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CHICKPEA – A LEGUME THAT CAN EXPAND THE RANGE OF GRAIN PRODUCTS IN UKRAINE

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Abstract The world commodity classification divides chickpeas according to grain size and color into two types: small grain, which has a brown color the "Desi" variety, and large grain with a light or beige color the "Kabuli" variety. At the same time, studies show that the light-colored grain, which is larger (the "Kabuli" variety), is used to a greater extent for food needs, while the smaller, dark-colored grain ("Desi" variety) is typically used for fodder needs. Chickpeas have a balanced chemical composition, indirectly containing up to 29.0% protein, 5.5% lipids, 48.0% starch, 3.2% minerals, 4.2% fiber. Like most legume crops, according to its anatomical structure, chickpeas consist of hulls (12.5%), cotyledons (85.5%) and germ (2.0%). Chickpea breeding in Ukraine began in the 90s of the last century and continues today. After reviewing the data of the Register of varieties of plants suitable for distribution in Ukraine (Register) [4], it is possible to note already 21 varieties of chickpeas that can be grown in Ukraine. At the same time, the first variety " Pam'iat`" was registered since 2002, and the last variety "Octavius" last year, 2023, and the largest number of varieties registered in the Register since 2019. The "Rosanna" chickpea variety is promising for the grain industry, the values of the main technological indicators are within the limits that are characteristic of the "Kabuli" variety, the grain of which is usually used for food needs. All analyzed indicators of technological properties correspond to the restrictive standards for chickpea grain for food needs defined by DSTU 6019:2008 "Chickpeas. Technical Specifications". In addition, the obtained values are close to the mediated values of the technological properties of pea, a legume culture traditional for Ukraine, which allows us to talk about the possibility of using the same regimes and technological scheme for cleaning grain from impurities in the processing of the investigated chickpea variety without reducing its efficiency in removing impurities, which in turn will delay the stage of cleaning this crop from impurities and expand the possibilities of introducing chickpeas to already operating grain factories.

Key words: chickpeas, cultivation prospects, global commodity classification, grain production, processing products, chemical composition, technological properties, Rosanna variety.

Introduction. Formulation of the problem

Chickpea grain is one of the oldest legume crops in the world, it was deliberately started to be grown together with wheat, barley and other crops from which primitive farms were born 10-12 thousand years ago [1]. At the same time, it can be noted that chickpeas were known to primitive people long before the first attempts at purposeful cultivation of chickpeas are known from archeological finds dating back to 46,000 years ago in the territory of modern Iraq. Finds of chickpeas on the European continent date from 1 to 5 thousand years BC [2]. This leguminous crop was one of the main ones in the human diet and also provided fodder for livestock almost all over the world. Chickpeas came to Ukraine from Transcaucasia and South-West Asia [3]. Despite the wide spread and use of this culture, for a long time, no special attention was paid to the development of this culture, and only at the beginning of the 60-70s of the last century, directed selection work with chickpeas began in the world, the goal of which was to increase the yield and expand the number of high-quality food varieties of chickpeas.

Chickpea (Cicer arietinum L.) is one of the key leguminous crops widely cultivated around the world. Its varieties, desi and kabuli, differ in agronomic and ecological advantages, which determine their distribution across various regions depending on

climatic conditions, soil types, and agricultural traditions. According to crop area, chickpeas rank third among legumes after soybeans and beans, covering 100,000 to 120,000 km². According to FAO data, the share of cultivated chickpea areas globally is up to 15% of all legumes. World production of chickpeas is estimated at approximately 10-11 million tons annually, while the demand for this grain today is between 12 to 15 million tons per year. In Europe, the cultivation of the kabuli variety dominates, characterized by larger, lighter seeds and a greater need for water. The largest producers are Mediterranean countries such as Spain, Italy, and Turkey. The total chickpea area in the region exceeds hundreds of thousands of hectares, with annual production volumes reaching several hundred thousand tons. Both varieties are grown in Asia, but the desi variety is predominant, especially in India, Pakistan, and Iran. India, as the world's largest chickpea producer, cultivates over 10 million hectares, with total production exceeding 9 million tons. This variety is better adapted to dry conditions typical of tropical and subtropical regions. Its ability to fix nitrogen in low-fertility soils ensures stable yields even in areas with limited rainfall. The kabuli variety is grown in regions with better moisture, such as northern and western India, where irrigation is widespread. In Africa, the desi variety predominates in countries like Ethiopia and Sudan, where the dry climate and low soil fertility dictate the choice of this resilient variety. The chickpea area of the desi variety in these countries is in the hundreds of thousands of hectares. At the same time, in North Africa, particularly in Morocco and Tunisia, the kabuli variety is cultivated. The Mediterranean climate of these countries favors the cultivation of kabuli for local consumption and export. Annual production volumes in North Africa reach tens of thousands of tons. In Australia, chickpea cultivation focuses on the kabuli variety, which is more profitable for export. The crops are concentrated in the southeastern regions with a temperate climate and fertile soils. The annual area of chickpea cultivation exceeds 300,000 hectares, with an average annual production of about 250,000 tons. In North America, chickpeas are mainly grown in the United States and Canada, where the kabuli variety predominates. The total chickpea area in the region exceeds 500,000 hectares. This variety is suited to temperate climates and intensive agricultural practices, including irrigation and mechanization. In South America, particularly in Argentina and Chile, the kabuli variety is also grown with an emphasis on export. Argentina, in particular, cultivates over 100,000 hectares of chickpeas, with an average annual production of more than 120,000 tons, investing in the breeding of varieties with high resistance to stresses and diseases. Chickpea varieties show wide adaptation to different climatic conditions, which determines their distribution around the world. The desi variety predominates in regions with dry climates and low resource availability, while the kabuli variety is grown in regions with moderate conditions and high levels of agricultural technologies [5-8].

Chickpea (Cicer arietinum L.) in Ukraine is a promising leguminous crop that is gradually increasing its cultivation areas due to its adaptation to local climatic conditions and growing demand in the global market. The main regions of chickpea cultivation are the southern and eastern areas of the country, including Zaporizhzhia, Dnipropetrovsk, Kherson, Odesa, Mykolaiv, and Kharkiv regions. These regions have a dry climate with moderate rainfall and fertile soils, creating favorable conditions for this crop.

Both main varieties of chickpeas, desi and kabuli, are grown in Ukraine. The kabuli variety is more popular due to its large seed size, light color, and high commercial value, making it attractive for export markets. However, desi, due to its drought resistance and ability to grow on less fertile soils, is also used, particularly in regions with limited water resources.

The area of chickpea cultivation in Ukraine is small compared to other traditional crops, but it has recently shown an increasing trend, currently reaching several tens of thousands of hectares. The total yield of the crop increases each year, reaching several tens of thousands of tons. Part of the chickpeas grown in Ukraine is exported, making it one of the important components of the country's agro-export potential. The main markets for chickpeas are the European Union, the Middle East, and South Asia, where the demand for chickpeas remains consistently high [9-11].

Analysis of recent research and publications

The world commodity classification divides chickpeas according to grain size and color into two types: small grain, which has a brown color of the "Desi" variety, and large grain with a light or beige color of the "Kabuli" variety. At the same time, studies show that the light-colored grain, which is larger (the "Kabuli" variety), is used to a greater extent for food needs, while the smaller, dark-colored grain ("Desi" variety) is typically used for fodder needs. Kabuli and Desi chickpeas have their differences in origin: the large, light-colored edible grain is of Mediterranean origin, while the dark, small, dark-colored one is of Asian origin. The "Kabuli" variety is characterized by a thinner seed coat, while the "Desi" variety has a thicker and rougher seed coat, for both chickpea varieties the seed coat is very difficult to separate from the cotyledons.

The technological properties of grain play a leading role in the choice of modes of cleaning and preparation of grain, modes of its processing: dehulling, sorting of dehulling products, pearling, sorting of pearling products, etc. The shape of the grain is decisive when choosing sieves for grain cleaning. Chickpeas are characterized by a round, semi-round, wrinkled and semi-wrinkled shape, depending on the variety. The

"Desi" chickpea variety is characterized by a wrinkled shape and a small, dark-colored grain, while the "Kabuli" variety is characterized by a more oval, rounded shape of a large, light-colored grain. The grain diameter of the "Desi" chickpea variety was within 7.1-8.0 mm, the "Kabuli" variety was 9.1-11.0 mm. According to other dimensional characteristics, the length of chickpea seeds varies between 4-12 mm, width – 4...8 mm. It is important to note that when the grain is moistened before processing, the change in the geometric characteristics of chickpeas increases immediately in all characteristics: length, width and thickness. The weight of 1000 grains is important when evaluating chickpea grains. According to the index of weight of 1000 grains, chickpeas are classified into three groups: small-seeded (up to 200 g), medium-seeded (200-350 g), and large-seeded (350 g). For the "Kabuli" variety, the typical average weight of 1000 grains is 708 g, for the "Desi" variety at the level of 280 g. The mass fraction of hulls on the grain surface of the "Kabuli" chickpea variety is 3.7-7.0%, for the varieties of the variety "Desi" their number is more 9.7-17.3 %.

Chickpeas have a balanced chemical composition, indirectly containing up to 29.0 % protein, 5.5% lipids, 48.0% starch, 3.2% minerals, 4.2% fiber. Like most legume crops, according to its anatomical structure, chickpeas consist of hulls (12.5%), cotyledons (85.5%) and germ (2.0%). According to the anatomical parts, the chemical components in chickpeas are unevenly distributed fiber, the vast majority of calcium is in the hulls, cotyledons - protein, carbohydrates, germ - protein, lipids, micro- and macroelements [9-11].

Comparison of the protein mass fraction in seeds of desi and kabuli chickpea varieties is a key aspect in analyzing their nutritional value, as protein is the main component of leguminous crops that determines their significance for human nutrition. The protein mass fraction in desi chickpea seeds usually ranges between 20–25%, whereas in kabuli it is typically within 17–22%. The difference in protein content between these two varieties is attributed to the structure of the seed coat. In desi, the seeds have a dark coat rich in polyphenolic compounds, particularly tannins. This promotes greater protein accumulation in the endosperm by inhibiting certain metabolic processes. Although tannins can negatively affect protein bioavailability, they do not reduce its absolute concentration. In kabuli, the seed coat is thinner and lighter, with a lower polyphenol content, which facilitates processing and consumption but is accompanied by a reduction in nitrogen compound concentration. Considering these differences, desi chickpea is regarded as a better choice for regions with protein-deficient diets, whereas kabuli is more promising for commercial cultivation and export due to its consumer appeal. The fractional composition of the chickpea protein complex, particularly the content and ratio of protein fractions such as albumins, globulins, glutelins, and prolamins, is an important aspect determining its nutritional value, functional properties, and applications in the food industry. Globulins make up the largest share of protein fractions in chickpea seeds, accounting for approximately 50–70% of the total protein content. The main globulins in chickpea are vicilins and legumins, which are reserve proteins supporting seedling growth and development during germination. In desi, the globulin concentration is generally higher than in kabuli, ranging between 60–65% of total protein, while in kabuli it is 50–55%. This difference is explained by the genetic characteristics of desi, which allow for greater accumulation of reserve proteins under arid climates and nutrient-poor soil conditions. In kabuli, breeding programs often focus on increasing seed size, indirectly affecting the relative globulin content. Albumins, which are water-soluble proteins, occupy the second most significant share of the chickpea protein complex. They play crucial roles in metabolism, including the transport of metal ions and low-molecular-weight compounds. The albumin content in desi is typically around 10–12% of total protein, while in kabuli it is about 8–10%. The higher level of albumins in desi is associated with a greater presence of bioactive compounds essential for plant survival under stress conditions. In kabuli, the reduced albumin content may result from agroclimatic conditions that are less extreme compared to the regions where desi is cultivated. Glutelins, which are soluble in acidic or alkaline solutions, also represent a significant portion of the chickpea protein complex, but their content is somewhat lower compared to globulins and albumins. In desi, glutelins account for about 15–18% of total protein, while in kabuli, their content is slightly lower at approximately 12–15%. This may be attributed to desi being better adapted to low-soil-fertility conditions, where glutelins act as reserve proteins supporting physiological processes. In kabuli, due to better agronomic conditions, the need for significant glutelin accumulation is reduced. Prolamins, which are alcohol-soluble proteins, constitute the smallest share of chickpea protein fractions, typically accounting for 2–5% of total protein. In desi, prolamin concentration is usually higher than in kabuli due to adaptive mechanisms that promote the accumulation of proteins with enhanced resistance to degradation under stress conditions. The fractional composition of chickpea protein complexes demonstrates clear differences between desi and kabuli varieties, determined by both genetic and environmental factors. The higher content of globulins and albumins in desi makes it more suitable for producing food products with enhanced nutritional value, while kabuli, owing to its commercial characteristics, is more attractive for export and broader applications in the food industry. The amino acid composition of chickpea is a key indicator of its nutritional value, as it determines the crop's ability to provide the human body with essential amino acids

necessary for protein synthesis. Desi and kabuli chickpea varieties exhibit certain differences in amino acid profiles, influenced by genetic traits, agroclimatic growing conditions, and adaptive mechanisms. Chickpea proteins predominantly contain essential amino acids such as lysine, isoleucine, valine, leucine, and threonine, which have high biological value. Lysine, crucial for the synthesis of collagen, hormones, and enzymes, is present in significant concentrations in the seeds of both varieties. In desi, lysine content is typically higher, at around 6.0–6.5 g per 100 g of protein, compared to kabuli, where it ranges between 5.5–6.0 g. The elevated lysine content in desi may result from its adaptation to stress conditions requiring greater accumulation of proteins rich in this amino acid. Isoleucine and valine, which belong to branched-chain amino acids, also show some variation between desi and kabuli. In desi, isoleucine concentration reaches 4.0–4.5 g per 100 g of protein, and valine 5.0–5.5 g, exceeding the levels found in kabuli, where these amino acids are present at 3.5–4.0 g and 4.5–5.0 g, respectively. These amino acids play a crucial role in energy metabolism and muscle tissue repair, which is especially relevant for people consuming chickpeas as a source of plant-based protein. Leucine, another essential amino acid, shows similar trends. In desi, its content is approximately 7.0–7.5 g per 100 g of protein, while in kabuli it is 6.5–7.0 g. The higher leucine level in desi indicates its greater ability to support protein synthesis in the body, enhancing its nutritional value. Threonine content is relatively similar in desi and kabuli but slightly higher in desi, ranging from 3.5–4.0 g per 100 g of protein compared to 3.0–3.5 g in kabuli. Threonine is vital for maintaining immune function, glycoprotein synthesis, and fat metabolism. Among other essential amino acids, phenylalanine and threonine are notable. In desi, phenylalanine is present at 5.0–5.5 g per 100 g of protein, while in kabuli it is 4.5–5.0 g. Glutamic acid and aspartic acid, which are highly metabolically active amino acids, constitute a significant proportion of the chickpea amino acid profile. In desi, glutamic acid content reaches 18–20 g per 100 g of protein, and aspartic acid 11–12 g, surpassing kabuli, where these values are 16–18 g and 10–11 g, respectively. These amino acids play a vital role in nitrogen metabolism and the synthesis of other amino acids, supporting energy exchange and stress resilience. The amino acid composition of desi chickpea is more enriched compared to kabuli, particularly in terms of essential amino acids such as lysine, isoleucine, valine, leucine, and phenylalanine. This makes desi more attractive for use as a high-quality plant protein source, especially in regions where consumers prioritize products with high biological value. Although kabuli is slightly inferior to desi in these parameters, it retains its significance due to its balanced amino acid composition, which ensures stable nutritional value along with high commercial characteristics [12-16].

The carbohydrate complex of chickpea consists of starch, sugary substances, fiber, and other insoluble polysaccharides, which together form the main part of the seed's dry mass. Starch is the primary carbohydrate component, providing energy value, while sugary substances and fiber influence the physiological properties of chickpeas and their nutritional value.

Starch in chickpeas is in the form of oval or spherical granules with a smooth surface measuring 11-20 microns. The microstructure of chickpea starch granules carried out by N. Singh and others [17] is shown in fig. 1.

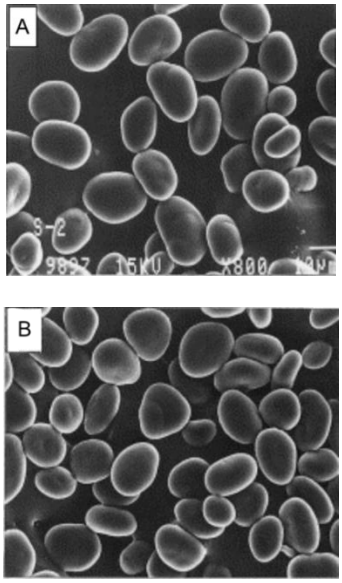

Fig. 1. Starch cells of chickpea grains of "GPF-2" (A) and "PDG-4" (B) varieties according to N. Singh and others [17]

In desi chickpea seeds, the starch content typically ranges from 40% to 50%, which is slightly lower than in kabuli, where this parameter varies between 45% and 55%. The lower starch content in desi is associated with a thicker seed coat and a higher content of proteins and polyphenolic compounds, which occupy a larger share of the dry mass. In kabuli, on the other hand, a thinner seed coat allows for the accumulation of more reserve polysaccharides, particularly starch, which provides a higher energy value for the seeds of this variety. Starch in chickpeas is composed of amylose and amylopectin, forming granules of varying structure depending on the variety. Differences in amylose and amylopectin content between desi and kabuli chickpeas are among the critical aspects determining their physicochemical properties, nutritional value, and technological applications. Amylose and amylopectin are the main structural components of starch that significantly affect its functional characteristics, such as gel formation, solubility, and thermal processing response. In desi varieties, the amylose content usually constitutes 28–30% of the total starch content, whereas in kabuli, this

figure is slightly lower, ranging from 24% to 26%. The higher amylose level in desi is attributed to the genetic characteristics of this variety, which ensure the synthesis of long, less branched starch chains. Such a structure promotes the formation of denser and more thermally stable gels, which is essential for preserving the texture of products during culinary processing. In kabuli, the lower amylose content is associated with lower starch granule density, making this variety more suitable for use in products with a soft texture, such as purees or creams. Amylopectin, in turn, is the primary component of starch in both chickpea varieties. In desi, its proportion is about 70–72%, while in kabuli, this parameter reaches 74–76%. The higher amylopectin content in kabuli enhances its solubility and ability to form viscous pastes, making this variety more attractive for commercial processing, particularly in the production of quick-cooking products. In desi, the higher amylose content results in slower starch hydration and reduced glycemic response, which is beneficial for developing products for diabetics and consumers with metabolic disorders. Furthermore, differences in the amylose-to-amylopectin ratio affect the size and morphology of starch granules. In desi, starch granules are generally smaller and denser, reducing their susceptibility to rupture during mechanical processing. In kabuli, granules are larger and less dense, contributing to better solubility in hot water but potentially leading to losses during intensive mixing or grinding. Sugary substances in chickpeas, consisting mainly of sucrose, raffinose, stachyose, and verbascose, also exhibit variations between varieties. In desi, the content of sugary substances is usually at the level of 3–5% of the total seed mass, while in kabuli, this parameter reaches 4–6%. Fiber, which comprises cellulose, hemicellulose, and lignin, plays an essential role in maintaining the structural integrity of seeds and ensuring the functional properties of chickpeas. In desi seeds, the fiber content ranges from 6% to 8%, significantly higher than in kabuli, where this figure is 4–6%. In kabuli, the thinner seed coat reduces the overall fiber content but provides a softer seed texture, making it more appealing to consumers and easier to process culinarily [18-21].

The fat content in chickpea seeds is an important component that determines their energy value, taste qualities, and nutritional properties. On average, the fat content in chickpea seeds ranges from 4% to 7%, depending on the variety, growing conditions, and genetic characteristics of the crop. In the desi variety, the fat content is 4.5–5.5%, while in kabuli, this indicator is usually slightly lower, ranging from 4% to 5%. The higher fat content in desi is due to the genetic characteristics of this variety, as well as its adaptation to harsher growing conditions, which promote the accumulation of energy reserves in the form of lipids. The fatty acid composition of chickpeas is a significant aspect of their nutritional value since fats influence the functional properties of food products and the metabolic response of the body. The primary fatty acids in chickpea seeds are linoleic acid (C18:2), oleic acid (C18:1), and palmitic acid (C16:0). Linoleic acid, which belongs to the omega-6 polyunsaturated fatty acids, constitutes the main portion of the lipid composition and plays an important role in maintaining normal cell membrane function and regulating inflammatory processes. In the desi variety, the linoleic acid content is 40–45% of the total fatty acid composition, while in kabuli, this indicator is at the level of 35–40%. Oleic acid, classified as a monounsaturated fatty acid, accounts for 25–30% in desi and 30–35% in kabuli. The higher oleic acid level in kabuli provides better stability during storage and thermal processing, as well as contributing to a milder taste of the seeds. Palmitic acid, the main saturated fatty acid in chickpeas, is present in smaller amounts. In desi, its content ranges from 15% to 18%, while in kabuli, it is slightly lower, at 12–15%. The higher level of palmitic acid in desi may be associated with a thicker seed coat, which contains an increased proportion of saturated lipids. In addition to the main fatty acids, chickpea lipids also contain other, less common components, such as stearic acid (C18:0) and myristic acid (C14:0). The stearic acid content in desi is about 2–3%, while in kabuli, this indicator is slightly lower, ranging from 1.5% to 2%. Myristic acid, found in trace amounts (less than 1%), also varies depending on the variety but contributes minimally to the overall lipid composition. The ratio of saturated to unsaturated fatty acids is an important indicator of the quality of chickpea lipids. In desi, this ratio is approximately 1:2.5, while in kabuli, it is 1:3. The higher content of unsaturated fatty acids in kabuli ensures better digestibility and functionality in dietary applications. Moreover, the chickpea varieties differ in their tocopherol content, which are natural antioxidants that positively affect lipid stability. In desi, tocopherol content can reach 100–120 mg/kg, whereas in kabuli, this indicator is typically 80–100 mg/kg. Thus, desi and kabuli chickpea varieties exhibit significant differences in fat content and fatty acid composition. Desi is characterized by higher fat content, saturated fatty acids, and tocopherols, which enhance its oxidative stability and adaptive properties. Conversely, kabuli has a lower fat level but is distinguished by an increased content of monounsaturated fatty acids, making it more attractive for use in the food industry [22-24].

Chickpeas are a valuable source of vitamins: folic acid, vitamin A, riboflavin (B_2), pantothenic acid (B_5), pyridoxine (B_6), vitamin C, niacin (B_3), α-tocopherol (E), etc. [22] and trace minerals: P, K, Mn, Ca and macroelements: Mg, Fe, Zn, Cu, Na [25,26]. The study of the ash index of the anatomical parts of chickpea showed that the highest ash content is in the germ parts (5%), hulls parts (2.8%), and cotyledons (2.6%). The ash content of the whole chickpea kernel is indirectly 2.7% [27].

Formulation of the problem

Chickpea breeding in Ukraine began in the 90s of the last century and continues today. After reviewing the data of the Register of varieties of plants suitable for distribution in Ukraine (Register) [4], it is possible to note already 21 varieties of chickpeas that can be grown in Ukraine. At the same time, the first variety "Pam'iat`" was registered since 2002, and the last variety "Octavius" last year was 2023, and the largest number of varieties registered in the Register since 2019 (table 1).

According to the data of the Register, the varieties Pam'iat` (2002) and Slobozhans`kyi (2004), which were the first to be registered in our country, belong to the grain intended for fodder needs, while the varieties Triumf (2005) and Budzhak (2008) are valuable varieties .

In Ukraine, chickpeas are not a traditional leguminous crop, its are grown in small quantities mainly in the southern regions. The total area of chickpea crops in Ukraine increases every year and is on average about 700...800 km^2, but considering that the main growing regions are the southern regions, with the beginning of hostilities, the area under chickpea cultivation in Ukraine decreased. If evaluate the production of chickpeas by regions over the past few years, the largest average fraction of all chickpeas produced in Ukraine is grown in Odesa (up to 65,000 tons), Kharkiv (up to 54,000 tons), Kirovohrad (up to 37,000 tons), Poltava (up to 37,000 tons) (up to 24,000 tons), Kherson (up to 15,000 tons), Zaporizhzhia (up to 13,000 tons), Vinnytsia (up to 12,000 tons), Mykolaiv (up to 11,000 tons) regions.

If compare chickpeas with the main grain crops in Ukraine, corn, wheat, barley, etc., then in terms of cultivation volume, this crop can be classified as a niche crop, but despite the small cultivation volume, this crop has a large export potential, it is exported from Ukraine to Saudi Arabia, Pakistan, India, Turkey, etc. The gross harvest of chickpea grain in Ukraine in recent years fluctuates within very wide limits, which are significantly influenced primarily by the general demand for this crop on the domestic and foreign markets and is from 535.6 thousand tons in 2018 to 93.4 thousand tons in 2021 [28-30].

In 2010, DSTU 6019:2008 "Chickpea Technical Conditions" entered into force in Ukraine, which applies to chickpea seeds intended for use for food and fodder and export needs. According to DSTU, chickpeas are divided into two types: type I is a food grain that has a white to yellow-pink color, type II is a feed grain that can be red-brown to black in color. Chickpeas for food needs, according to DSTU, are limited by protein content (not less than 20%), grain admixture (not more than 2.0%), garbage admixture (not more than 1.0%) and moisture content (not more than 14.0 %). For feed grain, all the same indicators apply, but with greater assumptions: for moisture no more than 15.0%, protein no less than 19.0%, grain admixture no more than 15.0%, garbage admixture no more than 3 .0%..

Table 1 – Chickpea varieties registered in the Register of plant varieties suitable for distribution in the territory of Ukraine (n=3; P≥0.95)

Variety name	Registration year	Weight of 1000 grains	Protein	Recommended region of cultivation
Pam'iat`	2002	290	29,0	Steppe
Slobozhans`kyi	2004	370	23,5	Steppe
Triumf	2005	410	29,0	Steppe
Budzhak	2008	420	27,4	Steppe
Odysei	2014	368	22,9	Steppe, Forest Steppe,
Skarb	2017	282	17,0	Forest Steppe
YeS Alunt	2018	410	29,8	Forest Steppe, Polissia, Steppe
Zehavit	2019	430	23,0	Forest Steppe, Polissia, Steppe
Zodiak	2019	290	28	Forest Steppe, Polissia, Steppe
Kozeroh	2019	440	25	Forest Steppe, Polissia, Steppe
Oven	2019	475	26,5	Forest Steppe, Polissia, Steppe
Stepovyi velet	2019	314	22,4.	Forest Steppe, Polissia, Steppe
Yaryna	2019	390	26	Forest Steppe, Polissia, Steppe
Blanko	2020	380	28	Steppe, Forest Steppe
Dostatok	2020	395	27	Steppe
Eva	2020	310	25,9	Forest Steppe, Polissia, Steppe
Kira	2020	350	26	Forest Steppe, Polissia, Steppe
Lara	2020	330	26,2	Forest Steppe, Polissia, Steppe
Rodin	2020	310	26	Forest Steppe, Polissia, Steppe.
Maestro	2022	380	26	Steppe, Forest Steppe
Oktavius	2023	there are no official data in open sources		

In Ukraine, there is no official regulation on the processing of chickpea grains into groats and groats products, this culture, the selection of which purposefully began on the territory of our country in the 90s, and the first food varieties appeared in the register in the first half of the 2000s, was not considered a promising raw material for a long time for the production of food products. But the imperfection of existing technologies and the range of groats and groats products led to the fact that product manufacturers began to pay attention to grain and leguminous crops, which traditionally in our country were not considered promising for the production of food products. Today, the processing of chickpeas into food grain products in our country is carried out according to the technical and technological instructions that each enterprise developed for its needs, taking into account the global trends in the processing of this crop. Among the assortment of chickpea processing products and technologies existing in Ukraine, can single out similarities with the legume culture traditional for our country with peas. Among the assortment of chickpea groats, can single out whole groats and groats from crushed kernels, as well as a more modern product, chickpea flour. Most of the technologies for the production of chickpea products in our country are built on the basis of pea processing technologies, but without scientific justification of the regimes for the new crop. This leads to the fact that the potential of the chickpea grain, which is laid by nature, is not fully used and remains in the finished product, the range of products is relatively small, despite the fact that it needs to be reasonably expanded and to create new products with chickpeas for our country, for example, muesli, cereal bars, flaked groats, flakes, breakfast cereals, etc. It is necessary to highlight and substantiate the stage of hydrothermal treatment as a separate line of research, taking into account the presence of anti-nutritive substances in chickpea grains.

The first direction in determining the suitability of a particular variety of grain or leguminous crop for processing into cereal products is the determination of the technological properties of the grain and its chemical composition. The purpose of this study is to determine the suitability for the production of groats and flakes from chickpea.

Materials and methods.

The subject of the research – samples of the chickpea variety "Rozanna" grown in the Odesa region in 2019-2021.

Determination of the main characteristics of the studied grain was carried out in accordance with the standards in force in Ukraine:

DSTU ISO 605:2007 Legumes. Determination of impurities, extraneous odors, pests, size, biological species and varietal belonging. Control methods (ISO 605:1991, IDT);

DSTU GOST 29144:2009 (ISO 711-85) Grain and grain products. Moisture determination (basic control method) and GOST 13586.5-93 Grain. Moisture determination method (GOST 13586.5-93, IDT);

DSTU ISO 520:2015 Cereals and legumes. Determination of the mass of 1000 grains (ISO 520:2010, IDT);

DSTU ISO 2171:2009 Cereals, legumes and products of their grinding. Determination of total ash by the ashing method (ISO 2171:2007, IDT)

DSTU ISO 20483:2016 Cereal and leguminous crops. Determination of nitrogen and crude protein content by the Kjeldahl method (ISO 20483:2013, IDT)

DSTU ISO 7302:2003 Grain and grain products. Determination of total fat content (ISO 7302:1982, IDT)

All the digital data obtained were processed using Excel software from the Microsoft Office 2007 service package. Data were presented as arithmetic mean and standard error ($M \pm m$).

The aim of the study is to determine the technological properties of chickpea seeds of the "Rozanna" variety, cultivated in the Odesa region, which belong to the Kabuli chickpea type and were grown during the 2019–2021 period. The research focuses on assessing the potential application of chickpeas as raw material for the domestic grain processing industry and expanding the range of groat products in Ukraine.

The objectives of the study are:

- To determine the technological properties of chickpea seeds of the "Rozanna" variety, cultivated in the Odesa region and classified as the Kabuli chickpea type, based on data from the 2019–2021 growing seasons.
- To evaluate the physical, chemical, and processing characteristics of the studied chickpea seeds to assess their suitability as raw material for the domestic grain processing industry.
- To analyze the potential of using chickpea for the production of groat products in Ukraine.

Results of the research and their discussion

According to organoleptic indicators, the grain of the investigated chickpea variety has no extraneous odors, and tastes has all the signs of fresh grain, is characterized by a yellow-cream color, and with this indicator, this variety can be attributed to the "Kabuli" variety, which is widely used in the world for food needs. The moisture content of the investigated chickpea samples varied from 13.5 to 14.0%. In the grain mixture, the content of seeds of other chickpea types for each year did not exceed 5.0%. The grain has a rounded pea-like shape with an elongated nose (Fig. 2.).

Fig. 2. General appearance of chickpea seeds variety "Rozanna"

The linear dimensions of the grains vary significantly depending on the year of cultivation and are indirectly characterized by a length of 7.1...9.6 mm, a thickness of 6.1...7.9 mm and a width of 6.0...8.0 mm (table 2).

The mass fraction of impurities in the studied samples of the "Rozanna" variety did not exceed the values that are limited for chickpea grains in accordance with DSTU 6019:2008. The mass fraction of grain admixture in chickpeas ranged from 1.5 to 2.0%, trash admixture 0.5 to 1.0%.

An important indicator by which it is possible to determine the suitability of grain for processing is uniformity. Batches of grain that have high uniformity of grain size and contain a larger amount of coarse grain will have better efficiency of the dehulling and pearling processes. Evenness is considered high if it exceeds 80%, and low if it is within 50...60%. The results of research on the granulometric characteristics of chickpea seeds of the "Rozanna" variety are presented in table 3.

Chickpeas of the “Rosanna” variety may have a fairly high level of grain uniformity by thickness and width, more than 85% of all grain is found at the passage of a sieve ø 10.0 mm and the passage of a sieve ø 6.0 mm. Instead of grain, the grain is removed by passing a sieve ø 5.0 mm, reducing the content from 2.5 to 3.3%. The high uniformity of the selected chickpea variety makes it possible to determine the optimal operating modes of grain cleaning and technological equipment and to create an effective division of grain into fractions before processing.

The weight of 1,000 grains additionally characterizes grain size. According to the indicator of weight of 1000 grains, the researched chickpea variety can be classified as average seed weight of 1000 grains, depending on the year of cultivation, it was within the range of values from 250 to 300 g.

Volume weight of graini a determining indicator by which the yield of finished products for traditional cereal crops is determined, as well as the volumes and required number of bunkers for unrefined grain and finished products are determined during the construction of the technology itself. It is a well-known fact that the processing of grain with higher values of volume weight of grain always gives higher values of yields of finished products. For the studied grain, the volume weight of grain indicator is in the range from 750 to 800 g/l. A feature of the researched variety of chickpea grain is also relatively high indicators of its technological properties - weight of 1000 grains and volume weight of grain.

A small value of the hulls index and high grain uniformity make it possible to process the surface of the grain more effectively during its dehulling and pearling. Uniformity of the chickpea grain also varied depending on the year of cultivation, which indicates the need for fractionation of the grain mass before the dehulling and pearling stage. Based on the obtained data, grain fractionation should be carried out on sieves with round holes.

In the course of research, indicators of the chemical composition that form the nutritional value of grain and its processing products were determined - the mass fraction of protein, fat, starch, fiber, and ash. Based on these indicators, the possibility of processing the studied chickpea samples into groats products was determined.

Table 2 - Geometric characteristics of "Rosanna" chickpea grain (n=3; P≥0.95)

Year growing	Length l, mm	Width a, mm	Thickness b, mm
2019	7,3...9,8	6,0...8,0	6,1...7,7
2020	7,4…9,6	6,3….7,8	6,2….7,8
2021	7,1...9,0	6,0...8,0	6,1...7,9

Table 3 - Granulometric characteristics of "Rosanna" chickpea seeds (n=3; P≥0.95)

Year growing	A set of sieves, pass/ coming off the sieve, %			
	ø 10,0 / 7,0	ø 7,0 / 6,0	ø 6,0 / 5,0	ø 5,0 / –
2019	52,5	33,0	12,0	2,5
2020	54,6	30,3	11,8	3,3
2021	51,7	32,3	12,9	3,1

The obtained values of the mass fraction of protein allow us to talk about the possibility of using this variety of chickpeas to create cereal products with an increased mass fraction of protein.

The mass fraction of starch (48-51 %), fat (5-7 %), fiber (4.1-4.2 %) and ash (3.0-4.5 %) in the studied chickpea samples was within the range of within the limits of values for chickpea grains of food purpose of the "Kabuli" variety (table 4).

Table 4 - Some indicators of the chemical composition of the studied chickpea grain of the "Rozanna" variety (n=3; P≥0.95)

Protein, %	Starch, %	Lipids, %	Fiber, %	Ash, %
24-26	48-51	5-7	4,1-4,2	3,0-4,5

Conclusion

The obtained research results allow us to conclude that the "Rozanna" chickpea variety is promising for the grain industry, the values of the main technological indicators are within the limits of those typical for the "Kabuli" variety, the grain of which is usually used for food needs. All analyzed indicators of technological properties correspond to the restrictive standards for chickpea grain for food needs defined by DSTU 6019:2008 "Chickpea Technical Conditions". In addition, the obtained values are close to the mediated values of the technological properties of pea, a legume culture traditional for Ukraine, which allows us to talk about the possibility of using the same regimes and technological scheme for cleaning grain from impurities in the processing of the investigated chickpea variety without reducing its efficiency in removing impurities, which in turn will delay the stage of cleaning this crop from impurities and expand the possibilities of introducing chickpeas to already operating grain factories.

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НУТ – БОБОВА КУЛЬТУРА ЩО ЗДАТНА РОЗШИРИТИ АСОРТИМЕНТ КРУПЯНИХ ПРОДУКТІВ В УКРАЇНІ

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Анотація. Світова товарна класифікація розділяє нут за ознаками крупності та кольором зерна на два типи: дрібне зерно, яке має коричневий колір різновид «Desi» та велике зерно зі світлим або бежевим кольором різновид «Kabuli». При цьому дослідження показують що зерно світлого кольору яке є більш крупним (різновид «Kabuli») використовується більшою мірою для харчових потреб, в той час як для більш дрібного зерна з темним забарвленням (різновид «Desi») характерним використанням є кормові потреби. Нут має збалансований хімічний склад опосередковано вміщуючи до 29,0 % білку, 5,5 % ліпідів, 48,0 % крохмалю, 3,2 % мінеральних речовин, 4,2 % клітковини. Як і більшість бобових культур за своєю анатомічною будовою нут складається з оболонок (12,5 %), сім'ядолей (85,5 %) та зародку (2,0 %). В Україні селекція нуту почалася в 90 роки минулого століття і продовжується сьогодні. Розглянувши дані Реєстру сортів рослин придатних для поширення в Україні [4] можна відмітити вже 21 сорт нуту який можна вирощувати в Україні. При цьому перший сорт «Пам'ять» було зареєстровано починаючи з 2002 року, а останній сорт «Октавіус» у минулому 2023 році і найбільшу кількість зареєстрованих у Реєстрі сортів починаючи з 2019 року. Сорт нуту «Розанна» є перспективним для круп'яної промисловості, значення основних технологічних показників лежать у межах які характерні для різновиду «Kabuli» зерно якого зазвичай використовують для харчових потреб. Всі проаналізовані показники технологічних властивостей відповідають обмежувальним нормам для зерна нуту продовольчих потреб визначених ДСТУ 6019:2008 «Нут. Технічні умови». Окрім цього отримані значення є близькими для опосередкованих значень технологічних властивостей традиційної для України бобової культури гороху, що дозволяє говорити про можливість застосування при переробці досліджуваного сорту нуту таких самих режимів і технологічної схеми очищення зерна від домішок без зниження її ефективності по вилученню домішок що в свою чергу спростить етап очищення даної культури від домішок і розширить можливості впровадження нуту на вже діючі круп'яні заводи.

Ключові слова: нут, перспективи вирощування, товарна світова класифікація, круп'яне виробництво, продукти переробки, хімічний склад, технологічні властивості, сорт «Розанна».