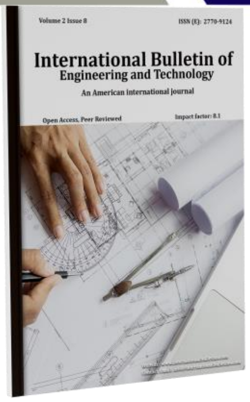

ANALYSIS OF RESEARCH METHODS CONDUCTED ON THE COMPOSITION AND FRACTIONATION PROCESS OF INDIGENOUS SOYBEAN SEEDS

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Abstrakt. The most important condition for obtaining high-quality soybeans is strict compliance with the technological requirements for each individual operation. Compliance with these requirements is possible only with the organization of on-farm quality control of soybeans during post-harvest processing. One of the ways to intensify the soybean aspiration process is the use of a grate with inclined holes in the aspiration zone and a selected fan to carry out the purification process from light and heavy impurities.

Keywords: technological process of aspiration, power, reliability, gas dynamics, hydrodynamics, aspiration, compressible liquids, mathematical models, physical models.

Аннотация. Важнейшим условием получения качественной сои является строгое соблюдение технологических требований на каждой отдельной операции. Соблюдение этих требований возможно только при организации внутрихозяйственного контроля качества сои при послеуборочной обработке. Одним из способов интенсификации процесса аспирации сои является использование решетки с наклонными отверстиями в зоне аспирации и отборного вентилятора для осуществления процесса очистки от легких и тяжелых примесей.

Ключевые слова: технологический процесс аспирации, мощность, надежность, газодинамика, гидродинамика, аспирация, сжимаемые жидкости, математические модели, физические модели.

Introduction: Soy - (botanical name of the genus Glycine) belongs to the legume family. Soybean seeds are spherical and oval, convex or flat, of a wide variety of colors and sizes. Of the large number of soybean species, only one (G. hispida) is cultivated. There are up to 600 varieties of soybeans. Soybean is cultivated on large areas in Russia, China, Korea, Japan, the USA and other countries. In Russia, the main soybean sown areas are concentrated in the Far East. Soybeans are cultivated in Moldova, Ukraine, Georgia and Krasnodaredge. Soya is one of the most valuable crops. Soybean seeds contain complete proteins and a significant amount of oil. Soy proteins have a high biological value and can largely compensate for the lack of animal proteins. A significant part of soybean seeds is processed to obtain vegetable oil and high-quality protein concentrates (from cake and meal).Soybean oil is used mainly in a refined form and as a raw material is used for the production of margarine. Lecithin is extracted from soybean seeds and oil,which is widely used in the manufacture of medicines, confectionery, margarine, textile and other industries that consume emulsifiers. Milk obtained from soybeans contains casein, which is used for the same purposes as animal casein.Of the four subspecies of soybean culture—Manchurian, Chinese, Japanese, and Indian—Manchurian is the most important. This subspecies includes the majority of soybean varieties cultivated in Russia.Currently, about 25 varieties of soybeans have been zoned in our country. The seeds of these varieties are oval, convex, of various colors, the weight of 1000 seeds is from 140 to 200 g.

Soybean seeds are covered with a seed coat, which makes up 5 to 10% of the seed weight. Soybean seed coats are rich in fiber and peitosan. They are usually used for livestock feed.

Soybean seeds are divided into types depending on the color of the shell:

Type I. Soy yellow. The color of the shell is yellow, different shades. The shape of the seeds is oblong-oval and rarely spherical. The surface of normal seeds is smooth, shiny or matte. The scar is light or colored (brown or black).

Type II. Soy green. Sheath color is green. The shape is oblong-oval and rarely spherical. The surface of normal seeds is smooth. The scar is light or colored (brown or black).

Type III. Soy brown. Sheath color is brown. The shape of the seeds is oblong or oval. The surface of normal seeds is smooth, shiny, rarely matte. The hem is light or dark.

Type IV. Soy black. Sheath color is black. The shape of the seeds is oblong-oval, rarely spherical. The surface of normal seeds is smooth, shiny or matte. The hem is light or dark.

Weed impurities in soybean seeds include: the entire passage obtained by sifting on a sieve with holes with a diameter of 3 mm, and from the exit from the sieve: mineral admixture (lumps of earth, sand, pebbles); organic impurities (parts of stems, pods, empty films);

seeds of all wild and cultivated plants; damaged soybean seeds spoiled by self-heating or drying, charred, rotten and moldy black.

Oilseed impurities include: broken soybean seeds; soybean seeds damaged during drying or self-heating, moldy, with a modified, non-black kernel; underdeveloped seeds, as well as germinated seeds, damaged by frost, obviously deformed, with a wrinkled surface, crushed and corroded, but not passing through a sieve with holes with a diameter of 3 mm.

Soybean seeds, split in half in the form of whole halves (cotyledons) with or without a shell, in an amount up to 5% inclusive, are classified as normal seeds, more than 5% - as an oil impurity. The quality of soybean seeds sold by the harvesting system to processing enterprises must not be below the restrictive standards.

Typically, soybeans are used as a raw material in the form of whole seeds, partially or fully defatted oilcake, or wholemeal for the manufacture of various soybean foods.

Whole seeds are used to make whole soy flour, dairy substitutes, fermented foods, and snack foods. Soy flour is also made from partially or fully defatted beans (cake/meal);

it is used to make baked goods, textured soy proteins, protein isolates and concentrates, extruded snacks, etc.

Methodology: For the preparation of various fermented and non-fermented soy foods, a whole range of physical, chemical and biological technologies or their combinations are used (Table 1). However, the choice of technology is determined by the type of product and how it is used.

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Table 1.
Exploring the Potential of Soy Foods: Technologies and Products (Fermented and Non-Fermented)

soybean shape	Technology	Products
Whole soybean seeds (direct food use)	Separation, soaking, blanching, boiling, drying, grinding, fermentation, extrusion, packaging, storage, sale	Whole soy flour, milk, tofu, ice cream, tempeh, sauce, sprouted and roasted soy snacks, extruded soy snacks, soy-fortified baked goods, fermented foods
Partially defatted soybeans (oil and meal)	Mechanical extraction, hardware cleaning, heat treatment, grinding, packaging, storage, sale	Butter, margarine, semi-skimmed soy flour, baked goods
Fully defatted soy (oil and wholemeal)	Solvent extraction, purification, hydrogenation, grinding, separation and concentration, packaging, storage, sales	Oil, hydrogenated oil, soy products, defatted soy flour, lecithin, soy protein concentrate, isolates and hydrolysates, specialty and diet foods
Soy by-products (husk, okara and whey)	Grinding, fermentation, separation, packaging, storage, sale	Fiber, single cell proteins, citric acid, enzymes, alcohol

Soy nuts are whole soy seeds that are soaked in water and roasted until brown. Like whole soy seeds, soy nuts are an excellent source of protein, fat, and isoflavones.

Soy nuts can be eaten as an alternative to peanuts, which are quite expensive and may contain aflatoxins.

Soy nuts provide more protein for less, and roasted soy nuts contain 60% less fat than peanuts.

Most common nuts are high in fat, while soy nuts are lower in fat and higher in protein (Table 2). They resemble peanuts in texture and taste, but are much cheaper.

Table 2.
Comparison of the nutritional value of nuts with soy nuts

Nut	Calories (in 100 g	Carbohydrates, %	Fats, %	Proteis, %
Almond	618	26,4	53,6	15,4
Cashew	607	18,2	49,3	31,8
soy nuts	500	28,2	26,4	37,1
Peanut	607	25,0	53,6	17,9

Many soy products, including roasted soy nuts, tofu, tempeh (a fermented cheese-like product made from soybeans), textured vegetable protein, and soy milk, are rich in calcium. The calcium contained in soy products is easily absorbed by the body.

The process of preparing soybeans for oil pressing/extraction is to prepare the seeds using a mechanical method, a solvent, or a combination of both methods. As far as possible, husks and other impurities should be removed from the kernels or pulp of the seeds. Typical processes associated with the preparation of seeds, and their goals are given in

Table 3

Basic Typical Processes for Preparing Seeds for Oil Extraction

Sample Process	Target
cleaning	Removal of foreign impurities from the mass of seeds. Includes removal of plant tissue, pebbles, dust, etc., to protect processing equipment, allows the production of high quality soy product
Drying	To effectively remove soy hulls, the moisture content should not exceed 10%, therefore, soy must be dried before cleaning
splitting	Splitting is necessary in order to break the soybean seeds into small pieces before shelling and flattening. In this case, 4–6 fragments of cotyledons are obtained from one seed, and the husk is separated by sifting. The bran obtained in the process is added to the flour prepared for oil extraction. This allows you to increase the yield
Reduction to the required conditions	The split soybean groats/mass is brought to the required conditions using heat and moisture to obtain the optimal plasticity required for the production of soy flakes from which oil is obtained. Steam heating raises the moisture content to approximately 11%
Flattening on rollers	Conditioned soybean grits are pressed to a thickness of 0.25–0.37 cm. This improves the passage of the solvent through the layer, which improves the penetration of the solvent. Flattening also reduces the diffusion distance that the solvent or micelle (mixture of oil and solvent) travels during oil extraction.

The preparation of high quality grain and fodder seeds is essential in the agricultural production system.

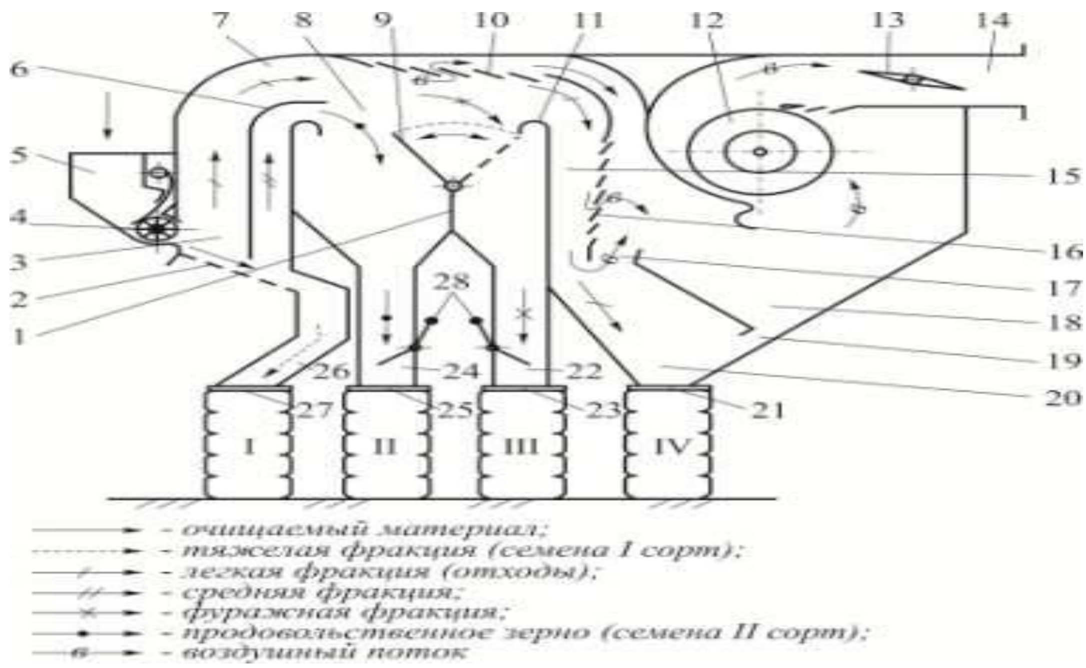
Isolation from the total mass of the largest seeds of uniform size using sieves allows you to increase the yield due to more friendly seedlings, an increase in the number of stems and the mass of a thousand grains [1, 2].

The most common and effective way to clean seeds from impurities is air treatment. Pneumatic separators are used at all stages of seed cleaning, both as part of complex air-sieve grain and seed cleaning machines, and as separate pneumatic separators.

The main technological disadvantage of the SP-4U-R pneumatic separator is the inability to separate seed material into seeds of the first and second grades, forage fraction and waste in one pass.

SUBSTANCE: pneumatic separator contains a frame, a diametral fan, a pneumatic separating channel (PSC), a separating and sedimentary chamber, an inertial louvered-counterflow dust collector devices for extracting material fractions, regulating the supply of material and air flow speed, mechanisms for driving working bodies (Fig. 1).

Air flow rate in



The air flow rate in the pneumatic separating channel 3 is set according to the quality of cleaning the heavy fraction (seeds of the first grade), taking into account the loss of valuable seeds to waste (IV) using the throttle valve 13

The purity of the seeds of the second grade is regulated by the position of the rotary valve 9. To increase the purity of the seeds, the valve 9 is turned towards the outlet 7, and to reduce the content of full-fledged grain in the fodder fraction - towards the adjacent wall 11 The supply of material to the pneumatic separator is set by the damper-vibrator of the input device 4 in accordance with the required seed quality.

Fig. 1. Technological scheme of the fractional seed pneumatic separator:

1 - partition; 2 - reference grid; 3 - pneumatic separating channel; 4 - input device; 5 - receiving hopper; 6 - solid dividing wall; 7 - withdrawal of PSK; 8 - separation chamber; 9 - rotary valve; 10 and 16 - horizontal and vertical sections of the louvre cleaner; 11 - adjacent wall; 12 - diametral fan; 13 - throttle valve; 14 - outlet pipe; 15 - inertial louvre-countercurrent dust collector; 17 - counterflow cleaner; 18 - air outlet chamber; 19 - bypass window; 20 - sedimentation chamber; 21, 23, 25, 27 - devices for extracting material fractions; 22, 24, 26 - material pipelines; 28 - dampers; I, II, III, IV - bags with fractions of seeds of I and II grades, feed grain and waste

The research methodology included the following sequence (Table 4).

1. The pneumatic separator was adjusted to the nominal flow rate, taking into account the cultivated crop - 1.4 t/h. The air flow rate was set on the basis of the required purity of grade I (99.0%) with an acceptable loss of valuable oat seeds to waste (no more than 3.0%).

2. When the machine was operating at a nominal feed rate, average samples of the initial material, seeds of I and II grades, feed fraction and waste were taken according to GOST 12036-85.

3. Using the method of cross division, samples were isolated from average samples to determine their quality.

4. Under laboratory conditions, each sample was disassembled and the following indicators were determined: the weight of 1000 grains according to GOST 12042-80, the purity and loss

of seeds according to GOST 12037-81, germination and germination energy according to GOST 12038-84.

Table4.

Indicators	Raw material	Received fractions			
		I grade	II grade	fodder	departure
Waste. %: - feeble and small grain;	2,57	0,60	1,75	3,05	19,1
Weight of 1000 seeds, g	41,82	43,90	38,80	37,20	28,40
Fraction yield, %		82,40	10,40	4,20	3,00
The content of the main culture,%	97,04	99,20	98,02	96,68	74,30
Loss of seeds to waste, %					2,2

Thus, reducing the number of passes of seed material through the air separator reduces the given costs. Based on the results of the research, the following results were obtained (Table 5):

Таблица 5.

culture		Ref. material	II faction	III faction	IV faction	V faction	Aspiration
Soya	Purity,%	84,2	99,9	99,1	79,3	-	-
	Fraction share,%	100	60	21	6	9	4

Thanks to the separation, soybean seeds are brought to a condition, which allows them to be used for processing and sale, both in domestic and foreign markets.

Conclusions.

Isolation of heavy and medium fractions of seeds with the help of pneumatic separators improves their processing and improves the quality of seeds.

However, when choosing a grain separator, you should pay attention not only to its power indicators - there are a number of other characteristics that need to be taken into account when choosing the type and model of the separator, which would be the best suited for your operating conditions. These are:

the quality of the cleaning;

the possibility of calibrating depending on the specific gravity;

design features that make it convenient to operate and maintain the projectile;

establishment of the maximum allowable values of contamination or moisture content of raw materials;

reliability and durability of equipment - these characteristics are determined by the quality of materials, components and parts that make up the separator;
a list of crops, the processing of seeds of which is possible with the help of this product;
sieves have a self-cleaning system.
the possibility of installing sieves with perforations of various shapes.
increased screen area (separation area), up to 18.0 m2
Removable clamping bars, viewing windows and hatches provide access to the screens for easy separator maintenance.
Adjustable cleaning modes make it possible to achieve the requirements of GOST in one pass: no more than 2% of weed impurities and no more than 10-25 pieces of other seeds per kilogram of soybeans.
In the process of cleaning with warm air, the grain is dried (up to 2% per pass), which is also important for soybeans, which have high hygroscopicity (the ability to absorb and release vapors from / to the environment).
And so, soy should be unheated. It should not contain castor seeds. Soy should not be infected with granary pests.
Soybean infected with a tick is stored separately and subjected to cleaning until complete disinfection.
Weeds: mineral impurities (pebbles, slag, ore); parts of leaf stems, bean shells; spoiled and rotten soybean seeds, seeds eaten by pests of grain stocks; frosty, feeble and green grain; crushed seeds; sunflower, etc..

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