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INVESTIGATION OF THE COEFFICIENTS OF THE EXTERNAL AND INTERNAL FRICTION OF THE HAZELNUT KERNEL, AS WELL AS THEIR DEPENDENCES DENSITY AND HUMIDITY

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Abstract.

Food additives are substances that are added to give them properties necessary during their preparation, transportation or storage, such as aroma (flavor), color (dyes), shelf life (preservatives), taste, texture, etc. [1,2]. The main goals of adding food additives to food products and drinks are: creating new technologies for processing, preparing, packaging, transporting and storing food raw materials or improving existing ones, increasing the stability and resistance of food products and drinks to influences that can impair their quality, creating and maintaining the structure of food products, changing (in the direction of improvement) or maintaining the organoleptic properties and appearance of food and beverages.

Food additives are divided into four groups: taste and aroma regulators of food products (flavoring agents that enhance taste and aroma, sweetening, acidifying, replacing salt, sugar and acids) or additives that improve the color of food and drinks (color stabilizers, dyes, bleaches); additives that regulate the consistency of products and form their density, contributing to an increase in their shelf life; additives that extend the shelf life; additives that improve the storage of products, prolonging their shelf life (antioxidants, preservatives, protective gases, moisture protective agents, stabilizers); additives, enzyme preparations, extractants, softeners, conditioners, defoamers, desiccants, etc., which facilitate and accelerate the flow of technological and biotechnological processes).

Most food additives have complex technological functions [3]. They manifest themselves depending on the nature of the food system to which they belong. The above classification is based on those technological properties of food additives that are not related to compounds and substances that increase the nutritional value of food. Food additives also include “non-nutritional additives.” They are usually added to food in small amounts, usually to improve texture, taste and appearance, and to increase shelf life.

Hazelnuts are distinguished by a high content of kilocalories of energy. Due to its high nutritional value, it plays an important role in nutrition. Hazelnuts have the properties of long-term transportation and can be stored in large volumes. Despite the fact that this product is rich in proteins, fats, acids, vitamins, minerals, it does not contain cholesterol. Nuts are widely used in the food industry, especially in confectionery and various food products, in the production of baby food. Hazelnut oil has found application in medicine and perfumery, painting, and the production of paints and varnishes. Secondary

material resources of hazelnut processing (coal) are used in fine arts, and its wood is used in furniture production. The bark and leaves of the tree are rich in tannins.

Keywords: hazelnut kernel, drying process, roasting, humidity, friction

Introduction. Eliminating the deficiency of complete proteins and vitamins is the main priority in improving the nutrition of the country's population [4]. Currently, livestock products such as milk, eggs, poultry, beef and lamb, fish, etc. are considered the main source of protein. However, these products are not included in the diet of a significant part of the population to a sufficient extent, and this is often associated with food culture, the high cost of products and, in some cases, with the region and lifestyle [5].

In view of the foregoing, research is underway to find a relatively inexpensive source of plant materials with a high protein content [6]. At the same time, special attention is paid to the oranoleptic characteristics of the product and its vitamin-mineral complex. In this regard, walnuts, hazelnuts, ground walnuts, etc., have hardly been studied in the aforementioned direction, despite the fact that they are attractive as a food supplement and an object of study.

Among fruits with shells, hazelnuts occupy a special place. We can say that the processing of this product in the food industry is considered waste-free. As a result of hazelnut processing, all products obtained from it are sold. Also, from an economic point of view, interest in hazelnuts in the world is constantly growing. Given the above, it is of interest to study the technological and technical improvement of the process of drying and roasting hazelnut kernels.

Purpose of the research. The aim of the study is to study the appearance of the kernel, the taste indicators of the commercial quality of the kernel during drying and roasting of the hazelnut kernel. During drying, an increase in the amount of oil, acid and iodine contained in the kernel should not be allowed. Otherwise, this reduces the marketability of hazelnuts [7]. This, in turn, leads to a loss of purchasing power.

The drying and roasting process must be carried out in such a way that the moisture contained in the kernel can be removed without damaging the product.

Research method. Among the structural and mechanical properties of nutrients, their adhesive and frictional properties occupy a special place. Friction properties are recorded at the border of the food material. They are characterized by mutual influence when moving relative to each other. External friction refers to frictional properties, in other words, it is the resistance to the movement of the surfaces of two solid bodies relative to each other. It depends on their stickiness and some other factors. There are two types of friction: static - before the start of movement and dynamic - in the process of movement of the product along the surface of the tray [8].

There are several types of frictional contact between two materials: elastic deformation, plastic compression, shear or splitting, cohesive and adhesive failure. In the process of friction of two materials, the simultaneous presence of five types of frictional contact at different points of contact is possible. The classification of methods for determining the coefficient of friction is based on the kinematic and geometric principles of the interaction of food products and friction surfaces [8].

The hazelnut external friction coefficient is determined on an experimental setup. For the experiment, batches of 8...10 samples were formed. The raw material particles had a smooth surface and the same mass. Cracks on the surface of the product are not allowed.

The coefficients of internal and external friction of each sample were determined by the following formula. The average numerical value of each coefficient was calculated from the results of a number of repeated experiments:

$$\bar{f} = \frac{1}{n}\sum_{i=1}^{n} f_i \,, \qquad (1)$$

Where: **i**- is the serial number of the sample (experiment);

n- is the total number of samples (experiments).

The values of the coefficients of the internal ($f_{middle\ external}$) and external ($f_{middle\ interior}$) the friction of raw materials are shown in Table 1.

Table 1. Coefficients of internal and external friction of hazelnuts

№	Humidity, %	Frictioncoefficients	
		External, $f_{middle\ external}$	interior, , $f_{middle\ interior}$
1	21	0.649	0.523
2	18	0.641	0.494
3	15	0.634	0.475
4	12	0.622	0.461
5	9	0.603	0.453
6	6	0.587	0.439
7	3	0.570	0.418

Important characteristics are the coefficients of external and internal friction. They reflect the physical and mechanical properties of plant materials. The determination of these coefficients makes it possible to organize a hydrodynamic regime that ensures uniform movement of the product with minimal friction and the associated intensification of the drying process.

f=ϕ(w) An analysis of the values f=ϕ(w) (Fig. 1) shows that the coefficients of external and internal friction increase with increasing humidity. This is explained by the fact that the elastic contact turns into plastic contact, the contacting surfaces have an increased resistance to the relative movement of the surfaces. Mathematical processing of the results of the experiment was used to determine the dependences of the coefficients of internal and external friction of raw materials on steel on moisture content (the value of the approximation reliability was R2=0.9558 ÷ 0.9995).

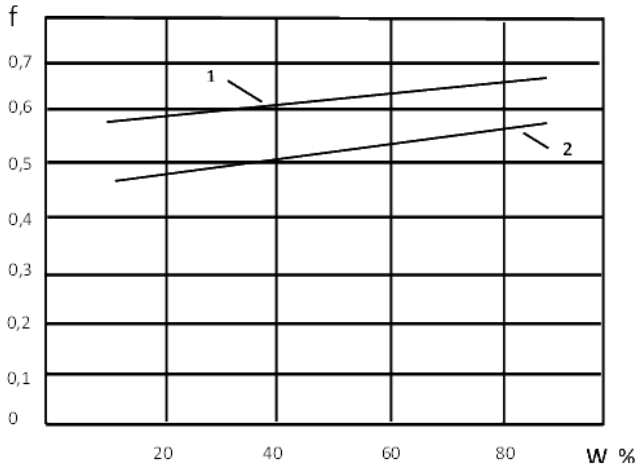

Figure 1. Change in the coefficients of external (1) and internal (2) friction (F) of hazelnuts depending on humidity.

$$f_{middle\ external} = 0{,}0011\,W + 0{,}5614 \qquad (2)$$

$$f_{middle\ interior} = 0{,}0013\,W + 0{,}4497 \qquad (3)$$

The obtained values of the coefficients of external and internal friction make it possible to calculate the strength criterion, which is an analogue of the Euler number. This, in turn, makes it possible to select a dryer fan of the appropriate power. The selected fan makes it possible to ensure the movement of raw

material particles over the mesh surface with less friction of the product on the fluidized bed and improve the quality of the finished product.

Density and moisture content of hazelnuts were determined with a Thermo Scientific ATC (2) pycnometer and were 39.81% and 5%, respectively. The methodical sequence was as follows: the experimental sample is placed in the second chamber of the device, the reference chamber of a known volume is filled with helium; the connecting valve opens, the sample passes into the measuring chamber of a known volume of gas; the reading of the pressure sensor is taken; a material balance equation is drawn up; the volume of the studied material is determined; the actual density of the test material is determined.

Figure 2. Pycnometer ATS

The values obtained for the raw material density are as follows: density 1153.4 kg/m^3 at a moisture content of 39.81%; density 1239.0 kg/m^3 at 5% humidity.

Some technological indicators of hazelnuts in comparison with characteristic varieties are as follows:

kernel yield: “atababa” – 57.95%; “Kudryavchik” - 53.56%; “fatty hazelnuts” -47.32%;

core weight: “atababa” - 0.623 g; “Kudryavchik” - 1.61 g; “fatty hazelnuts” -0.794 g.

The chemical composition of the nucleus can be characterized as follows - protein: “atababa” – 16.15%; “Kudryavchik” -17.18%; “fat hazelnuts” -15.76%; lipids: “atababa” – 69.04%; “Kudryavchik” -60.44%; “fat hazelnuts” -72.52%; ash: "atababa" - 2.19%; “Kurdryavchik” -2.27%; “fatty hazelnuts” -2.15%; sugar: "Atababa" -15.39%; “Kurdryavchik” -22.03%; “fat hazelnuts” -19.65%; starch: "Atababa" - 46.51%; “Kurdryavchik” -44.8%; “fat hazelnuts” -50.57%; polysaccharides: "atababa" - 38.1%; “Kurdryavchik” -33.17%; “Fat Nut” -29.78%. In the studied varieties, the lipid content ranges from 60 to 72.52%, and the proportion of soluble carbohydrates ranges from 9.75 to 20.1%.

Conclusion.

1. The moisture contained in the hazelnut kernel affects the density of the product during the frying drying process. Density 1153.4 kg⁄m^3 − at humidity 39.81%; density 1239.0 kg⁄m^3 − at 5% humidity.
2. Some technological indicators of hazelnuts are typical for different varieties.
3. According to the output of kernels: "Atababa" - 57.95%; "Kudryavchik" - 53.56%; the named varieties of hazelnuts are most appropriate to grow on the territory of the Republic of Azerbaijan.

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