IJCRR
Section: Healthcare
Sci. Journal Impact
Factor: 6.1 (2018)
ICV: 90.90 (2018)

Copyright@IJCRR

Analysis of the Quality of New Varieties of Mung Bean

**Dilodar Mirkhodjaeva¹, Gulnoza Djakhangirova¹, Dilorom Gafurova¹,
Nodira Aykhodjaeva¹**

¹Tashkent Chemical-technological Institute, C. Tashkent, Uzbekistan.

ABSTRACT

Introduction: The problem of protein deficiency in the diet of the world's population has been and remains one of the most urgent. Large-scale research is being carried out everywhere to find new raw protein resources for use in the production of socially significant food products, in particular bread.

Aim and Objective: The purpose of the work was to study the quality of new varieties of mung bean, selected and grown in Uzbekistan, as a potential protein fortifier of bread products. The experimental part of the work was carried out in the laboratories of the Department of Food Technology of the Tashkent Chemical-Technological Institute and the Central Laboratory of the State Bread Inspection. The research methods were used traditionally for the laboratories of food production enterprises. The ways of increasing the protein value of flour products are analyzed. The most priority ones have been identified, taking into account various factors, namely, availability, processing facilities, cost. This primarily applies to the mung bean.

Result: A comparative analysis of the chemical composition of seeds of mung bean varieties "Durdona" and "Zilola" with wheat grain has been carried out. It was found that in the studied samples of mung bean the content of proteins was on average 1.8, sugars - 3.5, fibre - 1.7, ash - 2.0 times more than in wheat grain. In addition to the standard set of nutrients, the uniqueness of mung bean lies in the presence of natural antioxidants - flavonol glycosides (vitexin and isovitexin). The effectiveness of special technological methods of pretreatment of seeds, namely peeling or germination, to increase the mass fraction of protein in them has been substantiated.

Conclusion: It has been established that peeling and germination of mung bean will increase their protein value relative to samples not subjected to special treatment (control), respectively, by 9.2 and 23.4%. The authors consider it possible to use mung bean processing products in the production of bakery products from high-quality wheat flour to increase their biological value while maintaining satisfactory organoleptic and physicochemical characteristics.

Key Words: Mung bean, Wheat grain, Bean shelling, Bean sprouting, Nutritional value, Safety

INTRODUCTION

The problem of providing the population with nutritious and safe food is one of the priority tasks of all sectors of the food industry, which is especially urgent at present due to the widespread protracted crisis caused by the coronavirus pandemic, falling incomes of the population and, as a result, consumer demand for certain food products. In particular of animal origin, which are the main source of protein. The problem of protein deficiency in the diet of the world's population will only get worse over the years, including due to its exponential growth, urbanization, a decrease in the amount of land suitable for grazing, and an increase in material costs

for its maintenance. And if we take into account the ever-increasing shortage of fresh water, then the cost of livestock production will increase and become practically inaccessible for certain social strata of the population, not only underdeveloped but also countries with a high standard of living. Therefore, science and food manufacturers are faced with the urgent task of finding new raw materials for protein and non-traditional technologies for producing protein substances (isolates, concentrates, etc.).

It is necessary to prevent protein, as well as mineral and vitamin deficiencies among wide layers of the population by focusing on products of everyday and mass demand, such

Corresponding Author:

Dilodar Mirkhodjaeva, Tashkent Chemical-technological Institute, C. Tashkent, Uzbekistan..
Email: djaxangirova77@mail.ru

ISSN: 2231-2196 (Print)

ISSN: 0975-5241 (Online)

Received: 15.07.2020

Revised: 05.09.2020

Accepted: 20.09.2020

Published: 06.10.2020

as bread and bakery products. Recently, large-scale research has been carried out on the enrichment of bread products with functional substances to increase their nutritional and biological value, which are of great scientific and practical importance. At the same time, it is necessary to take into account the capabilities of individual regions, namely, the availability of accessible and relatively cheap raw materials sufficient for the mass production of bread products, technical equipment of processing enterprises, national traditions.^{1, 2}

In this regard, the study of the prospects for the use of new types of protein-containing raw materials in the baking industry of the food industry to increase the nutritional and biological value of socially significant food products that are in constant and massive demand among the population is relevant, technologically and economically justified.

MATERIALS AND METHODS

The purpose of the work was to study the quality of new varieties of mung bean, selected and grown in Uzbekistan, as a potential protein fortifier of bread products.

Research objectives:

- analysis of nutritional value and safety of beans of domestic varieties of mung bean;
- determination of the effectiveness of preliminary hulling and germination of beans to increase their nutritional value.

Research objects: mung bean seeds, husked mung bean seeds, sprouted mung bean seeds, wheat grain.

The experimental part of the work was carried out in the laboratories of the Department of Food Technology of the Tashkent Chemical-Technological Institute and the Central Laboratory of the State Bread Inspection of Tashkent (accreditation certificate UZ.AMT.07.MAI.063).

The sampling of mung bean was carried out following GOST 13586.3-83; the quality was checked for compliance with the requirements of GOST 7758-75 Food beans. Specifications and GOST ISO 5526-2015 Cereal, legumes and other food crops; typical composition - according to GOST 10940-60, organoleptic characteristics - according to GOST 10967-90, humidity - according to GOST 13586.5-93, the fractional composition of weed and grain impurities - according to GOST 30483-97, 1000 grain weight - according to GOST 10842-89.

The mass fraction of moisture was determined according to GOST 30483-97, protein - by the nephelometric method according to GOST 10846-91, starch - according to GOST 10845-98, sugars - according to GOST 8756.13, fat - according to GOST 31902-2012, fibre - according to GOST

R 52839-2007, ash - according to GOST 28418-89, mineral substances were determined by the ICP-MS method according to MUK 4.1.1483-03; vitamins - by high-performance liquid chromatography on an SF-46 spectrophotometer following R 4.1.1672-03.³ The energy value was determined by calculation according to the guidelines.⁴

Indicators of the level of toxicological safety of mung bean were determined following generally accepted research methods for compliance with the requirements of sanitary rules and regulations No. 0366-19. Microbiological studies of NMAaFAM (number of mesophilic aerobic and facultative anaerobic microorganisms) were carried out following GOST 10444.15-94, GOST 30518-97 GOST 10444.12-88, GOST 30519-97.

DISCUSSION

Protein starvation is the most dangerous for the body since protein-energy deficiency includes a whole complex of pathological conditions: alimentary dystrophy, nutritional deficiency and alimentary marasmus (in case of nutritional deficiency, protein deficiency prevails, and in case of alimentary marasmus - energy). In children with protein deficiency, growth and mental development slow down, the process of bone formation is disrupted. In most people, hematopoiesis, metabolism of fats and vitamins are disturbed (hypovitaminosis occurs), resistance to infectious diseases and other diseases decreases, the risk of complications after an illness.

It has been established that the daily requirement for protein at the expense of bread, contained in 450 g conditional for daily consumption by an adult, is covered by 38.0%, and in individual amino acids - from 23.0 to 58.0%. The limiting amino acid of bread made from wheat flour is the most deficient amino acid in the global nutritional balance of mankind (23.1%). The need for such essential amino acids as cystine - by 24.8% and methionine - by 18.5% is insufficiently provided. Due to bread, 1/4 of the need for vitamin B₃ is covered, and for vitamin B₂ - only 18.7%. It has been established that flour with an ash content of less than 0.6% (premium grade) contains only 29.0% of the valuable nutritional components of whole wheat grain. Of the 28 vital elements of wheat 9 disappear altogether: anticarcinogenic selenium, hematopoietic vanadium and titanium; the mass fraction of calcium decreases to 19.0 from 60.0, iron - 1.86 from 5.38, manganese - 0.86 from 3.86 mg, etc. The constant use of bread made from fine flour leads to dysfunction of the gastrointestinal tract, urolithiasis, diabetes, anaemia, and obesity. The most valuable flour is considered to be made from the endosperm, aleurone layer and shells, which makes up about 97.0% of the grain weight. However, bread made from such flour contains phytic acid, which hinders the resorption of calcium, iron and other minerals, which

contributes to the development of rickets, anaemia, and thyroid dysfunction.^{5, 6}

The problem of increasing the biological value of bread is solved mainly in three main directions:⁶⁻⁹

- use as fortifiers of traditional types of protein-containing raw materials of vegetable (grain and legumes) and animal origin (milk and dairy products, fish and whale meal, etc.), as well as concentrated protein products from them;
- the use of non-traditional types of protein-containing raw materials - oilseed meal (sunflower, cotton, linseed, hemp, grape, apricot, almond seeds, tomatoes, safflower, lupine, etc.); concentrates and isolates of proteins of seeds of soybeans, sunflower, cotton, peanuts, sesame, beans, rapeseed, etc.;
- the use of new types of protein-containing raw materials - algae, the mycelium of higher fungi, yeast proteins obtained by microbiological and chemical synthesis.

Wheat and soy proteins are preferred.⁸⁻¹¹ So an effective complex enrichment of bakery products can be a wheat germ. The embryo contains 33- 39% of the protein in terms of dry matter. In terms of the content of amino acids lysine, methionine and tryptophan, which are deficient for bread, the protein of the embryo is similar to the protein of eggs. However, this product has a limited shelf life of no more than 2 months due to the possible rancidity of fat and additional technological measures are required for its use in the production of bread.

A protein concentrate with a protein content of 34.5% was obtained at an NGO for starch products from by-products of the production of starch of wheat flour.⁸

Technologies have been developed for the production of protein products and composites of the "protein-protein" composition with a complementary amino acid composition from the peripheral parts of wheat, rye, barley (grains, bran, husks) enriched with lysine, threonine and isoleucine.¹⁰

Barley flour is rich in complete proteins, containing a lot of lysine and tryptophan, while it has low baking properties, has a specific taste, gives a dark colour to the crumb, and shortens the freshness of bread. It is recommended to use in the form of infusions fermented with thermophilic lactic acid bacteria, adding them when kneading dough, which is not always acceptable in the production of mass bread from high-quality wheat flour.⁸

Also noteworthy are pseudo-cereal crops, in particular amaranth. Amaranth seeds, depending on the species, contain 14-20% of a unique protein with a balanced amino acid composition, 55- 62% of starch, 5-8% of vegetable oil with a high concentration of polyunsaturated fatty acids and biologically active components, including squalene (up to 10.0%). Ac-

cording to the results of medical research, squalene is recognized as the most important component that plays the role of a regulator of lipid and steroid metabolism in the human body and has antioxidant properties.^{12, 13}

In solving the problem of protein deficiency in bread, products of plant origin are becoming increasingly important, as they are cheaper and less laborious in their production. Among them, legumes have the highest protein value, which includes soybeans, peas, beans, lentils, lupine, chickpeas, mung bean, which contain large amounts of lysine and tryptophan. In terms of chemical composition and nutritional value, these crops are closest to the sources of animal protein - milk, meat, fish.^{8, 11, 14 -17}

Pulses are an important component of the grain complex, as they solve the problem of protein deficiency in the diet of the population. The amount of protein in the seeds of most legumes usually ranges from 25.0 to 30.0%. Soybeans stand out sharply in this regard since its seeds are not only rich in protein but also in fat. So, if in peas, beans, lentils and chickpeas the protein level ranges from 20-24%, and fat 1.5-4.5%, then in soybeans their content is 35-40 % and 17-20%. It is rational to add soy skim flour to wheat bread up to 3.0%, rye - up to 5.0% to the flour mass in the dough. A higher flour dosage degrades the quality of the bread. Soy is the only crop whose seeds are industrially processed to produce a wide range of protein products. High-protein soy flour (contains from 70.0 to 90.0% protein) is used in the production of pasta and bread products, gingerbread and other various food products.^{9, 11, 17, 37-40}

In the bakery, pea flour is also used, containing 25-30% of protein substances, differing in full amino acid composition. The lysine content in it is 8.5 times higher than in wheat flour. When the dosage of pea flour is 20-25% to the weight of wheat flour, the ratio of proteins and carbohydrates in bread is close to optimal. Technologies for obtaining pea protein concentrates and isolates, recommended as additives to increase the protein value of bread products, have been developed.^{8, 9}

A special place among legumes is occupied by beans, which can be cultivated almost everywhere. Bean flour contains an average of 25.5% protein and is relatively high in lysine. The flour dosage should not exceed 10.0% by weight of wheat flour in the dough. When making pastry, you can replace up to 35.0% of whole wheat flour with flour from beans fried at 270 ° C. As a result, the organoleptic indicators of the quality of the finished product are improved, the mass fraction of protein in it is 25.0% higher than in products made from wheat flour (6.2 instead of 5.0%). Technology for obtaining protein concentrate from beans containing up to 80.0% protein is proposed. The concentrate yield is 65.0% by weight of protein and 23.0% by weight of feedstock, the addition of which up to

10.0% to the weight of flour improves the quality of bread to a greater extent than bean flour.^{8, 14}

Recently, the attention of researchers^{15,18,19} have been attracted by lentils, the protein content of which is in the range of 26.9-32.2%, which is slightly higher than that of other legumes, except for soybeans. The seeds of this crop in terms of protein content exceed peas and beans by 2.6 and 6.1%, respectively, and in terms of their digestibility by the human body, they are higher than other legumes. A complete protein and rich mineral composition create all the prerequisites for its use in the technology of protein structured products with therapeutic and prophylactic properties. One of the ways to increase the biological value of lentil seeds is its germination, which ensures the maximum possible increase in the value of this indicator.

Pashenko L.P. et al.²⁰ proposed to use malt extracts from lentil beans in the production of bread. With an extract dosage of 25.0% to the mass of grade I wheat flour, the technological process of bread production is intensified, the fermentation time is reduced by 60 minutes, the gas-forming and gas-holding capacity of the dough increases, its fermentation activity improves, finished products have a more developed porosity, a greater specific volume, slows down the process of staling and their biological value increases significantly.

In terms of protein content and quantity, lupins are close to soybeans. The value of lupine has been known for a long time; earlier this crop was widely used in agriculture. Unlike soybeans, it is not demanding on heat and moisture. The grain of lupine, depending on the species and variety, contains from 32.0 to 40.0% of complete protein, up to 15.0% of fat. It is characterized by a high content of carotenoids - 24 times more than in soybeans. Lupine protein, like soy protein, is well digested by humans and has a high biological value. In terms of biological value (BV), lupine (BV = 60.0%) is superior to lentils (BV = 48.0%), chickpeas (BV = 51.0%) and peas (BV = 43.0%), second only to soybeans (BV = 80.0%). A specific feature of the protein complex of lupine, like other legumes, is the presence in it of proteins - inhibitors of proteolytic enzymes: proteases, invertases, etc. However, all types of lupine have the least amount of proteinase inhibitors in comparison with soybeans, peas and other legumes. Soybean seeds contain on average 29-32.0 g of inactivated trypsin per 1.0 kg, and in lupine seeds - 2.0-2.5 g, which characterizes them as a more valuable raw material for food production. In terms of the content of B vitamins, they are comparable to the seeds of other legumes (peas, soybeans) and significantly surpass wheat, rye and other grain crops. Lupine seeds differ especially in the amount of β -carotene (0.30-0.49 mg%) and tocopherols (3.9-16.2 mg%) versus 0.014-0.018 mg% and 1.1-5.5 mg% in cereals.¹⁷

One of the representatives of leguminous crops is mung bean. Sukhovarova M.A. et al.²¹ developed a technology for

producing a paste from mung bean beans for use in the production of bread from premium wheat flour. It was found that when the moisture content of the paste is 72.3%, the mass fraction of protein in it is 5.7%. The maximum paste dosage is 70.0% to the flour mass, which allows obtaining finished products of the required quality. At the same time, the rationality coefficient, numerically characterizing the balance of essential amino acids about the physiologically necessary norm, in the samples with paste exceeded the control value and amounted to 0.73.

To increase the consumer benefits of bread products with the use of processed products of leguminous crops, it is proposed to use ozonized water (with an ozone concentration of 2.0 mg/l). At the same time, the quality of wheat flour gluten of I and II grades with reduced baking properties was 64 and 70 units of the device, respectively, with the control values, respectively, 70 and 76 units of the device. It has been proven that the combined use of flour from leguminous crops and ozonized water provides nutritional value and microbiological safety of bread.^{2,22}

In solving the problem of protein deficiency in flour products, an important role is assigned to milk processing products (skimmed milk in natural and dry form, buttermilk, cottage cheese, curd and cheese whey in natural, dry and condensed forms).^{7,8} Dairy protein is balanced in lysine, tryptophan and methionine, which are deficient in bread. Technologies have been developed for obtaining milk protein concentrates from skim milk, whey or their mixtures (rennet casein, caseinates, coprecipitates, proteins obtained using membrane methods for separating skim milk) by separating water, lactose, minerals and simultaneously concentrating proteins up to 75.0% on dry matter. Main advantages: high protein content, low lipid content, relatively long shelf life.

The use of whey, soybean and condensed milk product "Lactonic" for the production of bakery products allows improving the quality of the final product due to its enrichment with easily digestible plant and animal proteins, water-soluble vitamins and micronutrients.²⁴

For enrichment of bakery products with protein, a protein composition is used, consisting of 2.0% wheat germ, 1.0 - slaughter blood hydrolyzate and 3.0% skim milk powder. This protein mixture is a source of lysine, isoleucine, calcium, phosphorus, iron.⁶

The group of high-grade raw materials serving as a food fortifier with protein and essential amino acids includes fish meal, fish protein concentrate. Currently, technology has been developed for obtaining fish meal containing 78.0...88.0% protein, no more than 10.0% moisture and 0.5% fat on dry matter. The high cost of fishmeal makes it possible to use it to make only special types of bread. It has also been established that this flour fully justifies itself as

a fortifier of corn starch, peanut meal, chickpea, rice, and therefore it is widely recommended to increase the protein value in the diets of children, including infants.⁶ Adding up to 2.0% fishmeal to bread increases the protein content in it by 15-16%, calcium - 2.7 times.⁹

A valuable protein raw material can be the blood of farm animals, which contains up to 19.0% of complete proteins. Technology has been developed for clarifying the blood of animals with a peroxide catalysis system and obtaining on its basis a dry protein mixture with a protein content of up to 59.3% for use in baking in an amount of up to 2.0% to the mass of wheat flour of the 1st grade.⁸

The use of non-traditional types of protein-containing raw materials is promising. Thus, methods have been proposed for obtaining finely dispersed protein from grape seed meal, a protein product from a mixture of sunflower and soybean meal, protein concentrates from mustard seeds.⁷

The Institute of Chemistry of Plant Substances of the Republic of Uzbekistan obtained high-protein flour from the cotton meal, containing up to 79.0 protein, 0.04 free gossypol (according to FAO / WHO, no more than 0.04% is allowed), 2.5 fibre and 4.1% phosphorus.⁷

Of particular interest is the protein-preserving effect of vegetables, that is, an increase in the degree of assimilation of proteins of other products by the body, their more rational use. This phenomenon is explained by an increase in the enzymatic activity of the secretions of the digestive glands under the influence of vegetables, although the vegetables themselves have a low protein value. The exception is potatoes. About the proteins of chicken eggs, the biological value of potatoes is 85.0%, and to the ideal protein - 70.0%. The limiting amino acids in potatoes are methionine, cysteine and leucine. Products made from boiled potatoes, grains, juice, flakes or protein concentrate are used abroad in bakery production.^{25,26,27}

The possibility of increasing the biological value of plant proteins by adding free lysine, as well as the use of dry gluten wheat flour as a prescription ingredient in the amount of 2-4% to the flour mass has been established.⁶

Algae, fungi, yeast, and other rapidly multiplying lower organisms can become a promising source of dietary protein. All over the world, there is a growing interest in protein substances obtained from the products of microbiological synthesis. The possibility of industrial production of protein substances from non-traditional types of raw materials has been proven: baker's yeast, ethanol, methanol, natural gas, paraffin, etc. In terms of economic efficiency, these protein sources are the most profitable, but their use is associated with several technological and medico-biological difficulties. no less development of this direction is quite promising.

^{6, 8, 9}

L.I. Voino and O.I. Konovoy analyzed the possibility of using protein preparations of the "Letiporin" type, obtained by cultivating the higher edible basidiomycete *Leitiporus-sulphureus*, in the production of wheat bread from premium flour. This improves the porosity of the crumb, increases the protein content and slows down the process of staling of bread.²⁸

Work is underway to isolate protein from the green mass of herbs and to obtain protein concentrates for food purposes from them. Thus, an experimental technological line for the production of cytoplasmic paste with a protein content of up to 60.0% from the green mass was created in Russia, from which a dry protein concentrate is obtained. In terms of biological value, this protein is significantly superior to the protein of cereals and in the amino acid composition is close to proteins of animal origin.⁸

Analysis of the data from scientific and technical sources showed that various protein-containing additives are widely used to eliminate the deficiency of dietary protein in bread products. However, the possibilities of Uzbekistan, like several other CIS countries, are limited due to the lack of its production of protein concentrates and protein isolates on an industrial scale.

The most promising in terms of production and availability of protein-containing raw materials for the production of bread and bakery products, especially for the countries of Central Asia, are leguminous crops and products of their processing. The advantages of leguminous crops relative to cereals (wheat) are also in the fact that they produce more high-quality, digestible and cheap protein per unit area, including the biological cycle of air nitrogen, which is inaccessible to other plant species. Thus, depending on the type of crop and environmental conditions, the capacity for biological nitrogen binding in leguminous crops ranges from 50 to 200 kg per hectare per year.²⁹

The inclusion of these crops in crop rotations makes it possible to increase plant biodiversity and diversify the farming system. Research in this direction is technologically and economically justified, has scientific, practical and social significance.

RESULT

Mung bean or mung beans, or Lui-dau, Asian or golden beans (Latin- *Vigna radiate*) - an annual herb; a species of the genus *Vigna* of the legume family (legumes).³⁰

We used the varieties of mung bean Durdona (NM - 94) 2011 and Zilola (VC 1178) 2008, created by the Uzbek Research Institute of Plant Production within the framework of the IARAGResearch Program (IPC) "Arid Systems". These varieties of mung bean are early maturing, drought and disease

resistant, high-yielding, with large seeds (more than those of the zoned varieties).³¹

Investigated indicators of quality, chemical composition and food safety of mung bean seeds of the above varieties.

The research results are presented in tables 1-4.

It was found that according to the typical composition, the seeds of the studied varieties of mung bean belong to type II

subtype I and according to organoleptic indicators, contamination, moisture and weight of 1000 grains meet the requirements of GOST 7758-75 and GOST ISO 5526-2015.

In the process of studying the chemical composition and energy value of the seeds of the studied varieties of mung bean and comparing these indicators with the grain of cereals (in our case, wheat)³², certain differences were revealed in the content of basic nutrients (Table 1).

Table 1: Chemical composition and energy value of the seeds of the studied varieties of mung bean and wheat grain

Nutrients	Massfractionofnutrients					
	Softspringwheat		Durdona		Zilola	
	<i>g/100g of product</i>	<i>g/100g DM *</i>	<i>g/100g of-product</i>	<i>g/100g DM</i>	<i>g/100g of product</i>	<i>g/100g DM</i>
Water	14,00	-	8,91	-	8,83	-
Protein	12,50	14,53	23,30	25,58	26,20	28,74
Carbohydrates:						
Starch	53,00	61,63	43,80	48,08	43,40	47,60
mono- anddisaccharides	0,90	1,05	3,35	3,68	3,40	3,73
Cellulose	2,50	2,91	4,52	4,96	4,48	4,91
Fats	2,30	2,67	2,44	2,68	2,21	2,42
Ash	1,70	1,98	3,53	3,87	3,37	3,70
Minerals, including:						
calcium Ca	0,057	0,066	0,005	0,005	0,005	0,005
magnesium Mg	0,104	0,121	0,020	0,022	0,015	0,016
sodium Na	0,008	0,009	0,015	0,016	0,020	0,022
potassium	0,350	0,407	1,500	1,647	1,500	1,645
phosphorus	0,400	0,465	0,020	0,022	0,020	0,022
Ferrum Fe	0,006	0,007	0,006	0,006	0,004	0,004
Vitamins, including:						
ascorbicacid C	-	-	5,28	5,80	4,78	5,24
pyridoxine B ₆	0,00	0,00	0,42	0,46	0,45	0,49
tocopherols E	0,28	0,33	0,61	0,67	0,52	0,57
Othersubstances	12,82	14,90	3,84	4,22	2,36	2,60
Energyvalue, kcal	296	344	322	353	330	362

Note: *DM - dry matter

From the data in Table 1, it follows that the samples of seeds of the studied varieties of mung bean seeds do not have significant differences in chemical composition and energy value. Also, mung beans are characterized by an increased protein content relative to wheat (based on the dry matter) by an average of 1.8, sugars - 3.5, fibre - 1.7, ash - 2.0 times. Mass fraction of fat in all studied samples is practically the same. The energy value of mung bean exceeds the control values of the reference sample by 2.6...5.2%. There are also no fundamental differences in mineral composition. The

presence of vitamin C in mung bean is not important, since it is destroyed when baking bread. Vitamins B₆ and E are more heat resistant.

In addition to the standard set of nutrients, the uniqueness of mung bean seeds lies in the presence of specific pharmacologically active flavonol glycosides - vitexin and isovitexin, which are natural antioxidants that can regulate intracellular lipogenesis and adipogenesis through anti-inflammatory mechanisms, as well as ensure normal myocardial oxygena-

tion. The protease inhibitor mungoin in mung bean seeds has potent antifungal and antitumor properties.³³

It should be noted that mung beans seeds also contain anti-nutritional substances, namely, proteins that inhibit proteolytic enzymes (trypsin and chymotrypsin), which are inactivated during heat treatment during the baking process, so they can be ignored.

Food raw materials, as well as food, must comply with medical and biological requirements and sanitary quality standards and must not contain carcinogenic nutrients and pathogenic microorganisms above the maximum permissible concentrations.

Therefore, studies are needed to determine the indicators of the environmental and epidemiological safety of the additives investigated raw materials (Table 2).

Table 2: Indicators of the level of toxicological safety of the studied mung bean seeds

Index	Indicator value, in mg/kg		
	OnND*, nomore	Durdona	Zilola
<i>Toxic elements:</i>			
Lead	0,10	0,04	0,06
Arsenic	0,30	0,18	0,16
Cadmium	0,10	0,04	0,05
Mercury	0,02	N/F	0,00
<i>Pesticides:</i>			
Hexachlorocyclohexane (α -, β - and γ - isomers)	0,50	0,38	0,32
DDT and its metabolites	0,05	0,007	0,006
Organomercurypesticides	Not allowed		
2,4 D acid, its salts, esters	Not allowed		
<i>Harmful impurities and pests:</i>			
The creeping bitterling, knotweed, sophora, etc.	Not allowed	N/F	N/F
Pest infestation	Not allowed	N/F	N/F
Aflatoxin B ₁	0,005	0,000	0,000

Note: * ND - normative document; ** N/F - not found

It was found that the content of heavy toxic metals and pesticides did not exceed the normative indicators, harmful impurities in the samples of mung bean were not found. The obtained data testify to the compliance of the quality of the studied raw materials with the regulatory requirements of toxicological safety of sanitary rules and regulations No. 0366-19 (paragraph 4.2. Seeds of legumes).

The microbiological contamination of the studied raw material was determined by incubating the substrates on nutrient agar media in conditions optimal for the growth of colonies of microorganisms, then the species and quantitative composition of the microflora was determined employing phase-contrast microscopy (Table 3).

Analysis of the research results confirms the compliance of the studied varieties of mung bean grown in Uzbekistan with the requirements of GOST 7758-75, GOST ISO 5526-2015 and of sanitary rules and regulations No. 0366-19.

Table 3: Indicators of microbiological contamination of the studied beans mung bean seeds

Index	Value of indicators		
	OnND, nomore	Durdona	Zilola
NMAaFAM, CFU/g, no more	1×10 ⁴	3,2×10 ³	2,8×10 ³
ECB(coliforms), in 1 g	Not allowed	N/F	N/F
Salmonellain 25 g	Not allowed	N/F	N/F
Yeast, CFU/g, no more	1×10 ²	0,3×10 ²	0,3×10 ²
Mold, CFU/g, no more	1×10 ²	0,6×10 ²	0,5×10 ²
Listeria monocytogenes 25 g	Not allowed	N/F	N/F

However, the use of processed products of legumes, in particular, flour from them, in the production of bread and bakery products from wheat flour is very limited (no more than 10.0% of the prescription amount of flour). It has been established that the use of these additives above the recommended limits leads to a decrease in the consumer value of finished products: darkening of the crumb, the appearance of a taste and smell of legumes not characteristic of bread, a decrease in volume and deterioration of the porosity structure due to the absence of gluten proteins in this raw material. Besides, an increase in the dosage of these additives, in our case, dispersed mung bean seeds (hereinafter mung flour), positioned as food improvers and, which is especially important, the biological value of flour products can lead to an increase in the cost of finished products, which, along with a deterioration in quality indicators, can reduce consumer demand for it. Consequently, it is advisable to search for technological methods that allow increasing the nutritional and biological value of finished products with the raw materials under study without increasing its dosage. Moreover, these solutions should be acceptable for small producers of bakery products, namely, so that for their implementation there is no need to purchase special equipment and master complex technologies, as in the case of obtaining protein concentrates and isolates.

In this aspect, special treatment of seeds, preliminary before dispersing, deserves attention: option 1 - peeling (cleaning from shell particles), option 2 - germination.

The peeling process of seeds consists of the following steps:

In the process of peeling off the seeds, the outer epidermis is almost completely separated and the parenchymal and inner sclerenchyma (parchment) layers are partially captured. The product yield after peeling was on average 91.6% of their initial weight.

The process of sprouting mung bean consists of the following steps:

Next, the chemical composition of husked and sprouted mung bean seeds was investigated. As a comparison sample (control) using natural mung bean, that is, not subjected to special processing. The averaged experimental data (from two varieties of mung bean) are presented in Table 4.

Table 4: Influence of special treatment on the chemical composition and energy value of the seeds of the studied varieties of mung bean

Nutrients	Mass fraction of nutrients, g/100g DM				
	control	after peeling		after germination	
		quantity	increase in% to control, ± Δ	quantity	increase in% to control, ± Δ
Protein	27,16±1,58	29,65±1,50	+9,2	33,52±1,50	+ 23,4
Starch	47,84±0,24	53,23±0,25	+ 11,3	38,67±0,20	- 19,2
Mono- and disaccharides	3,70±0,02	4,04±0,01	+ 9,2	9,11±0,01	+146,2
Cellulose	4,93±0,02	1,34±0,01	- 72,8	3,81±0,02	- 22,7
Fats	2,55±0,13	2,78±0,12	+ 9,0	1,93±0,10	- 24,3
Ash	3,78±0,08	1,65±0,10	-56,3	3,85±0,10	+ 1,8
Minerals, including:					
calcium Ca	0,005±0,00	0,002±0,00	- 60,0	0,017±0,001	+ 240,0
magnesium Mg	0,019±0,003	0,010±0,003	- 47,4	0,055±0,003	+ 189,5
sodium Na	0,019±0,003	0,009±0,003	- 52,6	0,054±0,002	+184,2
potassium K	1,646±0,001	0,536±0,001	- 67,4	3,750±0,001	+ 127,8

Table 4: (Continued)

Nutrients	Mass fraction of nutrients, g/100g DM				
	control	after peeling		after germination	
		quantity	increase in% to control, $\pm \Delta$	quantity	increase in% to control, $\pm \Delta$
phosphorus P	0,022 $\pm$ 0,00	0,008 $\pm$ 0,00	- 63,6	0,080 $\pm$ 0,00	+ 263,6
Ferrum Fe	0,005 $\pm$ 0,001	0,002 $\pm$ 0,001	- 60,0	0,018 $\pm$ 0,001	+ 260,0
Vitamins, including:					
pyridoxine B ₆	0,47 $\pm$ 0,02	0,51 $\pm$ 0,02	+ 8,5	1,34 $\pm$ 0,03	+440,0
tocopherols E	0,62 $\pm$ 0,05	0,67 $\pm$ 0,05	+ 8,1	1,58 $\pm$ 0,03	+154,8
Othersubstances	8,95 $\pm$ 0,81	6,13 $\pm$ 0,87	- 31,5	8,12 $\pm$ 0,80	- 9,3
Energyvalue, kcal	357	378	+ 5,9	358	+ 0,3

The results of the studies (Table 4) indicate the effectiveness of using special technological methods to increase the nutritional and biological value of mung bean processing products to use them in baking. It was found that peeling and germination of mung bean seeds allowed to increase their protein value relative to mung bean samples not subjected to special processing (control), respectively, by 9.2 and 23.4%.

It is evidence³⁴⁻³⁶ that during the transition of grain (seeds) during germination into a state of biological activity, high molecular weight biopolymers dissociate to low molecular weight soluble substances, which sharply increases the degree of their assimilation by microorganisms. Water is absorbed at the same time; polyribosomes are formed, which are responsible for protein synthesis; phytohormones are activated, accelerating the synthesis of vitamins; proteolytic activity increases. Mineral substances are partially chelated, that is, they are in a natural state - they are associated with amino acids, therefore they are well absorbed by the human body. Besides, phytates are partially destroyed in seedlings, which prevent the full assimilation of these substances by the body.

Thus, the task was accomplished, since the priority was precisely the task of obtaining products of increased protein value. At the same time, a high increase in minerals and vitamins in sprouted seeds and a natural decrease in the mass fraction of fibre and minerals in husked mung bean seeds were noted.

It is advisable to use the separated casings for the enrichment of other types of bakery products with food fibres, which will ensure a waste-free production process.

CONCLUSION

Thus, the complex of theoretical and experimental studies carried out confirms the feasibility of using leguminous crops

to increase the nutritional and biological value of bread and bakery products. It has been established that the availability, quantity and content of proteins, food safety and relatively low-cost price deserves special attention to mung bean, the potential of which has not yet been sufficiently studied, especially in the production of wheat varieties of bread products. Moreover, mung bean is traditionally used in oriental cuisine.

It should be noted that the consequences of global climate change, the success of breeding and agricultural technology made it possible to significantly expand the area of cultivation of legumes and increase their productivity. The ever-increasing importance of legumes in the diet of a modern person contributes to an increase in the interest of farmers, processors and entrepreneurs in them. And if we also take into account that the digestibility of animal protein is not higher than that of legumes, then, naturally, interest in them will only grow.

The advantage of using processed products of leguminous crops in bread production is also that they are a natural source of especially valuable nutrients, the use of which does not require significant changes in the technological process of producing new products creates preconditions for diversification of processing and bakery industries. The use of this raw material and products of its processing as an alternative to animal proteins in the production of flour products is of significant social importance and economically feasible.

REFERENCES

1. Auerman, LY, Puchkova LI, Technology of bakery production: Textbook - 9th edition, revised. and additional, Under the total. ed.. - SPb.: Professiya, 2006;416.
2. Matveeva, T.V. Functional flour confectionery products. Scientific bases, technologies, recipes: monograph / T.V. Matveeva, S.Ya. Koryachkin. - Oryol: FGOU VPO "State University - UNPK", 2011. 358.

3. R 4.1.1672-03. Guidelines for quality control and safety of biologically active food supplements. - M.: Federal Center for State Sanitary and Epidemiological Supervision of the Ministry of Health of Russia. 2004, Access mode: <https://files.stroyin.ru/Data2/1/4293855/4293855460.htm> (date of access: 25.07.20).
4. Sokol N.V. Calculation of food, energy and biological value of confectionery products, 2009; 32.
5. Melnikova M.M. Unbalanced nutrition as a factor in the development of alimentary-dependent diseases, Bulletin of NGPU, 2014, no. 1, p. 197-202.
6. Litvitsky P.F. Disorders of the metabolism of proteins, amino acids and nucleic acids, Questions of modern pediatrics, 2015, No. 14 (1), pp.95-107.
7. Syganova T.B. Application of protein-containing additives in the production of bakery products, Overview Series: Bakery and Pasta Industry. M.: SNITEI, 1990. 32.
8. Drobot VI, The use of unconventional raw materials in the bakery industry, 1988. 152.
9. Pashuk ZN, Apet TK, Bakery production technology: reference book., I.I. Apet. – SPb.: GIOR, 2009; 400.
10. Kolpakova V.V., Herbal protein preparations: composites, composition, properties, purpose, 2010; 6: 39-41.
11. Gevorkyan G.R. Comparative assessment of the chemical composition of protein preparations from various sources: Storage and processing of agricultural raw materials. 2006; 1:32-35.
12. Abramov I.A., Abramov I.A., Yeliseyeva N.Y., Kolpakova V.V., Piskun T.I., Storage and processing of agricultural raw materials. 2011;6: 44-48.
13. Belonjokina T.G., Belonjokina T.G., Aktualnyye V.A. Amarant. Actual problems of innovation with non-traditional natural resources and the creation of functional products. 2003; 33-35.
14. Manjesov VI, Churikova SY, Kurchayeva YY. Prospects for the use of beans for protein concentrates. Storage and processing of agricultural raw materials. 2011;8: 64-65.
15. Manjesov VI, Kurchayeva YY, Storozhik V.V. Possibilities of using non-traditional plant raw materials for food purposes. Storage and processing of agricultural raw materials. 2008;5: 58-61.
16. Kravsova I.S., Rudneva I.V., Antipova L.V., Bogatryova J.I. Method of obtaining protein concentrate from lupine seeds. Modern problems of science and education. 2009; 3:79-80.
17. Pashyenko L.P., Chernyx I.P., Pashyenko V.L., Lupine seeds - a promising protein fortifier of food, Modern high technologies, 2006, №6, c. 54-55. Access mode: www.rae.ru/snt/?section=content&op=show_article&article_id=1917 (date of the application: 28.06.2019).
18. Pashyenko V.L. Lentil beans - a promising protein food fortifier. The successes of modern natural science, 2006; 12 :96-97. www.rae.ru/use/?section=content&op=show_article&article_id=4638 (date of the application: 28.06.2020).
19. Antipova L. V. Increasing the biological value of lentil seeds by germination. Proceedings of universities. Food technology, 2000, № 2 – 3, c. 18 – 19.
20. Pashyenko L.P., Bioactivated grain products in bread technology. Bakery of Russia, 2006; 7: 41-46.
21. Suxovarova M.A., Chijikova O.G., Korshenko L.O., Prospects for the use of mung bean seeds in baking, Far Eastern Agrarian Bulletin, 2017, №1, c.34-38.
22. Iskakova G.K., The influence of flour from leguminous crops on the baking properties of wheat flour I and II grade, Bulletin of Agricultural Science of Kazakhstan, 2006, №5, c.51-52.
23. Iskakova G.K., The effect of ozonized water on the physical properties of dough from a mixture of wheat flour I grade and chickpea/G.K. Iskakova, Search, 2008, №1, c.19-22.
24. Shirokov A.V., Development of a technology for bakery products enriched with a multicomponent additive based on secondary raw materials. Cand. tech. sciences 05.18.01. – M., 2015, 136 s.
25. Dobavka V.S. Adding potato flour when making bread from wheat flour. 1980, 5: 25-26.
26. Drobot V. Die Vernundung von Karteffelmehl bei der Herstellung von weisbrot, Nutr. 1988, 12, № 6, s. 380-383.
27. Einsatz von Sulfidbehandeltem Subkartoffelmehl bei der Herstellung von Weizenbrot, Getreide, Mehl und Brot. 1988, 42, № 7, s. 215-217.
28. Voyno L.I., Konnova O.I., Protein supplements of mushroom origin for bread enrichment. Confectionery and bakery production. 2011; 7:18-20.
29. Zotikov V.I., Naumkina, T.S., Gryadunova I.V., Pulses are an important factor in sustainable agriculture. 2016;17: 6-12.
30. Mung beans – Wikipedia, Access mode: <https://ru.m.wikipedia.org/wiki/Mash> (date of the application: 23.07.20).
31. The use of legumes, Access mode: <https://www.cac-program.org/news/detail/455> (date of the application: 23.07.20).
32. Skurixin, I.M., Tutelyan V.A. Tables of the chemical composition and caloric content of Russian food products: Reference book. – M.: DeLi print, 2007, 276 s.
33. Baymuradov R.R., Karomatov I.D., Shodiyeva M.S., Electronic scientific journal “Biology and Integrative Medicine”, Access mode: <https://cyberleninka.ru/article/n/mash-pishevoe-i-lekarstvennoe-rastenie/viewer> (date of the application: 25.07.20).
34. Myachikova N.I., Sprouted seeds as a source of food and biologically active substances for the human body. Modern Prob Sci Edu. 2012; 5. Access mode: [URL:http://www.science-education.ru/ru/n/article/view?id=7007](http://www.science-education.ru/ru/n/article/view?id=7007) (date of the application: 25.07.20).
35. Dietary Guidelines for Americans, 2010. 7th Edition. Washington. DC: US Government Printing Office, 2010. Access mode: <http://www.health.gov/dietaryguidelines/dga2010/dietaryguidelines2010.pdf> (date of the application: 26.07.20).
36. Raven P.H., Germination P.H., Raven, R.F. Evert S.E. Biology of Plants, 7th Edition, W.H. Freeman and Company Publishers. – New York, 2005;70.
37. Rakhmonov K.S., Atamuratova T.I., Djuraeva N.R., Isabaev I.B., Haydar-Zade L.N., Influence of leavens of spontaneous fermentation and phytoadditives on the provision of microbiological safety of bread. J Critical Rev. 2020; 7(5):850-860.
38. Jabborova S.K., Kurbanov K.S., Khaydar-Zade T.I., Application of products of processing mulberries and roots of sugar beet in the production of cupcakes, J Critical Reviews. 2020; 5(5): 277-286.
39. Rakhmonov K.S., Atamuratova T.I., Mukhamedova T.I., Application of phito supplements from medicinal vegetable raw materials in the production of drugs .J. Critical Rev.2020; 7(12): 934-941.
40. Barakayev N.R., Rajabov A.N., Improvement of the design of mobile equipment for post-harvest processing of crops. J Critical Rev. 2020; 7(14): 306-309.