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 food products (snacks, breakfast cereals, instant cereals, cereals, etc.).

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
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 Andropogonoeae, 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 ensures homogeneity of the product [14,18]. Nowadays, production of refined corn bran is set, addition of which ensures homogeneity of the product [14,18].

Table 1 shows content of the most important substances in corn grain of the most common botanical types.

<table>
<thead>
<tr>
<th>Botanical Group of Corn</th>
<th>Content in % in terms of dry matter</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>starch</td>
</tr>
<tr>
<td>Sugar corn</td>
<td>74,43</td>
</tr>
<tr>
<td>Siliceous corn</td>
<td>78,96</td>
</tr>
<tr>
<td>Zooby corn</td>
<td>80,10</td>
</tr>
<tr>
<td>Bursting corn</td>
<td>76,53</td>
</tr>
<tr>
<td>Starch corn</td>
<td>77,63</td>
</tr>
</tbody>
</table>

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.

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 metabolic 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.

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, glutelins) in comparison with dent and flint corn.
Cereal, in contrast to grain varieties, allows it to be used in baby food. The absence of gliadin protein fraction in corn starch (more only in rice), sugars, fiber and vitamin E means being low in fat.

Corn cereal is a source of vegetable protein, carbohydrates and energy, while at the same time it is available 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 зросла. В Україні кукурудза є основною кормовою культурою і, іноді 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 гідній сільськогосподарській тваринництві.

Сьогодні з кукурудзи видобувають близько 3500 харчових і технологічних продуктів. Кукурудза здатна значною мірою задовольняти потреби тваринництва, його частка становить майже 30% у складі концентратів. Кукурудзяна крупа, яка здебільшого поширена у різних країнах світу, входить до складу багатьох продуктів. Вона використовується в морській, мучній, бурхливій і інших галузях промисловості.

Показано, що в Україні надзвичайно поширеними є два підвиди кукурудзи: зубовидна (крупнозерниста, продовольча) і кремниста (округле зерно). Присутність вітамінів групи B (B1, B2), PP, кальцію, магнію, фосфору і заліза, а також мікроелементів (мідь, нікель і т.д.) в зерні кукурудзи дозволяє рекомендувати кукурудзу як продовольчу продукцію.

Анотація

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