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USE OF CORN GRAIN IN PRODUCTION OF FOOD PRODUCTS

Abstract

In Ukraine, the following basic crops are used as raw materials for the production of cereals, flour, flakes: wheat, barley, buckwheat, oats, corn, rice, millet, peas. The volume of world grain production in recent years has grown significantly.

In Ukraine, corn is the main fodder crop, and only in small quantities is used as food. Corn takes the leading place among the main grain crops in the world agricultural production. The production of corn for grain is concentrated in warm regions. In some regions, corn is the basis of the traditional food of the population, but mostly it is part of the feed in the feeding of farm animals. Corn does not accumulate nitrates and is an environmentally friendly product. Corn is a plant of versatile use.

Currently, corn is one of the most important food crop cultivated by man. As to the largest producers of this cereal are the United States, China, Mexico, India, Brazil, Argentina, Indonesia, South Africa, France and Italy.

Today, about 3500 food and technological products are made from corn. Corn is able to largely meet the needs of animal husbandry, its share is almost 30% in the composition of concentrated feed. Corn is used in food, starch, brewing and alcohol industries. With the advent of new directions in the development of biotechnology in the world, the importance of this culture is growing even more.

In the countries of the European Union in recent years, the production of various types of fuels from plant materials - biodiesel, bioethanol, biomethanol and biofuel is actively developing. Bioethanol is obtained from all cultures with a high content of starch and sugar, for example, potatoes, sugar beet, corn, various types of cereals, and therefore a significant expansion of the acreage under corn is projected.

In the article volumes of corn grain collection in different years in Ukraine for the production of cereals and groats are considered. Various types of maize as a perspective raw material for use in the food industry are considered. It is shown that two subspecies of maize are most widespread in Ukraine - a dentate (large grain of elongated form) and siliceous (a rounded grain). The presence of vitamins B (B1, B2, PP), calcium, magnesium, phosphorus and iron, as well as trace elements (copper, nickel, etc.) in maize makes it possible to recommend corn products as a separate product or in combination with other people with blood diseases, allergies, diabetes mellitus, obesity and other forms of metabolic disorders and pathology of the gastrointestinal tract.

The authors analyzed the chemical composition of corn grain of various botanical groups intended for the production of cereals and products from them. The composition of micro- and macronutrients of corn groats used in the production of food products (snacks, breakfast cereals, instant cereals, cereals, etc.) is given.

Key words: corn, production, processing, chemical composition, corn grits.

The technologies of obtaining products from grains are the most common and varied, since grain is the main and indispensable source of food products. Cereal products contain a complete set of nutrients necessary for normal functioning of human body. They are the most valuable source of carbohydrates, proteins, macro- and

micronutrients, vitamins, enzymes, food fibers, phospholipids and other biologically active substances. At the same time, production of cereal products is the cheapest in comparison with production of other food products.

Due to the use of grain products in food, up to 40% of need for vitamins in B group is covered and up to

Fig. 1 - Gross harvest of corn in Ukraine, mln. tons

50% of energy needs of people. In some countries, about 70% of consumed protein comes from protein crops. In Ukraine, the share of grain accounts for about 40-45% of the total diet [12].

The main crops such as wheat, barley, buckwheat, oats, corn, rice, millet, peas and other are used as the main raw material for production of grit, flour, cereals, and dry breakfasts in our country.

At the present stage of agriculture development of Ukraine, one of the main tasks is to increase the volumes of grain production, in particular corn grain, 20% of which is used as food, 15-20% - for technical needs, the rest - as feed grain [13, 21-24].

Corn (*Zeamays L.*) botanically belongs to the grass family (Poaceae) or (Graminea), subfamily Andropogonodeae, tribe Maydeae (Zeeae), genus *Zea*. Inside the species were previously distinguished subspecies, for example: flint corn, flour, dent, pop, sweet, pod and waxy corn. However, today such a systematic distribution is considered unreasonable neither genetically nor morphologically [11].

Corn has a leading place among the main grain crops in world agricultural production. According to FAO, its grain and the plant itself serve as raw materials for production of almost 3,500 types of products that are used not only in agriculture but also in industries (medical, processing, food, etc.). In Ukraine, the food industry is associated with processing of mainly pop and sweet corns, although its dent and flint subspecies are no less valuable, especially for production of various types of cereals.

In world production, more than a quarter of the grain yield of corn is directed to food purposes. Average annual corn consumption per capita in many countries reaches more than 30 kg, while in Ukraine it is only 3-7 kg.

One of the factors hindering the expansion of the range of corn products in Ukraine is the lack of hybrids recommended for processing industries and valuable raw materials for their creation [12].

The volume of world grain production has grown significantly in recent years. Corn grain production is concentrated in warm regions. In some regions, corn is the basis of traditional population diet, but it mainly forms part of feed for farm animals. Modern maize hybrids of both foreign and domestic origin have a yield of 10-15 t/ha for use on grain. Corn can largely

satisfy needs of livestock; many use its grains in poultry: its share in composition of concentrated feed is almost 30% [23-24].

With the emergence of new directions in biotechnology development in the world, the significance of this culture will increase even more. The program of biofuel production is gaining momentum, due to what significant expansion of area for this crop is forecasted.

In Ukraine, corn is the main feed crop, and only in small quantities it is used as a food. According to the State Statistics Service of Ukraine, in 2016, domestic farmers collected 23.21 million tons of corn (an average of 5.2 tons per hectare) [24]. According to analysts of the IA "APK-Inform", in 2016/17 MY, the gross harvest of maize amounted to 25.8 million tons. Growth of corn crops took place in most main grain producing countries. At the same time, consumption of this grain has increased [23]. According to the USDA, world corn consumption has reached its historic high. This once again confirms the general household and economic importance of this culture (Fig. 1).

Thus, Ukraine's share in world corn trade grows. In some regions, corn is the basis of traditional population diet, but it mainly forms part of feed for farm animals. Modern maize hybrids of both foreign and domestic origin have a yield of 10-15 t/ha for use on grain [16].

The current situation in Ukrainian consumer market has led to deformation of daily rations, diminishing their value and reducing consumption of basic nutrients. According to UkrNII of nutrition, their deficit is: for proteins of animal origin - 36,1%, food fibers - 28,1%, vitamins - 29,4...55%, minerals - 22...52% [15]. The result of such an imbalance in nutrition is an increase in incidence of a variety of diseases: cardiovascular, gastric, oncological, and others. Therefore, the most important task in improvement of nutritional structure of the population is the increase of mass consumption products production with high nutritional and biological value.

Corn grain contains salts of mineral substances important for human body: salts of potassium, calcium, magnesium, iron and phosphorus. Its protein contains essential amino acids such as lysine and tryptophan. High content of carbohydrates, facility of storage make corn especially suitable for industrial use. The chemical composition of different botanical corn subspecies is approximately the same. The main substance of grain, starch, makes an average of 60-68% of the mass of grains and is concentrated in the endosperm. The germ of corn grain, which occupies almost a third, contains 35% of fat. Corn does not accumulate nitrates and is an environmentally friendly product. Corn is a plant of diverse use. In the world, more than 550 different major and by-products are produced from corn [1-2].

Corn is used in food (flour, cereals, corn flakes and sticks, canned food, starch, syrup, alcohol, beer, substances that are nutritious for the environment of microorganism cultures, some medicines, extracts, pastes, corn oil rich in vitamin E, etc.), starch, brewing, alcoholic industry, as well as for xylitol - dietary sugar [12-15]. From corn stalks, cane rods, their wraps they produce paper, linoleum, viscose, insulating materials, cinefilm, and others. Sufficiently diverse assortment of canned foods from corn of various subspecies, among which: corn porridge with minced meat, with meat, pumpkin, carrot, apple, apricot and plum puree, cabbage stuffed with corn porridge and meat with tomato sauce and others [17].

Corn flour is used as an additive to wheat flour in the manufacture of confectionery products, breweries, and others. It differs significantly from barley because it contains more extractive substances. Composition of proteins in corn flour meets requirements of beer production technology better than in barley flour (barley). In corn, for example, there is almost no water-soluble albumin, that is contained in barley and may cause turbidity of beer. Therefore, corn can replace up to 50% of barley in the brewing industry.

In order to increase the functional properties of grain products, they are enriched with additives: from plant raw materials, vegetables and fruits, while as a separate technological problem is considered the process of milling the enrichment to a size of its particles which ensures homogeneity of the product [14,18]. Nowadays, production of refined corn bran is set, addition of which to foods leads to a significant reduction of cholesterol and triglycerides in body. This does not increase the energy value of products. They can be added to pasta, dry breakfasts, rolls, pancakes (20-40% to a mass of wheat flour) [12].

Stalk and other vegetative parts of plants are also used: from them building and packaging materials, paper, soil improvers, explosives are acquired. Corncobs give furfural - raw material for production of plastics, nylon and other synthetic substances. Wrappers (leaves) of wicker are widely used as a stuffing. From the soft core of stems they produce paper for cigarettes [3-5]. Table 1 shows content of the most important substances in corn grain of the most common types. [19].

As can be seen from Table 1, most starch is found in dent and flint corn (79-80%); protein in pop corn (16.7%); and fat – in sweet corn (9.4%). By ash content (i.e. content of mineral salts), all these types have little difference. Corn grain also contains B vitamins (including B1 and B2), PP vitamins (nicotinic acid) and vitamin E (tocopherol). Yellow varieties of corn are also rich in vitamin A (in the form of carotene - provitamin A). The content of carotene in yellow corn varies from 60 to 240 gamma * per gram of substance [20]. (* Gamma is a weight unit equal to 0.001 milligrams, that is, one millionth of a gram. Presence of vitamins B1, B2, PP, calcium, magnesium, phosphorus and iron in corn, as well as trace elements - copper and nickel, allows to recommend corn products, as a separate product or in combination with other, to people who have blood diseases, allergies, sugar diabetes, obesity and other forms of met-

Table 1 - The content of the most important substances in the corn grain of the most common botanical types

Botanical Group of Corn	Content in% in terms of dry matter			
	starch	protein	fatty	mineral salts
Sugar corn	74,43	14,5	9,40	1,67
Siliceous corn	78,96	14,40	5,10	1,54
Zooby corn	80,10	13,30	5,00	1,60
Bursting corn	76,53	16,70	5,45	1,32
Starch corn	77,63	14,10	6,86	1,42

abolic disorders and pathology of the gastrointestinal tract (Table 2) [2,12,18].)

Unfortunately, in mature grain there is no vitamin C, and vitamin PP is contained in small quantities. As for mineral salts, corn is rich in phosphorus (an average of 0.43%), which is more than wheat, rye, rice and other cereals [8,19]. Thus, the nutritional value of corn is primarily in carbohydrates, but not less important role is played by other components of grains contained in them even in small quantities.

In Ukraine, the two main subspecies of corn are the most common - dent (large grains of prolonged form) and flint (grains are rounded).

Unlike other subspecies, mature sweet corn contains the smallest amount of starch (25-37%), but many water-soluble polysaccharides (19-31%). It contains more proteins than flour subspecies of corn (41.2-16.1% on dry matter) and this indicator is second to only pop corn. Its grain, when dried over the entire surface, strongly wrinkles and becomes translucent, horny, which is its characteristic feature.

According to the definition of A.T. Marha and S.I. Yurchenko, sweet corn in the stage of milk-wax ripeness contains more complete proteins (albumins, globulins, glutenins) in comparison with dent and flint

Table 2 - The content of microelements, vitamins in corn groats.

Microelements (mg/100 g)	
β-carotene	0,200
Thiamine (vitamin B1)	0,13
Riboflavin (vitamin B2)	0,07
Pyroxine (vitamin B6)	0,25
Niacin (vitamin PP)	1,1
Biotin, μg	6,6
Pantothenic acid (vitamin B5)	0,35
Vitamin E	2,7
Folacin, μg (vitamin B9)	19,0
Potassium (K)	147
Calcium (Ca)	20
Magnesium (Mg)	36
Sodium (Na)	4
Phosphorus (P)	109
Iron (Fe)	2,7
Cobalt (Co)	4,5

Fig. 2 - Chemical composition of corn grits (macronutrients, g / 100 gr)

corn: 45,9-65,7% in relation to all proteins, and less inferior protein (zein), which characterizes its increased nutritional value. In addition, it also has high levels of valuable in the nutritious sense, extractable non-protein nitrogen, that is easily digestible, and the less difficult to digest, which stays in insoluble combinations. Sweet corn grains also contain a significant amount of minerals (calcium, magnesium, potassium, sodium, phosphorus, chlorine, sulfur, iron, etc.). In this respect corn is not inferior to other cereal crops.

In the fatty fraction of sweet corn, a number of researchers have established presence of microagents that have a positive effect on cholesterol metabolism in human body [19].

One of important food products derived from corn grains is a variety of cereals of different assortment and destination. Corn cereal is a source of vegetable protein, carbohydrates and energy, while at the same time being low in fat.

Corn cereal also contains a large amount of starch (more only in rice), sugars, fiber and vitamin E. Corn cereals are irreplaceable for medical purposes and baby food. The absence of gliadin protein fraction in corn cereal, in contrast to grain varieties, allows it to be used

to prepare specialized foods for sick people suffering from enzymatic imbalances.

Corn grain is well absorbed by the human body, its regular consumption improves health and promotes immunity. It is one of the few products whose use does not cause allergic reactions, so it is widely used in child and diet nutrition for diseases of the central nervous system,

diseases of the pancreas, cystitis, metabolic disorders, body aging. Corn contains essential amino acids: valine, isoleucine, leucine, lysine, methionine + cystine, threonine, tryptophan. The product does not contain gluten, therefore corn cereals are included in the diet of people with allergies to wheat gluten [6-7].

Corn cereal is rich in macronutrients: proteins, fats, carbohydrates (Fig. 2).

Corn cereal is widely used in production of quick-cooked cereals, dry snacks, flakes, etc. [1,6,7]. According to UkrAgroConsult, in production of cereals in 2016 there was an increase: corn increased by 2.5% (to 63.5 thousand tons); also increased production of oat, rice and millet. At the same time, buckwheat, barley and pearl production declined.

Most of the corn grown in our country today goes to export. Experts note that Ukraine has great potential for production and trade of cereals on the foreign market [21-24].

Thus, taking into account all the data presented above, it can be said that today in Ukraine there is a need to increase capacity of corn processing, as well as improve existing technologies.

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ВИКОРИСТАННЯ ЗЕРНА КУКУРУДЗИ У ВИРОБНИЦТВІ ХАРЧОВИХ ПРОДУКТІВ

Анотація

В Україні як сировину для виробництва крупи, муки, пластівців використовують такі основні культури: пшеницю, ячмінь, гречку, овес, кукурудзу, рис, просо, горох. Об'єм світового виробництва зерна за останні роки значно виріс. В Україні кукурудза є основною кормовою культурою, і лише в невеликій кількості використовується як продовольча. Кукурудза займає провідне місце серед основних зернових культур в світовому сільськогосподарському виробництві. Виробництво кукурудзи на зерно сконцентровано в теплих регіонах. У деяких регіонах кукурудза є основою традиційного харчування населення, але в основному вона становить частину кормів у годівлі сільськогосподарських тварин.

Сьогодні з кукурудзи виготовляють близько 3500 харчових і технологічних продуктів. Кукурудза здатна значною мірою задовольняти потреби тваринництва, його частка становить майже 30% у складі концентрованих кормів. З появою нових напрямків у розвитку біотехнологій у світі значення цієї культури зростає ще більше. Набирають обороти програми по виготовленню біопалива, у зв'язку із чим прогнозується значне розширення посівних площ під кукурудзою.

У статті розглянуто об'єми збору зерна кукурудзи в різні роки в Україні для виробництва круп і крупианих продуктів. Розглянуто різні види кукурудзи як перспективної сировини для використання в харчовій промисловості.

Показано, що в Україні найбільш поширені два підвиди кукурудзи - зубовидна (крупнозерниста, продовгувата форма) і кремниста (округле зерно). Присутність вітамінів групи В (В1, В2), РР, кальцію, магнію, фосфору і заліза, а також мікроелементів (мідь, нікель і т.д.) в зерні кукурудзи дозволяє рекомендувати кукурудзяні продукти у вигляді окремого продукту або в комбінації з іншими, людям із захворюваннями крові, алергіями, цукровим діабетом, ожирінням і іншими формами метаболічних розладів і патологією шлунково-кишкового тракту.

Авторами проведено аналіз хімічного складу зерна кукурудзи різної ботанічної групи, призначеної для виробництва круп і продуктів з них. Наведено склад мікро- і макроелементів кукурудзяної крупи, що використовується при виробництві харчових продуктів (снеки, сухі сніданки, каші швидкого приготування, пластівці та ін.).

Ключові слова: кукурудза, виробництво, переробка, хімічний склад, кукурудзяна крупа.

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ЕФЕКТИВНІСТЬ ЗАСТОСУВАННЯ ВИСОКОБІЛКОВИХ ФУНКЦІОНАЛЬНИХ ПРОДУКТІВ У ВИРОБНИЦТВІ БУЛОЧОК

Анотація

Хлібобулочні вироби є важливим продуктом харчування для більшості населення України. Потреба в хлібобулочних výroбах притаманна людям будь-якого віку, соціального статусу і рівня доходів. Хлібопекарська галузь покликана забезпечувати споживачів країни цими життєво значущими продуктами харчування в необхідних обсягах, асортименті та якості.

В даний час в світі велика увага приділяється збагаченню хлібобулочних виробів різними корисними речовинами, що додають їм лікувальні та профілактичні властивості. Лікувальний і профілактичний ефект від вживання дієтичних хлібобулочних виробів забезпечується або введенням в рецептуру необхідних додаткових компонентів, або вилученням небажаних, або зміною технології їх приготування. Однією з ключових умов сучасного виробництва функціональних хлібобулочних виробів є пошук і використання нових компонентів рецептурного складу. Функціональні продукти - це харчові продукти, що є частиною звичайного раціону, які крім поживних властивостей мають здатність позитивно впливати на ті чи інші функції організму людини.

У статті розглянуто сучасні напрями розширення асортименту хлібобулочних виробів з оздоровчими властивостями. З метою урізноманітнення продукції хлібопекарського виробництва функціонального призначення було запропоновано введення в рецептуру булочок високобілкових функціональних продуктів, а саме льняного шроту та шроту з насіння гарбуза. Відомо, що насіння льону та гарбуза містять у своєму складі всі есенціальні амінокислоти.

На основі експериментальних досліджень розроблено рецептури булочок з додаванням льняного і гарбузового шроту, які дають змогу одержати збагачені білком булочки відповідної якості. Проведено органолептичну оцінку якості булочок з різним вмістом шротів, побудовано профілограми на основі бальної оцінки. Зроблено висновок стосовно впливу концентрації шротів на пористість та вологість готових виробів. Обрано оптимальну концентрацію льняного шроту та шроту з насіння гарбуза в рецептурі булочок.

Ключові слова: льняний шрот, гарбузовий шрот, високобілкові продукти, булочки, органолептичні показники, вологість, пористість