ТЕХНОЛОГІЯ ХАРЧОВОЇ ТА ЛЕГКОЇ ПРОМИСЛОВОСТІ

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COMPARATIVE ASSESSMENT OF CHEMICAL COMPOSITION AND PHYSICAL AND TECHNOLOGICAL INDICATORS OF LAND SEED AND LAND CHIA

The article presents a comparative characteristic of the chemical composition and physical and technological properties of flax seeds and seeds. For the organization of a highly effective process of primary processing and storage of seeds of chia and flax seeds, it is necessary to study its physical and technological properties in order to substantiate and develop modern methods and modes of purification and drying, which affects technological and consumer qualities. The results of the study of the physical and technological properties of flaxseed seeds and chia seeds will justify a rational technological scheme and its post-harvest treatment regimes.

Key words: *chemical composition, chia seeds, flax seeds, physical and technological properties, storage.*

The problem is presented in general terms and its connection with important scientific or practical tasks. Cereal masses have certain physical and technological properties that need to be taken into account in the practice of storage. Skilful use of these properties during transportation, processing and storage will reduce losses, improve the quality of the lots of grain and reduce losses in elevator-warehouse.

Of particular importance is the knowledge of the physical and technological properties of the grain mass in connection with the mechanization and automation of the processing processes in the flow, the introduction of new methods of drying, the use of pneumatic transport and storage of large batches of grain. The grain mass has the following physical properties: creep, self-sorption, sparrow, and others.

The grain mass is based on both the volume and the mass. In addition, the grain mass contains mineral and organic impurities. All this ensures certain movement of the grain mass, its vibrancy. Sediment is called the ability of grain and grain mass to move on any surface, located at a certain angle to the horizon. The good graininess of grain masses makes it easy to move them with the help of trenches, conveyors and pneumatic transport units, load in different size and form of grain storage and apply the principles of self-injection. This property is used in the processing of grain and loading and unloading operations [1−4].

The analysis of recent researches and publications, based on which the author considers this problem and approaches to its solution. The Chia plant (Chia White, or Salvia Hispanica) is a nutritious plant that has a long history of the traditional use of food for Mayans by Indians and residents of other countries in South America (Mexico, Bolivia, Ecuador), which are still used in food and drinking seeds and other parts of this plant, in particular – greenery and seed oil. In Europe, the consumption of this plant to date has not been widespread. Companies in the USA, Canada, Mexico, Chile, Australia, New Zea-

land and the European Union are widely using Chia seeds in the food, bakery and confectionery industries for the production of baby sticks, cereals, cookies, corn stalks, cookies, and others [5]. Such a high demand for the components of the Chia plant is due to its unique chemical composition.

Comparative data on the nutritional value of seeds of the Chia plant and flaxseed, which are widely used in the diet of the Ukrainian population, are given in Table 1.

Table 1

Comparative characteristics of the composition of the nutrients of seeds Chia and flax seed, g per 100 g of product [6]

Nutrients	Content in the seed of Chia	Content in flax seed
Protein, g	22	18,3
Fat, g	35,0	42,2
Carbohydrates, g	40,0	1,6
Dietary fiber, g	30,0	27,3
Ash, g	6,0	3,7
Saturated fatty acids, g, including ω-3, g	27,0 21,0	20,0 17,5
Mineral substances, mg		
Calcium	536	255
Magnesium	350,3	392
Sodium	12,2	30,0
Potassium	564,0	813,0
Phosphorus	751,0	642,0
Iron	6,3	5,7
Zinc	4,4	4,3
Vitamins, mg:		
Vitamin B_1 (thiamine)	0,45	1,6
Vitamin B_2 (riboflavin)	0,04	0,16
Vitamin B_6 (pyridoxine)	0,1	0,473
Vitamin B_9 (folic acid), mkg	110	87
Vitamin C	5,4	0,6
Vitamin E	1,16	0,31
Vitamin PP (niacin)	6,13	3,08
Energy value, kcal	472	534

Thus, a comparative estimation of the content of nutrients in the seed of Chia and in the seeds of flax indicates a sufficient similarity of the main indicators. At the same time, attention is drawn to higher protein content and lower fat content in Chia seed compared with flaxseed seeds. They have a lower content of saturated fatty acids (3.3 vs. 3.7 g / 100 g in the seeds of Chia and flax, respectively) and above the content of unsaturated fatty acids (27 vs. 20 g / 100 g), which ratio is 9: 1 and 6: 1 in the seeds of Chia and flax, respectively). In the seed of Chia, the highest content of ω-3 polyunsaturated fatty acids (21 vs. 17%). Chia seeds are richer than flax seed, calcium and contain less phosphorus, which leads to a more favorable relationship between calcium and phosphorus. The seeds of Chia also have higher iron content than flax seeds. The comparison of the vitamin content of the two products shows that in the Chia seedlings the vitamin B1, B2 and B6 content is lower, but the higher content of folic acid, the higher content of ascorbic acid (5.4 mg vs. 0.6 mg in the seeds of Chia and flax, respectively) and, especially significantly, the higher content of tocopherol. Thus, the nutritional value of the seed of Chia is quite close to the nutritional value of flaxseed, which is widely used in the nutrition of the population of Ukraine. At the same time, as noted, the characteristic of the Chia seed is even higher content of ω-3 fatty acids than in the seeds of flax, and simultaneously the Chia seeds contain much more natural tocopherol antioxidant than flax seeds. It can be assumed, because the seeds of Chia and the oil derived from them will be significantly less oxidized, which is characteristic of flaxseed oil. It is especially important to emphasize, given the available literature data and clinical observations that indicate a rapid bullying of flaxseed oil with the appearance of bitter taste, which is impeded by its use in feeding children, including children with bronchial asthma, who require an additional amount of ω-3 PFA.

PFA, especially ω-3 families, are an important essential nutrition factor, since they have a pronounced effect on the human body, and especially children:

• They are part of the structural components of cell membranes, affecting their permeability, fluidity, activity of embedded enzymes.

• Play a special role in maturation and functioning of the central nervous system in the fetus and infants, participating in the process of myelinization of nerve fibers; ensure the normal development of sensory, motor, behavioral, and others. Functions due to 9 concentrations in synaptic membranes and neural overload modulation; perform the most important role of stimuli of neurogenesis, synaptogenesis and neuronal migration.

• Participate in the formation of biologically active substances - eicosanoids [7, 8].

The grain content of the grain is characterized by the angle of friction and the angle of the natural slope. Under the angle of friction is understood the smallest angle at which the grain mass begins to slide on any surface. At an angle of the natural slope, or else it is called the angle of rolling, understand the angle at which the grain is slipping over the grain. In addition to these indicators, known coefficients of friction of grain mass, which are transmitted in different ways and on different materials [9−11].

Many factors influence the grain mass of the grains. The main ones are: the shape, size, character and condition of the grain surface, its moisture, the amount of impurities and their species composition, material, shape and condition of the surface on which the grain is moved. The smallest angle of friction and the natural inclination, that is, the greatest slush, have grain masses, in which the grain is spherical form with a smooth surface. The more the shape of the grain is spilled from the spherical and the more rough the surface, the smaller the graininess of the grain mass. Impurities reduce the graininess of the grain mass. Due to the large number of light impurities, as well as a significant amount of weed seeds with rough and sticky surface, the vibrations can be completely lost.

Different movements of grain mass is accompanied by self-assorted, that is, uneven distribution of components within the embankment, capacitance.

Self-sorting is the result of the gravity and heterogeneity of the particles from which the grain mass is composed. The heterogeneity of grain in form, specific gravity, grain size, fillability contributes to the different sailness of the grain, that is, the movement of each particle in the air stream. The largest self-sorting of the grain mass is shown during loading and unloading of grain storage facilities. In this case, a large, filled grain with a large specific gravity and low sailing quickly reaches the bottom or surface of the embankment. Small, succulent grains and impurities with a large sailing fall down slowly and are thrown by vortical streams of air to the walls or slide along the surface of the cone, which is formed by grain mass. In this connection, an inhomogeneous grain mass is created in silos, embankments and storage [9; 10].

Self-sorted − a negative phenomenon. The heterogeneity of the party is violated, conditions are created for the development of various physiological processes, the accumulation of light impurities and dust, for self-warming, the development of insects and mites and microorganisms, and in the end it leads to partial or complete damage to the grain due to the lack of monitoring of the grain mass.

The space formed between solid particles of grain mass, filled with air, is called spurs, and its amount, expressed as a percentage of 1 m3 of grain mass, is sparrow. Shanks form a significant part of the volume of grain mass and significantly affect the physical properties and physiological processes occurring in it. Spacing indicates which part of its volume falls on intergranular spaces [9−11].

The air circulating in the hollows facilitates the transfer of heat through the convention, as well as the displacement of water in the form of steam. The large gas permeability of the grain mass makes it possible to blow it out with air (during active ventilation), as well as disinfect appropriate preparations. A certain amount of air in the intergranular space is necessary to maintain the viability of the seeds.

When storing grain, the overall dimensions of the chinks and their structure are important. The greater the spareness, the smaller the proportion grains mass. In this regard, for its placement, a larger storage space is required. The size and shape of the bubbles affect the air and gas permeability of the grain mass, its sorption properties and air resistance during active ventilation.

The coupling of the grain mass depends on the shape, size, size and condition of the grain surface, the amount and type of impurities, the mass and moisture content of the grain mass, the shape and size of the granary. Large admixture, as a rule, increases the coarseness of the grain mass; the small ones are easily placed in the intergranular spaces and reduce it.

The shape and size of the granary, the mass of the grained grain also affects the stacking density. With the increase in the cross-sectional area of the silo, the grain mass is denser. As the height of the mound increases, the density in the lower layers increases to a certain limit, after which it does not change. The density of stacking also increases depending on the length of storage.

For the organization of a highly effective process of primary processing and storage of chia seeds, it is necessary to study its physical and technological properties in order to substantiate and develop modern methods and modes of cleaning and drying that affect technological and consumer qualities. Samples of chia and flaxseed were used for comparative characterization.

The determination of physical and technological properties was carried out using methods approved by the corresponding GOSTs, or applied in scientific research and recommended in the relevant literature [11].

The results of researches of physical and technological properties of seeds of chia and flax are given in Table. 2

Despite its similarity in chemical composition, chia seeds and flax seeds have some differences in physical and technological properties. Chia seeds have a significantly smaller mass of 1000 grains and a true volume of 1000 grains than flax seeds.

We have found that chia seed has a higher stench, because it has a smaller angle of natural slump than flaxseed (25 degrees and 30 degrees, respectively). We also determined the coefficients of external fric-

tion in motion coefficients and coefficients of external friction of rest on different materials, characterizing the graininess of the grain mass.

Table 2

Results of the study of the physical and technological properties of flaxseed oil seed and seed chia

Characteristic	flax seed	chia seeds
Mass fraction of moisture, %	6,7	7,3
Nature (volumetric mass), kg/m^3	675	612
Weight of 1000 grains, g	5,62	1,34
The true volume of 1000 grains, cm^3	6,0	0,8
Spacing, %	22,3	63,6
Angle of natural slope, deg.	30,0	25,0
The coefficients of external friction of rest:		
on plastic	0,33	0,29
on the steel	0,33	0,26
by rubber	0,32	0,31
The coefficient of external friction in motion	0,46	0,35

We have studied granulometric characteristics of flaxseed and chia seeds. The study of dimensional characteristics is carried out with the necessary accuracy, as indicated by the mean error value δ, which does not exceed 5%. The geometric dimensions of the grains were determined by measuring the sample of 10−100 grains, since it is impossible and inexpedient to check the distribution law of the general set of random variables.

The shape, volume and surface of individual grains affect the density of their stacking during storage. These indicators are used in determining the sizes of capacities, diameters of gravity, material pipelines pneumatic transport, as well as in calculations of thermodynamic nature. So, for the estimation of the grain form, use the ratios l/a, l/b, a/b. The ratio of the surface of a ball F_k to a surface of a single grain F3 equivalent in volume, has been called spherical [11].

Changes in size affect such parameters as the grain size V, the area of the outer surface F, the sphericity *F* and the ratio of the grain V / F, is displayed on the grain size uniformity, and the latter, as is known, determines the efficiency of the process. These data allow us to determine the volume of grains V_g, the grain surface area F_g, the hydraulic radius rg and the equivalent grain diameter d_e. [11].

Determination of the specific surface a_0 (m^2/m^3), that is, the ratio of the surface of grains A to their volume V, for particles of irregular shape, presents considerable difficulties due to the complexity of determining the external and internal surfaces of the grains and the dependence on the coarseness [11].

The geometric parameters of the studied samples are shown in Table. 3

Table 3

Geometric indices of flax seed and chia seeds

Characteristic	flax seed	chia seeds
Geometric dimensions: length (*l*) width (*a*) thickness (*b*)	 3,82 2,02 0,98	 1,22 1,00 0,96
The amount of grain V_g, mm^3	4,23	0,80
The area of the outer surface F_g, mm^2	14,35	3,51
Sphericity ψ	0,28	0,61
Equivalent diameters d_e, mm	2,01	1,15
Specific surface area a_0 (mm^2/mm^3),	3,39	4,38

Analysis of the data showed that the seeds of flax have a larger grain size V_g, the area of the outer surface F_g, is equivalent to the diameter d, but the smaller specific surface of the grain a_0. The calculated basic geometric parameters of flax seeds and chia seeds allow to simulate the processes of ventilation, drying, to select the regime parameters of technological machines.

Conclusions from this study and further perspectives in this direction. The basic physical and technological properties of flax seeds and seeds of chia are determined - the mass of 1000 grains, the nature, the mass fraction of moisture, the angle of the natural slope, the coefficients of external friction in a state of rest and motion, abrasion, spariness that affect the storage and primary processing of grain.

The investigated physical and technological properties of flax seeds and chia will allow us to substantiate the rational technological scheme and regimes of its after-harvesting.

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ПОРІВНЯЛЬНА ХАРАКТЕРИСТИКА ХІМІЧНОГО СКЛАДУ ТА ФІЗИКО-ТЕХНОЛОГІЧНИХ ВЛАСТИВОСТЕЙ НАСІННЯ ЛЬОНУ ТА НАСІННЯ ЧІА

У статті наведено порівняльну характеристику хімічного складу та фізико-технологічних властивостей насіння льону та насіння чіа. Для організації високоефективного процесу первинної обробки і зберігання насіння чіа та насіння льону необхідне вивчення його фізико-технологічних властивостей із метою обґрунтування і розробки сучасних способів і режимів очищення і сушіння, які впливають на технологічні і споживчі якості. Результати дослідження фізико-технологічних властивостей насіння льону та насіння чіа дадуть змогу обґрунтувати раціональну технологічну схему і режими його післязбиральної обробки.

Ключові слова: *хімічний склад, насіння чіа, насіння льону, фізико-технологічні властивості, зберігання.*

СРАВНИТЕЛЬНАЯ ХАРАКТЕРИСТИКА ХИМИЧЕСКОГО СОСТАВА И ФИЗИКО-ТЕХНОЛОГИЧЕСКИХ СВОЙСТВ СЕМЯН ЛЬНА И СЕМЯН ЧИА

В статье приведена сравнительная характеристика химического состава и физико-технологических свойств семян льна и семян чиа. Для организации высокоэффективного процесса первичной обработки и хранения семян чиа и семян льна необходимо изучение его физико-технологических свойств с целью обоснования и разработки современных способов и режимов очистки и сушки, влияющих на технологические и потребительские качества. Результаты исследования физико-технологических свойств семян льна и семян чиа позволят обосновать рациональную технологическую схему и режимы его послеуборочной обработки.

Ключевые слова: *химический состав, семена чиа, семена льна, физико-технологические свойства, хранение.*