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CHEMICAL COMPONENT OF THE SEEDS OF CORN GRAIN (SORGHUM BICOLOR) DEPENDING OF BIOLOGICAL FEATURES OF THE HYBRIDS

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Abstract. The chemical component of seeds of the studied hybrids of grain sorghum was determined. The content of proteins, fats, carbohydrates, as well as vitamins, macro- and microelements has been established in hybrids of different selection.

Key words: grain sorghum, vitamins, micro- and macroelements, hybrid.

Formulation of the problem. Sorghum is an adaptive crop, its high pliability drought and heat resistance is due to African origin. Grain sorghum can grow where the worst conditions for other crops: on saline and infertile sandy soils, in conditions of moisture deficiency, the culture easily tolerates high temperatures during flowering and forms a waxy coating, protecting itself from overheating, pests and diseases [1, 3, 4].

minerals - 1.8-2.5%, fiber – 2 - 3%. Sorghum grain contains more protein and less fat compared to corn [2, 4, 5].

Nitrogen-free extractives of sorghum grain consist mainly of starch, so its digestibility is very high. In general, the chemical composition of sorghum grain depends on a number of factors - the biological characteristics of varieties and hybrids, cultivation technology, as well as climatic conditions [1]. In this case, different hybrids of grain sorghum have very different characteristics, determined by the chemical composition and nutritional value of this crop. For versatile use of sorghum grain, it is necessary to neatly knows all its properties, as well as its chemical and quantitative component of various elements: proteins, fats, carbohydrates, vitamins, micro and macronutrients.

Analysis of recent research and publications. Grain sorghum is a cereal crop with a long history of cultivation. Its morphological and physiological features, such as the structure of the leaf apparatus, the presence of a waxy protective layer, the ability to use water sparingly, the possibility of prolonged stay in a state of anabiosis and restoration of vegetation with moisture, determine heat resistance [6, 8].

This crop is using to feed domestic animals as a food crop as well as in organic nutrients. Sorghum has a small amount of gluten and a large amount of fiber, which is the basis of the principle of healthy eating in many countries [7, 10].

Globally, sorghum grains are in third place after wheat and rice in the human diet. Sorghum grain contains vitamin B1, biotin (vitamin H), phosphorus and more. Moreover, as an antioxidant and anti-inflammatory agent is almost more useful than blueberries and pomegranates: 1 g of sorghum contains up to 62 mg of polyphenolic compounds. For comparison, blueberries, which always be consider the "champion" in the content of these components, have only 5 mg per 100 g. The caloric content of sorghum varies, depending on the variety. However, on average, cereals have about 300 kcal. Moreover, 100 g of sorghum flour contains 350 kcal. If you take 90% of wheat flour and add 10% of sorghum - you will get diet bread, which hardens more slowly and has a longer shelf life [9, 11, 15].

In addition, in Ukraine sorghum is using to produce cereals, extruded products, starch, oil, canned meat, beer components, organic dyes [12, 14]. Important elements in sorghum cereals are vitamins (folic acid, biotin, provitamin A, thiamine (B1), riboflavin (B2), niacin (PP), B6, E), minerals (phosphorus, potassium, magnesium) and trace elements (iron, manganese, copper, molybdenum). Thus, grain sorghum (two-color) provides a person with almost all nutrients: proteins and amino acids, fats and fatty acids, carbohydrates, vitamins, minerals, trace elements and it using by others as an important source of nutrition [13, 16].

Research methodology. The studies used seeds of grain sorghum hybrids, which are included in the State Register of plant varieties suitable for distribution in Ukraine: selection of Ukrainian (Lan 59), French (Targga, Anggy, Burggo) and American (Prime, Yuki) selection.

The mass fraction of protein substances was determining by the Kieldal method [18], fat content - by Sokslet method [18], starch content - by Evers method [18], ash content - according to GOST 27494-87, sugar content - by iodometric method, dietary fiber content - by GOST R 54014-2010.

Fatty acid composition of lipids - according to GOST 30418-96, the composition of individual amino acids - by ion-exchange liquid chromatography on an automated amino acid analyzer TT 339 (Czech Republic).

Other trace elements on X-ray fluorescence analyzer by vitamin method o electrophoresis, fat-soluble vitamins - HPLC method GOST 26753.1-93 and GOST 50929-96 of the Russian Federation.

Research results. Knowing the content of proteins, fats and carbohydrates, you can determine the caloric content of a product that must meet standard standards and requirements.

According to the results of research on the caloric content of seeds of American hybrids of grain sorghum, it differed slightly from hybrids of French and domestic selection. The caloric content of seeds of American hybrids was in the range - 316-320, the French - a

little less - 305-318 kcal. The highest rates were in the seeds of a hybrid of sorghum grain American selection - Prime - 320 Kcal, from the French stood out - Burggo - 318, compared with the Ukrainian Lan 59 - 215 Kcal.

Based on the different caloric content of seeds of the studied grain sorghum hybrids, it was arguing that there is a significant difference in their composition of protein; fat and carbohydrate content (Fig. 1).

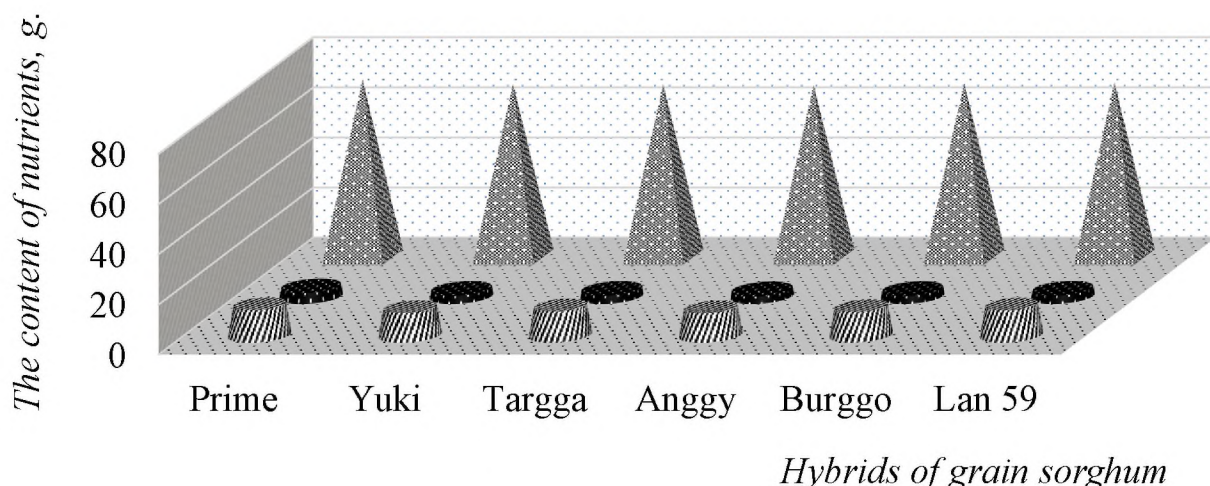


Fig. 1. The content of proteins, fats and carbohydrates in the seeds of various hybrids of grain sorghum, g.

▨ - proteins, g. ■ - fats, g ▤ - carbohydrates, g

The protein content in the seeds of hybrids of American selection ranged from 11.3 to 12.5 g, fat -3.08 to 4.10, while the carbohydrate content was at the level of 69.2 to 71.0 g.

Seeds of hybrids of grain sorghum French selection was define by slightly lower rates, as the content of proteins in their composition was - 11.2-12.0, fat - 2.87 - 3.07, and carbohydrates - 68.7 - 69.5 g. In a hybrid of Ukrainian selection Lan 59 protein content was almost at the level of hybrids of American selection and was - 12.4 g, fat content was slightly lower - 3.12, while the carbohydrate content was at a higher level and tanovyyv - 69.8 hours ahead of French performance hybrids.

Therefore, according to the nutritional value, namely the higher content of proteins, fats and carbohydrates among the studied hybrids, we can distinguish the American hybrid -

Prime, whose caloric content was - 320 kcal., From the French - hybrid - Burggo with caloric content - 318 kcal.

Vitamins, organic matter, are need in small quantities in the diet of both humans and most vertebrates. Unlike inorganic substances, they are unstable and break down when heated.

In the seeds of all studied hybrids, the content of vitamins of one group differed depending on biological characteristics. According to our research, among all groups of vitamins, we can distinguish vitamin B4 (choline), which provides protein-lipid metabolism and the content of which in sorghum is the highest. In the seeds of hybrids of domestic and American selection, namely Lan 59 and Prime, its quantitative content was - 95 and 97 mg. In the seeds of French hybrids Targga, Anggy, Burggo choline content was - 93, 87 91 mg / 100 g

Vitamin B1 (thiamine) is part of the most important enzymes of carbohydrate and energy metabolism, which provide the body with energy and plastic substances, as well as the metabolism of branched-chain amino acids. The highest levels of thiamine were in the seeds of hybrids of American selection - Yuki and Prime, which were - respectively - 0.43-0.45 mg / 100 g (Fig. 2).

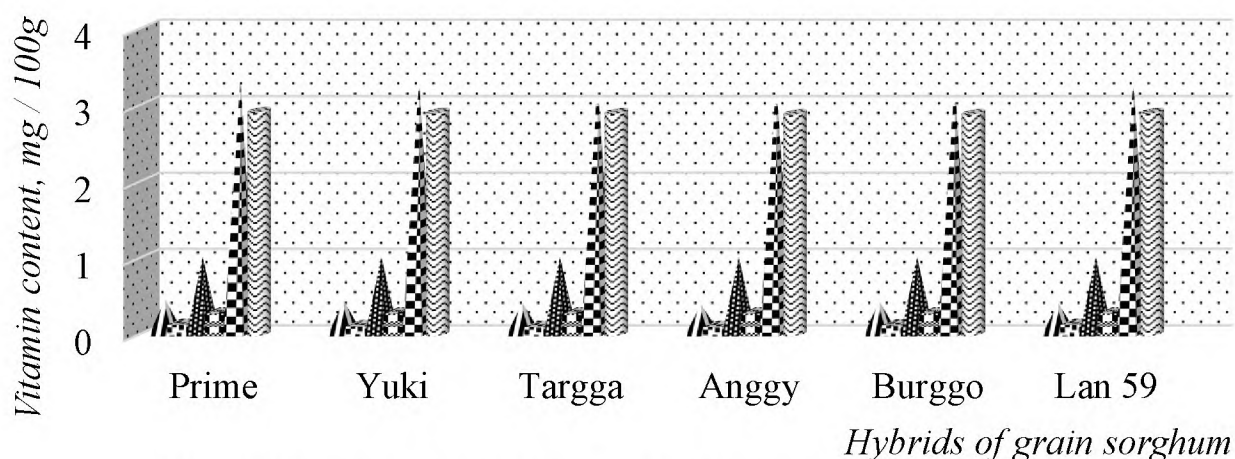


Fig. 2. The content of vitamins in the seeds of the studied hybrids of grain sorghum, mg / 100 g.

|| - vitamin B1, mg ☼ - vitamin B2, mg ■ - vitamin B5, mg
 ▣ - vitamin B6, mg ✖ - vitamin B3, mg ⋈ - vitamin PP, mg

The content of vitamin B1 in the seeds of the Ukrainian hybrid Lan 59 and French - Targga, Anggy, Burggo was slightly lower and amounted to 0.38 - 0.42 mg / 100 g, respectively.

At one quantitative level in the seeds of hybrids of Ukrainian and American selection Lan 59 and Prime was the content of Vitamin B2 (Riboflavin), which was - 0.15 mg. In other hybrids, these figures ranged from 0.12 to 0.14 mg / 100 g.

The highest content of vitamin B3 ("niacin" or "niacinamide"), which provides normalization of energy metabolism, is characterized by seeds of hybrids of American and domestic selection. Thus, in Prime, Yuki and Lan 59, the niacin content was - 3.2 - 3.3 mg, in the French - it was at the same level - 3.0 mg / 100 g.

The content of pantothenic acid (vitamin B5), which is involved in metabolic processes and synthesis of a number of hormones, in the seeds of the studied hybrids was at the same level and was - 1.0 mg / 100 g. A similar situation with pyridoxine (vitamin B6), which corresponds for the immune and nervous systems, and is contained in the same quantitative composition at the level of 0.3 mg / 100 g of all studied hybrids of grain sorghum.

Vitamin B7 is involved in the synthesis of fats, glycogen, amino acid metabolism; it is called vitamin H (biotin). The seeds of the French hybrid Burggo were defined by its lowest content, which was 0.014 mg / 100 g. In the hybrid Lan 59 and the French - Targga and Anggy biotin content ranged from 0.016 to 0.017 mg / 100 g. In the American hybrid grain sorghum - Prime found the highest biotin content, which was 0.018 mg / 100 g.

Vitamin PP is involved in redox reactions of energy metabolism. The lowest content of vitamin PP was observed in the seeds of French hybrids Targga, Anggy, Burggo at the level of 2,899 - 2,912 mg. The best indicators were characterized by the American grain sorghum hybrid Yuki and Ukrainian Lan 59, in the seeds of which the same content of vitamin PP was noted in the range of 2,917 mg / 100 g. 100 years.

The nutritional value of seeds of different hybrids of grain sorghum was determined not only by the content of proteins, fats and carbohydrates, but also by active catalysts of

biochemical reactions, which are micro- and macroelements. Their quantitative composition in different hybrids of grain sorghum is an important indicator for their further use.

The higher content of Na in grain sorghum seeds is observed in American and domestic hybrids compared to French. Thus, the American Yuki and Ukrainian Lan 59 Na content was at the same level and was - 23 mg. Whereas in the French hybrids Targga, Anggy, Burggo these figures were much lower and ranged from 17 to 21 mg / 100g (Fig. 3).

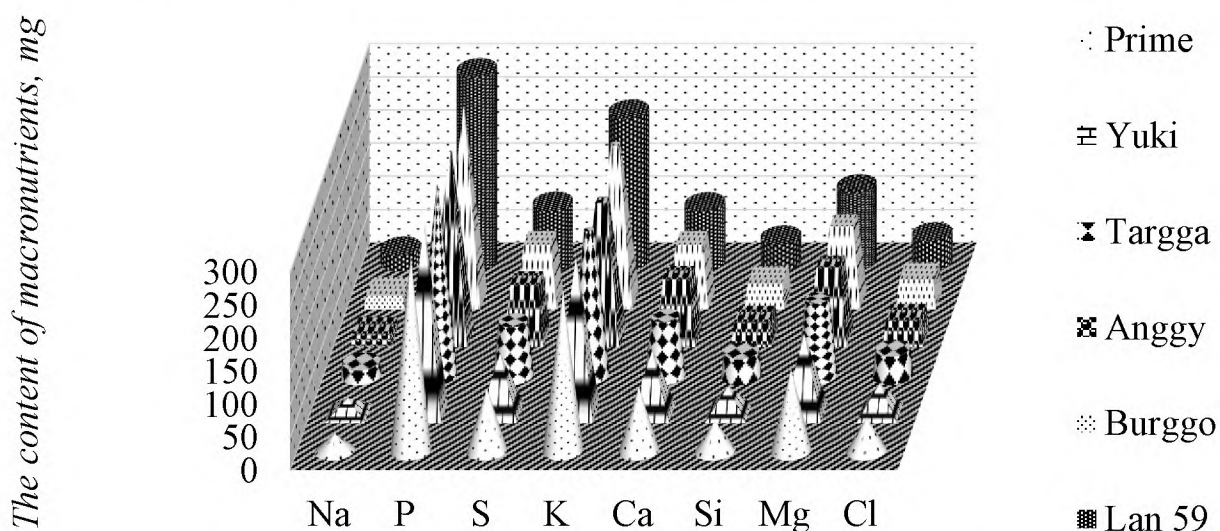


Fig. 3. The content of macronutrients in the seeds of the studied hybrids of grain sorghum, mg

The studied hybrid of sorghum grain American selection Prime was defined by the highest content of Na in the seeds and was - 26 mg / 100g.

Phosphorus is involved in many physiological processes, including energy metabolism, regulates acid-base balance, and is part of phospholipids, nucleotides and nucleic acids. In the presence of P in the seeds of American hybrids, significantly outnumber the French, as its content in hybrids Targga, Anggy, Burggo ranged from 281 to 290 mg. The highest rates were forming in the American hybrid Prime, the P content of which was 295 mg, while in the Ukrainian hybrid Lan 59 and the American Yuki; they were slightly lower, at the level of 291-292 mg / 100 g.

The lowest content of S in its composition - 84 mg, was define by a hybrid of French selection - Targga, 12 mg more was in the hybrid Prime - 96 mg / 100 g

In the seeds of French hybrids, the content of potassium (K) range from 208 to 235 mg, in American hybrids, these figures were higher. Thus, in the hybrid Yuki and Prime, the potassium content was respectively - 237 and 245 mg / 100 g

It was determined that the lowest Ca was in the seeds of the Ukrainian hybrid Lan 59, in which its content was 90 mg, while the highest values of this element formed the American and French hybrids Prime and Anggy - 98 mg / 100 g.

Such a macroelement as silicon (Si) is included as a structural component in the composition of glycosaminoglycans, this element was present in smaller quantities in the seeds of French hybrids in the range from 35 to 37 mg. Slightly higher rates were in the hybrids Lan 59 and Yuki, respectively - 40 and 41 mg / 100 g. The American hybrid of sorghum grain contained much more silicon, at the level of - 46 mg / 100 g.

Magnesium is involved in energy metabolism, as well as the synthesis of proteins and nucleic acids, has a stabilizing effect on the membranes needed to maintain homeostasis of calcium, potassium and sodium. The lowest content was founding in the seeds of the Anggy hybrid - 115 mg, this hybrid also contains the lowest Cl content - 38 mg / 100 g. It was founding that the highest content of magnesium and chlorine was in the American hybrid sorghum, which was - 125 and 51 mg / 100 g.

Therefore, it was be argued that the American hybrid of sorghum grain Prime was define by the highest performance of all components that form macronutrients. In addition to macronutrients, micronutrients also play an important role in the biological (genetic) characteristics of various grain sorghum hybrids. Thus, iron (Fe) is part of various functions of proteins, including enzymes, and provides redox reactions. The content of this microelement in the seeds of French hybrids ranged from 3.78 to 4.23 mg, while that of American hybrids ranged from 4.31 to 4.40 mg / 100 g, respectively (Fig. 4).

A trace element such as cobalt (Co), which is part of vitamin B12, also activates the enzymes of fatty acid metabolism and folic acid metabolism. As a result of research it

was found that the content of this trace element in all studied hybrids of grain sorghum was in the same amount and was - 2.0 mg / 100 g

In their species composition, hybrids of French selection in terms of Al content predominate over French and Ukrainian Lan 59. Thus, in the seeds of American hybrids Yuki and Prime these figures were - 1,545 - 1,548 mg, and an even smaller indicator of the content of this trace element was a hybrid of Ukrainian selection Lan 59, which was - 1,540 mg. The highest Al content was in French hybrids, ranging from 1,550 to 1,555 mg / 100 g.

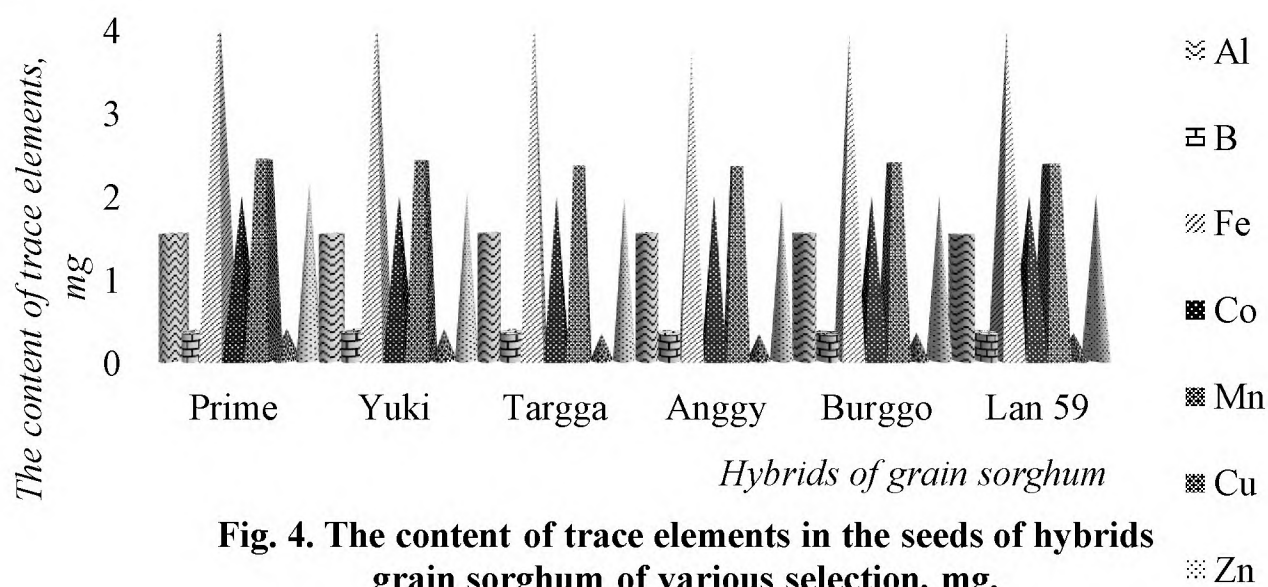


Fig. 4. The content of trace elements in the seeds of hybrids grain sorghum of various selection, mg.

Manganese is involved in the formation of bone and connective tissue and is part of the enzymes involved in the metabolism of amino acids and carbohydrates. It was founding that the content of this trace element is much lower in the seeds of French, compared with Ukrainian and American hybrids of grain sorghum. Thus, in the studied French hybrids Targga, Anggy, Burggo the content of Mn was in the range from 2,367 to 2,412 mg, and the highest was in the American Prime and was - 2,455 mg / 100 g

The American hybrid Yuki was the best in terms of content B, as the content of this microelement was 0.347 mg, while the content of boron was the lowest in the French hybrid Burggo - 0.325 mg.

Copper is part of the enzymes that provide redox activity and participate in iron metabolism, stimulating the absorption of proteins and carbohydrates. In the composition of French hybrids such as Targga and Anggy, there was a much smaller number of them at the level of 0.315 and 0.312 mg, in Lan 59 the content of Cu was slightly higher - 0.325 mg. Significantly higher rates of copper were in the seeds of American hybrids and ranged from 0.375 to 0.380 mg / 100g.

Regarding no less important trace element as zinc, which is part of more than 300 enzymes, and participates in the synthesis and breakdown of carbohydrates, proteins, fats, nucleic acids, we can note the advantage of American and Ukrainian hybrid Lan 59 over the French. Thus, the zinc content of French hybrids ranged from 1.94 to 2.00 mg, compared with the American hybrid Yuki and the Ukrainian hybrid Lan 59, respectively 2.02 and 2.03 mg. The American hybrid sorghum grain Prime has the highest content of such a trace element as zinc at the level of 2.15 mg / 100 g.

Conclusions. In terms of nutritional value, namely the highest content of proteins, fats and carbohydrates among the studied hybrids, the American - Prime stood out, the caloric content of which was - 320 Kcal., From the French - the hybrid - Burggo with caloric content - 318 Kcal.

The highest levels of thiamine were founding in the seeds of hybrids of American selection - Yuki and Prime, which were - respectively - 0.43-0.45 mg / 100 g. In the seeds of American hybrid sorghum grain - Prime found the highest biotin content - 0.018 mg / 100 g.

The studied hybrid of sorghum grain American selection Prime was define by the highest content of Na in its composition, which was - 26 mg / 100 g. Because of research, it was founding that the content of Co in all studied hybrids of grain sorghum was in the same amount and was - 2.0 mg / 100 g.

The highest content of Al was founding in the seeds of French hybrids, these figures ranged from 1,550 to 1,555 mg / 100 g. The content was the best American hybrid Yuki, as the content of this trace element was - 0.347 mg, the French hybrid Burggo had the

lowest boron content - 0.325 mg. In the seeds of the American hybrid sorghum grain Prime found the highest content of such a trace element as zinc at the level of 2.15 mg / 100 g/

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