation of mung bean seeds include the relative high cost of enzymes available on the market, since such methods will entail the need to eliminate excess chemicals that can negatively affect the body and human health. Also, some methods of chemical fermentation may require technological re-equipment of the entire process. This may cause additional costs and have a negative impact on economic feasibility as a whole [6].

The relevance of the topic is justified by the absence in Kazakhstan of a functional product based on fermented mung bean seeds, which have high biological value due to the vitamins, minerals and amino acids they contain.

Materials and research methods.

The object of the study is the seeds of *Vigna radiata* of the domestic selection "Zhasyl Dan". The studies were conducted from October 2023 to March 2024 in the department of testing laboratories "Testing regional laboratory of the engineering profile "Structural and biochemical materials" of the Auezov South Agricultural University. Microelements and macroelements of *Vigna radiata* seeds were determined as a result of X-ray fluorescence energy dispersive microanalysis. The biochemical composition of *Vigna radiata* was determined using a Varian Pro Star high-performance liquid chromatograph. The content of the main food components, vitamins, minerals, as well as the amino acid composition were established according to GOST methods and scientific research in this area. Biochemical parameters of *Vigna radiata* were determined according to GOST971731 [7].

Recent studies have shown that the safest and most cost-effective method of fermenting mung bean seeds is fermentation based on the use of the plant's own enzyme system, without the use of additional chemicals. The plant's enzyme system is activated by germinating the seeds in ordinary water.

As a result of the germination process, enzymes that were initially in an inactive state become activated upon receiving sufficient moisture. This moisture provides the necessary conditions for enzyme activation, which in turn stimulates the metabolism of nutrients within the mung bean seed. The enzymatic activation accelerates various biochemical processes, leading to significant reorganization of key enzymes, particularly those involved in amylolytic and proteolytic pathways. Simultaneously, this process triggers a shift in the composition of compounds within the seed: the concentration of insoluble compounds decreases, while the level of soluble compounds increases. This transformation enhances the overall nutritional profile of the mung bean by making its nutrients more readily available and digestible. [8].

For this study, the X-ray fluorescence analysis (XFA) method was used. This method is one of the modern methods of spectroscopic analysis and allows obtaining accurate data on the elemental composition of a substance. As a result of using XFA, the mineral composition of mung bean seeds was determined [9].

Results and discussion

As a result of the fermentation process of mung bean seeds, the level of proteolytic enzymes increased more than twofold. However, in the subsequent 60 hours of the fermentation process, the mung bean proteinase level gradually

decreased as a result of the increase in the acidity of the medium [10].

During mung bean seed germination, significant biochemical transformations occur, enhancing the biological activity and nutritional value of the sprouts. Mung bean seeds and sprouts are rich in bioactive compounds with various health-promoting properties, including antioxidant, antidiabetic, anti-inflammatory, antimicrobial, antiviral, antianemic, and antitumor effects. They also exhibit antihyperlipidemic, antihypertensive, and antimutagenic activities, making mung bean sprouts a valuable ingredient in functional and preventive diets. [11].

The germination process triggers notable changes in the composition and concentration of key organic compounds such as proteins, lipids, and carbohydrates. Proteolysis of seed proteins generates new biologically active peptides. For instance, the storage protein vicilin, which is known to cause allergic reactions in some individuals, loses over 70% of its immunoreactivity during germination, significantly reducing the risk of allergic responses.

Additionally, there is a marked reduction in anti-nutritional factors such as phytic acid, hemagglutinins, protease inhibitors, and tannins. For example, the reduction in phytate levels can range from 15-76%, which enhances the bioavailability of essential minerals like zinc, iron, and calcium. Furthermore, the levels of minerals such as sodium, potassium, phosphorus, magnesium, and manganese are observed to increase during sprouting [12].

Moreover, the content of oligosaccharides, including raffinose and stachyose, which are known to cause digestive discomfort such as flatulence, decreases significantly during germination. As a result, sprouted mung beans offer improved nutritional quality and are better suited for broader use in therapeutic and preventive nutrition.

Table 1. Amino acid composition of *Vigna radiata* seeds before and after fermentation (mg/100g product)

Amino acid	*Vigna radiata* seeds before germination	Germinated seeds of Vigna radiata
Replaceable:		
aspartic acid	2096	2720
alanine	384	423
arginine	1118	1326
histidine	620	841
glycine	1072	1327
glutamic acid	3555	3712
proline	772	854
serine	987	989
Essential:		
phenylalanine + tyrosine	1019	1301
valine	636	798
isoleucine	992	1348
leucine	2112	2806
tryptophan	133	218
threonine	1274	1847

As can be seen from Table 1, germination of *Vigna radiata* seeds leads to an increase in their

biological value by improving the balance of the overall amino acid composition with an increase in the share of the most important for food technology and human nutrition Thus, the biological value of mung bean seeds before fermentation was 60%, and after fermentation - 51%. [13].

The organic acids identified in mung bean sprouts play a crucial role in key metabolic energy processes and contribute to the biosynthesis of various metabolite groups, while also supporting the digestive system. Succinic acid, a byproduct of the Krebs cycle, serves as an endocrine stimulant, exhibits antioxidant properties, and plays a significant role in mitigating mitochondrial dysfunction, which is linked to the development of several diseases such as atherosclerosis, diabetes, and neurodegenerative disorders [14].

Lactic acid, another important component, is essential for brain metabolism, particularly in recovery from traumatic brain injuries. It also plays a role in reducing lipolysis in adipose tissue, enhancing calcium bioavailability, and demonstrating anti-inflammatory effects. These properties underscore the broad health benefits of organic acids in maintaining metabolic balance and supporting overall health.

Table 2. Biochemical composition of *Vigna radiata* before and after germination

Name	Contents, per 100 g of product	
	Vigna radiata seeds before germination	*Vigna radiata* seeds after germination
Protein	23.18	27.82
Fats	1.3	0.8
Carbohydrates	52.9	40.2
Water	13.56	35.12
Ash	3.65	3.61
Vitamins, mg		
B1	0.49	0.76
B2	0.28	0.51
WITH	-	0.05
RR	2.1	3.2
b-carotene	0.04	0.07
Minerals, mg		
Magnesium	43.1	43.0
Sodium	52.89	55.98
Potassium	645.54	646.12
Calcium	81,12	81.15
Phosphorus	118.35	118.42
Iron	11.07	11.28

Macro- and microelements (calcium, iron, zinc, etc.), vitamins and biologically active compounds (hydroxycinnamic acids, flavonoids) contained in mung beans also showed an increase. Anti-nutrients – phytic acid, verbascose, trypsin inhibitors, which prevent the bioavailability of macro- and micronutrients, are eliminated by fermentation.

The mass fraction of fats is reduced by 8% due to oxidation and their breakdown into glycerol and free fatty acids. The presence of vitamin C in sprouted *Vigna radiata* seeds was noted, while ascorbic acid was absent in unsprouted seeds. The composition of minerals did not reveal significant changes [15].

All the studied protein isolates from *Vigna radiata*, in terms of their technological properties, are not inferior to any other legume crop, except for soybeans, which are mainly genetically modified.

Results and discussion

The study of mung bean fermentation has a number of significant advantages that open up new possibilities for improving the nutritional value and functional properties of mung bean-based products:

Increased bioavailability of nutrients: the fermentation process reduces the content of anti-nutrients, such as phytic acid, which binds minerals (zinc, iron, calcium). This improves the absorption of microelements, which is important for preventing deficiency of these substances in the body.

Improved protein digestibility: Fermentation promotes protein hydrolysis, resulting in the formation of peptides with improved digestibility and potential biological activity. This is especially important for increasing the nutritional value of products and their use in diets that require high protein digestibility.

Reduced allergen content: Some mung bean proteins, such as vicilin, lose their immunoreactivity during the fermentation process, reducing the risk of allergic reactions in susceptible individuals. This makes mung bean-based products safer to consume.

Reduced Oligosaccharide Content: Oligosaccharides such as raffinose and stachyose, which cause flatulence, are destroyed during the fermentation process. This makes mung beans more easily digestible and reduces the likelihood of gastrointestinal problems.

Antioxidant and anti-inflammatory properties: Fermentation increases antioxidant activity, which helps protect the body's cells from oxidative stress. It also increases anti-inflammatory properties, which may be useful in preventing chronic diseases.

Expanding the possibilities of application in functional nutrition: Due to the improvement of nutritional and functional properties, fermented mung beans can be used in the composition of products for the prevention and treatment of various diseases (lowering cholesterol levels, normalizing blood pressure, improving gastrointestinal function) [16].

Thus, the study of mung bean fermentation allows us to obtain products with improved

properties, which opens up new possibilities for the use of mung bean in functional and therapeutic and prophylactic nutrition.

Vigna radiata is a very valuable vegetable crop. It has high nutritional properties. An example is the production of *Vigna radiata* in Uzbekistan. Over the past ten years, the area under *Vigna radiata* in this neighboring country has increased from several hundred hectares to 140 thousand hectares. Currently, Uzbekistan exports *Vigna radiata* to China, Saudi Arabia, the Netherlands and other countries at a price of up to 2 US dollars per 1 kg. This is a very favorable price. At the same time, farmers have the opportunity to cultivate Vigna radiata as a second crop after winter wheat, i.e. they get two harvests in one field season. Due to this, a colossal economic effect is achieved. Therefore, there is such a great interest in the *Vigna radiata* crop from producers

State policy in the field of nutrition promotes the formation of the value of ecology and food hygiene, the creation of educational programs on healthy nutrition for different categories and groups of the population, which will improve the quality of life of the population, increase life expectancy, and improve the demographic situation in the country. The introduction of special, functional food products into the diet for systematic use by certain groups of the population has a beneficial effect on reducing the risk of occurrence and development of diseases, including those associated with professional activity, maintains and improves health indicators [17].

Conclusion

Currently, research aimed at developing food products with increased nutritional value is relevant. The article presents the parameters of *Vigna radiata* seeds before and after fermentation, and the possibilities of its use in the production of functional foods. The study found that fermented *Vigna radiata* seeds have a balanced chemical and amino acid composition in terms of nutritional properties, which corresponds to modern FAO/WHO recommendations, with the exception of sulfur-containing acids. The functional properties of *Vigna radiata*, i.e. protein solubility, as well as thermal properties, are useful for the food industry. Studies of the functionality of *Vigna radiata* were conducted to develop technologies for new product recipes. The fermentation process made it possible to increase the beneficial properties in the amino acid composition of *Vigna radiata*, which makes it possible to use *Vigna radiata* to create functional foods for various population groups. Thus, *Vigna radiata* proteins and their amino acids are very promising as sources of raw materials for creating new food products. Active use of *Vigna radiata* in the production of functional food products in our country will allow:

1. Enrich the diet by creating new functional products.
2. Reduce the risk of occurrence and development of diseases associated with vitamin deficiency.
3. Make efficient use of local and available raw materials.
4. Follow the food security program and make a significant contribution.
5. To increase the export potential of Kazakhstan.
6. Improve the health indicators of the nation.

Currently, the only variety of domestic selection approved for use (zoned) in the Republic of Kazakhstan is "Zhasyl Dan" (the originator is the Kazakh Research Institute of Potato and Vegetable Growing). This variety is a variety of vegetable *Vigna radiata*, at the same time this variety also belongs to leguminous crops. The use of local raw materials is a priority task in the creation and production of food products.

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ИЗУЧЕНИЕ СОРТОВОГО ПОМОЛА ПРОРОЩЕННОЙ ПШЕНИЦЫ НА ЛАБОРАТОРНОЙ МЕЛЬНИЦЕ LAB MILL

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В статье представлены данные исследования выхода продуктов при сортовом помоле пророщенного и нативного зерна пшеницы. В ходе исследования получены новые данные об основных показателях качества муки из биологически активного зерна пшеницы. Будет доказана целесообразность применения пророщенного зерна пшеницы как альтернативного вида сырья при производстве муки. В качестве объекта исследований применяли озимую пшеницу урожая 2023 года белорусской селекции сорта «Рассвет». Муку, полученную путем помола пророщенной и исходной пшеницы, сравнивали по основным показателям качества. Общий выход муки из пророщенного и исходного зерна пшеницы при сортовом помоле составил 68,7 % и 66,6 % соответственно. Установлено, что выход муки из биологически активного зерна пшеницы на 2,1 % больше, чем из нативного зерна пшеницы. В результате помола получены три сорта муки (высший, первый и второй) из пророщенного и исходного зерна пшеницы. Выход отрубей с дранных систем меньше на 0,3 %, чем выход отрубей с размольных и шлифованных систем на 2,1 %. При оценке качества мука из пророщенного зерна по белизне и зольности превосходила муку из исходного зерна пшеницы.

Ключевые слова: мука, пшеница, биологически активное зерно, пророщенное зерно пшеницы, белизна, зольность, выход муки.