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Determining the Dependencies between Drum-Type Working Body Parameters

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Abstract. Citrus fruits are famous for their ever-increasing consumption all over the world. Among them, walnuts, hazelnuts, pistachios, almonds, peanuts, and pine nuts are the most popular among consumers. Currently, it is considered more profitable in Azerbaijan to grow hazelnuts and walnuts than hard fruits. Nuts are grown in almost most regions of our country. Hazelnuts are produced the most in our country, among these fruits. The development of this sphere has been repeatedly mentioned by the state in special speeches in Azerbaijan as a separate issue. The Head of State noted that more attention is being paid to this area, Taking into account the relevance of the issue, this research paper proposes a justification for effective technological and technical parameters for the preparation of high-quality hazelnut kernels that meet the requirements of the food industry. Basically, we were tasked with investigating the physical and mechanical properties of the kernel, shell and shell of hazelnuts, as well as developing theoretical justifications for the process of cleaning the core from the shell and shell of fruits;

***Keywords*.** Agriculture, hazelnuts, physical and mechanical properties of the kernel, process of cleaning the core

1.Introduction.

The richness of the nutrition structure of the country's population with more biologically valuable food products, such as meat, meat products, milk, dairy products, fish, fish products, eggs, vegetable oils, fruits, is still below the level of medical standards. As a result of the created nutrition structure, a violation of the nutritional status comes to the fore: a lack of animal proteins against the background of an excess of animal fats, a lack of unsaturated fatty acids, most vitamins, a number of minerals and trace elements, a lack of food tissues, in this regard, human trace elements (vitamins, trace elements, unsaturated fatty acids) are in the first place in terms of the degree of negative impact on health. Their deficiency is primarily due to a violation of the antioxidant defense system and the development of immunodeficiency causes a sharp decrease in the body's resistance to adverse environmental factors. The solution to this problem is reflected in State programs as the main concept of state policy in the field of healthy nutrition of the population [1]. The concept is aimed at their rational and healthy nutrition, taking into account the traditions and habits of the population, the economic situation, medical regulatory requirements, as well as creating conditions to meet their needs for unsaturated fatty acids, a full range. vitamin complex, the introduction of micro-macronutrients is confirmed by theoretical studies [2]. However, it is very important that food products consist not of artificial mixtures, but of natural food components necessary for life. In this regard,

the use of oilseeds as a food ingredient, including hazelnut kernels, is considered a promising area of practical solution to the issue of creating a food diet. [3]. So, in addition to the attractive taste qualities, the hazelnut kernel contains the main nutritional components: proteins, fats (80% unsaturated fatty acids) and carbohydrates. This product is also rich in minerals and has vitamins A, B1, B2, PP, C [4]. In the system of effective nutrition of the population, an important place is occupied by the problem of replacing fat-and-oil components obtained from animal products with vegetable ones in prepared food products. In this regard, it is convenient to use raw materials with a favorable biochemical composition, including hazelnuts. This product also contains 60...65% of lipids, essential fatty acids, tocopherols and biologically valuable proteins [5,6]. If we take into account the cultivation of valuable local and introduced varieties of hazelnuts in large areas of the republic, the state's concern for the development of this sphere, as well as the growing interest of producers, then we can see the great potential of these products in the food industry and in the production of biologically active additives in the country. At the same time, it should be noted that the hazelnut kernels produced in Azerbaijan are competitive in the foreign market due to their quality and are among the priorities that bring foreign currency into the country.

Currently, about 35 thousand tons of hazelnuts are produced annually in our republic. In general. More than 25 thousand farming families, uniting about one hundred thousand people, work in the field of hazelnut cultivation. According to statistical data, in 2013, the sown area of hazelnut tree fruits in the republic amounted to 34,330 hectares, including 28,571 hectares in fruiting age, production of 42,263 tons, yield of 18.2 sen/ha [5]. According to the same statistics, the sown area of hazel trees in all farms of Azerbaijan amounted to 298 thousand hectares, at the fruiting age of 24.8 thousand. ha, yield - 32 thousand tons, yield - 12.5 cents/ha. Among the economic regions of our republic, the Sheki-Zagatala economic region occupies the first place in the production of hazelnuts. The acreage of walnut orchards in this economic area is 23,682 hectares. Of these, 20,378 hectares were in fruiting age, the hazelnut harvest was 24,906 tons, the yield was 12.1 sen/ha [7]. The data is shown in table 1.

Table 1. Indicators of hazelnut production in the regions of the Sheki-Zagatala economic region

s/s	**the Sheki-Zagatala economic region**	**Total acreage, ha**	**Including fruiting, ha**	**Hazelnut production, ton**	**Productivity, sen/ha**
1	Balaken	4424	3488	3873	11,1
2	Zagatala	9418	8336	9895	11,9
3	Gakh	3952	3766	3393	9
4	Sheki	372	248	597	16,5
5	Oghuz	1955	1385	1026	7,4
6	Gabala	3561	3195	6122	19,1
	Total:	23682	20378	24906	12,1

As can be seen from the table, among the six districts of the Sheki-Zagatala economic district, the largest sown area in the Zagatala district was 9418 hectares, including 8336 hectares in fruiting age, and crop production amounted to 9895 tons. In the Sheki district, the sown area is at least 372 hectares, including 248 hectares at the age of fruiting, despite the yield of 597 tons, it ranked second among these six districts in terms of yield - 16.5 sen/ha. At the same time, in the Gabala district, which occupies the fourth place in terms of sown area, the sown area amounted to 3,561 hectares, including crop production - 6,122 tons, yield - 19.1 sen/ha. If we apply the experience of the most productive Gabala region of this economic region of our republic to other regions and achieve the production of 19.1 quintals per hectare, then the yield of this economic region will increase by more than 1.5 times. The Sheki-Zagatala economic region has natural and climatic conditions and opportunities to achieve the so-called hazel indicators and greater productivity [10].

Although the yield of the kernel of this walnut is 52%, processing enterprises calculate the yield of the kernel as 45% and buy fruits at a low price of 2 manats at the time of harvest, and in subsequent months at a slightly higher price. They sell the purchased fruit kernels 5-6 times more expensive and make a big profit. If farmers sell their crops after processing them into grains, their profits will be at least 5 times higher. Today, farmers themselves are very interested in buying kernels.

2.The purpose of the study.

• investigation of the physico-mechanical properties of the kernel, shell and shell of hazelnuts;

• development of theoretical justifications for the process of cleaning the core from the shell and shell of fruits;

3.Research methods.

Experimental studies were conducted in accordance with existing standards in laboratory conditions using the theory of multifactorial experiment planning based on generally accepted and specially developed techniques.

An experimental drum device (Fig. 1) that separates the hazelnut core (kernel) from the hard shell, developed on the basis of the working hypothesis, was taken as the research object..

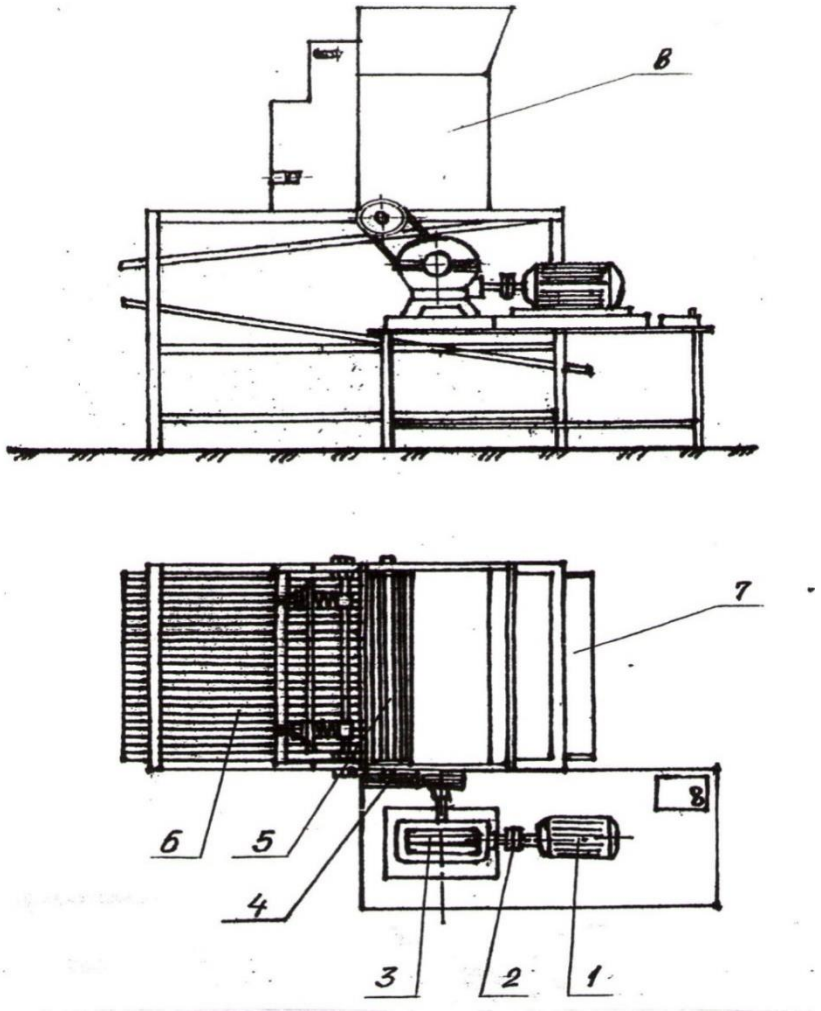

Figure 1. An experimental device that separates the hazelnut kernel from the shell:

1-electric engine; 2-clutch; 3- endless screw reducer; 4 – belt transmission; 5-drum that breaks the shell of nuts; 6-halbir; 7-shell removing plate, 8-shell nut hopper.

The device consists of an electric motor – 1, a clutch – 2, a worm gear reducer – 3 and a belt drive – 4, a drum that breaks the nut shell – 5, a cutter that separates the shell from the shell – 6, a plate that removes the shell – 7 and 8 - consists of a hopper of shelled hazelnuts. Here, the main working organ role is taken by drum and khalbir. We use the report scheme (Fig. 2.) to determine the dependencies between the parameters of the organ that breaks the shell of the nut. This. It consists of a drum and a drum under the drum rotating with an angular velocity ω. There is a certain gap between the drum and the sub-drum with a diameter of D. At this time, pushing forces perpendicular to the surfaces of the drum and drum base (drum - N_1 and drum base - N_2) and tangential friction forces F_1 and F_2 will act on the cross section of the "b" size nut. The real reaction forces of the drum and the drum base will be inclined by the angle φ from the norm.

Here, when the surfaces are of different material and quality, the friction angles in "nut - drum" and "nut - sub-drum" pairs will be different, and will be equal to $\varphi_1$and φ_2, respectively.

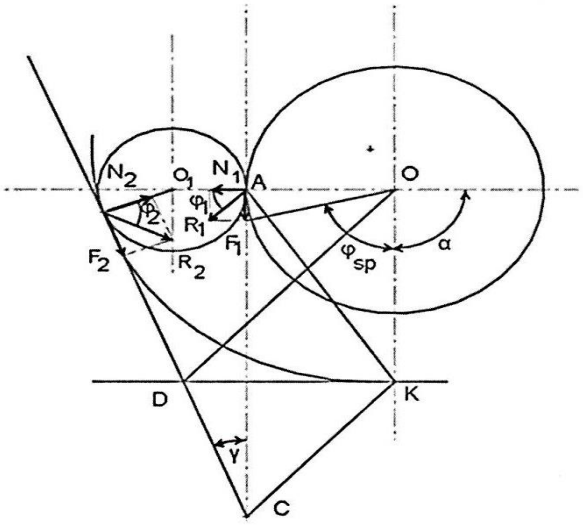

Figure 2. Report scheme of the shell breaker

Considering the angle γ formed between the touching perpendicular axes, it can be concluded that this angle characterizes the state of operability of the selected mechanism. In other words, the angle γ must be less than any angle of the friction cone ($2\varphi_1$or $2\varphi_2$) so that the nut is picked up by the drum and subsequently destroyed. In other words, the angle γ must be less than any angle of the friction cone ($2\varphi_1$or $2\varphi_2$) so that the nut is picked up by the drum and subsequently destroyed. Since the shape of the drum base has the shape of a logarithmic spiral, it will be located below the point "A" where the nut contacts the base of the drum. To simplify the calculation, assume that the cross section of the nut is a circle with a diameter of "d". The drum with a diameter of D_b rotates counterclockwise with an angular velocity of ω_b. Considering that the destruction of the nut shell occurs over 900 revolutions of the drum [6], the limits of the technological gap are determined [15]: The size "b" is determined by the size of the nut;

- The size of "d" is determined by the size of the core;
- The sizes "b" and "d" are determined by the results of research.
- $\Delta\, DCK$and $\Delta\, AKO$ is similar, and the angle γ has the following form:

$$\gamma = \pi - \alpha - \varphi_{SP} \qquad (1)$$

where α - the angle of rotation of the starting radius of the logarithmic spiral

φ_{SP} – the angle between the initial radius of the logarithmic spiral and the tangent drawn to this point.

To determine geometric dependencies, we draw up a system of equations for point "B". So, this point is common to both the circumference of the nut and the logarithmic spiral (drum roll) (Fig. 2.).

With the center at the point O_1 -, we bring the equation of the circle to the common center to the center "O" [15]

where X_0 – distance between centers, $x_0 = \frac{D_b + d_f}{2}$

The equation of a logarithmic spiral in polar coordinates is as follows:

$r = r_0 e^{k\alpha}$ (2)

where r_0 - starting radius of the helix

k – scale parameter

$r_0 = \frac{D_b + d}{2}$ (3)

$x_0 - in \;\; r_0 - a$ replacing the ratio with λ, or get $\frac{x_0}{r_0} = \lambda$

$k = \frac{\ln\frac{\lambda}{2}\cos\alpha}{\alpha}$ (4)

$$k = ctg\varphi_{SP}$$

Thus, the conditions for the interaction of geometric parameters are obtained. They were used to determine the optimal size of the developed device for breaking hazelnut shells. By projecting forces in the direction of the nut axis, it can be determined that in order for the nut to be captured and broken by the drum without taking into account deformation, the following condition must be observed [17]:

$F_1 \cos\alpha_1 + F_2 \cos\alpha_2 \geq N_1 \sin\alpha_1 + N_2 \sin\alpha_2$ (5)

there,

$F_1 = N_1 tg\varphi_1$ and $F_2 = N_2 tg\varphi_2$ (6)

Where

$\varphi_1 \; and \; \varphi_2$ – are the friction angles on the drum and under-drum surfaces. We get their values if we use them in the previous expression:

$N_1 tg\varphi_1 \cos\alpha_1 + N_2 tg\varphi_2 \cos\alpha_2 \geq N_1 \sin\alpha_1 + N_2 \sin\alpha_2$ (7)

In the given case, the angles $\alpha_1 \; and \; \alpha_2$ can be taken as the same (α). Thus, the points of contact between the nut and the drum and the bottom of the drum are determined by the force of gravity and are on the horizontal line. From here, the condition of catching the nut to crack is as follows:

$tg\varphi_1 + tg\varphi_2 \geq 2tg\alpha$ (8)

Otherwise, the process does not occur. In other words, if the cross-sectional diameter of the nuts, characterized by the angles $\varphi_1 and \; \varphi_2$, exceeds the required size, they will jump out of the capture zone.

Considering that the cross-section diameter is very scattered due to its size, the presence of additional protrusions on the drum increases the value of the angle α_1- to α_1 (while α_2 remains unchanged), which means that the friction angles $\varphi_1 and \; \varphi_2$ decrease, the nuts are not subjected to the breaking process conditions for the eclipse are significantly improved. In other words:

$\text{tg}\; \varphi_1^1 + tg\varphi_2 \gg 2\left\{tg\alpha_1^1 + tg\frac{\alpha_2}{2}\right\}$ (9)

α – The value of the angle depends on the geometric dimensions of the drum, the cross-sectional size of the nut, the gap, the distance (a) between the exact contact points of the drum and the nut, i.e. the condition that the nut is not compressed. According to the reporting scheme (fig. 2).$\cos\alpha = \frac{2OA}{D}$

$$OA = \frac{D}{2} + \frac{a}{D} - \frac{b}{D} \quad (10)$$

Because it is

$$\cos\alpha = 1 + \frac{a}{D} - \frac{b}{D} \quad (11)$$

From here, it is possible to reliably crack nuts of cross-sectional size "b" under the following conditions:

$$a \leq b - D\,(1 - \cos\varphi) \quad (12)$$

From this inequality, it follows that the gap is determined by the size "b".

By increasing the gap to a certain value, the ability of the drum to introduce nuts into the breaking process increases. However, in this case, the nut holding zone can have a large arc size. This size should be such that Let it serve to break the shell and separate the kernel by squeezing the nuts.

As can be seen from theoretical considerations, the productivity of the device that separates the hazelnut kernel from the shell depends on the ability of the drum to catch the hazelnut and enter it into the process. Here, the nuts should be fed evenly to the compression zone, and clogging at the entrance to the working zone should be prevented.

The drum plays an important role in the construction of a nutcracker with a drum slot. Therefore, it is necessary to analyze the constructive parameters. These parameters include the diameter, length, width and wall thickness of the drum.

The length of the drum can be determined by the formula given by M.A. Berezi [10] with reference to G.T. Pavlovsky:

$$L = \frac{53\,Qa}{DZ\delta\varepsilon_y n} = \frac{2{,}7Qa}{Z\varepsilon_y v_b} \quad (13)$$

where Q – device productivity, kg/hour;

a – the presence of hazelnuts in nests, %;

D – diameter of the drum, m (D = 2R);

Z – number of slots per $1m^2$ of drum surfaceМесто для уравнения.;

δ – drum wall thickness,m;

ε_y – nest surface utilization factor;

v_b – the peripheral speed of the drum, v_b=0,25 ... 0,8 m/sec is assumed;

n – the number of cycles of the drum, sec^{-1};

In these devices, the nuts are directed to the surface of the rotating drum and fall into the slot under their own weight and are transported to the breaking zone. Since the slots are conical with both sides open, they do not pass through the slot and move together with the drum towards the clamping plate. Here, the shape and size of the nests of the drum should be selected according to the shape and size of the hazelnut variety grown in the zone. As for the number of nests, they should be determined depending on the required productivity, the width and diameter of the drum.

The number of slots on the surface of the drum can be calculated using the following formula:

$Z = \frac{4BD\varepsilon_b}{d^2}$ (14)

where B – working width of the drum, m;

D – diametr of the drum, m;

ε_b – drum surface utilization factor;

d – the diameter of the nut (it is equal to the diameter of the slot on the outer surface of the drum), m.

The drum surface utilization factor is defined as follows:

$$\varepsilon_b = \frac{S_{deş}}{S_y} = \frac{\pi d^2}{S_y} = 0{,}785 \quad (15)$$

where $S_{deş}$ – the area of the hole in the elementary slot (the area of the hole selected according to the size of the nut), m^2;

S_y – area of the nest, m^2;

We define the area of the conical socket (S_y) as the area of the truncated cone:

$$S_y = (r_1 \cdot r_2)l \quad (16)$$

where r_1 – the radius of the cone's circumference, m;

r_2 – the radius of the small circle of the cone, m;

l – the height of the nest (centers of the sole and small circles

distance between), m;

Taking into account the distance between the cells, the area needed for one cell can be calculated using the following formula:

$$S = \pi r^2 + k_ə \quad (17)$$

where $k_ə$ – additional coefficient ($k_ə = 2 - 3$),

πr^2 – the area of the circumference of the slot on the drum surface corresponding to the size of the nut, m^2;

The optimal step between cells is as follows:

$$t = 2r + k_ə^2$$

The diameter of the drum can be determined as follows [13]:

$$D = \frac{4 \cdot \vartheta_b^2}{\pi^2} \quad (18)$$

Where

ϑ_b – peripheral speed of the drum ($\vartheta_b = 0{,}25 - \frac{0{,}8m}{san}$ m/sec is accepted), m/sec.

Based on the received prices, it is possible to choose the appropriate pipe for the drum production in accordance with GOST 10704 – 91 [12].

Drums for slotted construction, the width of the drum surface can be determined based on the condition of the number of slots along the row:

$$B = \frac{n_y}{\pi D} \cdot t\,, \quad (19)$$

where n_y – number of cells in one row ($n_y = 3 \ldots 7$ units are taken depending on productivity, number;

D – diametr of dram, mm;

t – inter-slot optimality problem, mm.

The thickness of the drum can be determined by the following formula:

$$\delta = \delta_k + C, \quad (20)$$

where δ_k – the thickness of the drum wall determined according to the strength reporting norms, mm;

C - addition (technological and operational), C=2.

The strength standard and the report method are adopted according to GOST 14249-89-a [11].

4. Research results

4.1. investigation of the physico-mechanical properties of the kernel, shell and shell of hazelnuts;

This article analyzes [4] the mechanical properties of the shell and the kernels are useful experimental data to improve the efficiency of machines for the selection of substandard and damaged hazelnuts, as well as to improve the numerical simulation of the anisotropic behavior of hazelnuts. The procedure for the experimental determination of the physical and mechanical properties of hazelnuts is described, and optimized shapes of samples for obtaining stresses before destruction and values of the elastic modulus of the core and shell are determined. The technique was applied to the commercial launch of Italian hazelnuts, and the mechanical properties of both the kernel and the shell were obtained experimentally on samples made from healthy and damaged hazelnuts. But the authors superficially conducted research on the physico-mechanical properties of hazelnut shells. In this study, [6] a high-precision network structure based on deep learning was used to distinguish the “whole kernel” of hazelnuts from other varieties such as “damaged kernel”, “shell” and "stunted”, which are present in small quantities after mechanized sorting and then undergo manual sorting. As a result of training using Imagenet weights, the highest test accuracy was calculated, equal to 99.28%, for the EfficientNetB2 and EfficientNet B3 structures. Although both networks produce the same result when classifying four varieties of hazelnuts, the successful isolation of the “whole kernel” of hazelnuts from other varieties is a key solution to reduce economic losses due to incorrect classification. From this point of view, according to the confusion matrices, it was concluded that the EfficientNetB3 structure is four times more efficient than the EfficientNet B2 structure. However the authors analyzed mainly the hazelnut kerne. In this study, [7] to improve the efficiency of machines for the selection of substandard and damaged hazelnuts, as well as to improve the numerical simulation of the anisotropic behaviour of hazelnuts, the mechanical properties of the shell and kernels are useful experimental data. The procedure for the experimental determination of the physical and mechanical properties of hazelnuts is described, and optimized shapes of samples for obtaining stresses before destruction and values of the elastic modulus of the core and shell are determined. The technique was applied to the commercial launch of Italian hazelnuts, and the mechanical properties of both the kernel and the shell were obtained experimentally on samples made from healthy and damaged hazelnuts. However the authors analyzed the selection of hazelnut fruits. In this study, [8] the effect of the type of hazelnut, the concentration of hydrocolloids and the use of ultrasound on the physico-chemical and organoleptic characteristics of hazelnut-based milk was studied. Hazelnut-based dairy products were prepared according to three different recipes (F1, F2 and F3) using raw kernels (group G1) and roasted hazelnut kernels (group G2) and homogenized after thermal ultrasound treatment (20 kHz, 100 W) with two different duration modes (5 and 10 minutes). The physicochemical and structural properties of the samples were strongly influenced by heat treatment and application in the USA. The homogenization process after heat treatment improved the solubility of the protein, and the zeta potential values for samples belonging to both groups. In the samples of homogenized hazelnut-based milk, the particle size was significantly reduced. The type of hazelnut significantly influenced the taste characteristics of hazelnut-based milk. The combined use of gellan

gum (GG) and carboxymethylcellulose (CMC) in hazelnut-based milk mixtures reduced the stability of the samples. However the authors studied ultrasound for the physico-chemical and organoleptic characteristics of hazelnut-based milk

Conclusion.

The analysis of the theoretical research results shows that with the increase of the gap in the drum-type nutcracker up to a certain value, the ability of the drum to include nuts in the crushing process increases. However, in this case, the zone of capture of the nuts can have a large arc size. This size should be such that it served to break the shell and separate the kernel by squeezing the nuts. As can be seen from theoretical considerations, the productivity of the device that separates the nut kernel from the shell depends on the ability of the drum to catch the nut and enter it into the process. For this, the nuts should be distributed evenly to the compression zone, and clogging at the entrance to the working zone should be prevented.

Conflict of interest

The authors have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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The study was performed without financial support.

Data availability

– manuscript has no associated data

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

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References

[1] Zeynep Ünal, Hakan Aktaş, (2023) Classification of hazelnut kernels with deep learning, Postharvest Biology and Technology, Volume 197, 2023, 112225,

[2] ISSN 0925-5214, https://doi.org/10.1016/j.postharvbio.2022.112225.

[3] Cristiana Delprete, Raffaella Sesana, (2014) Mechanical characterization of kernel and shell of hazelnuts: Proposal of an experimental procedure, Journal of Food Engineering, Volume 124, 2014, pp 28-34, ISSN 0260-8774,

[4] https://doi.org/10.1016/j.jfoodeng.2013.09.027.

[5] Linnik Yu. V. The method of least squares and the basics of the mathematical and statistical theory of observation processing. - 2nd ed. - M., 2014. (mathematical theory)

[6] R.M.Haciyev, R.A.Saidov, G.B.Mammadov, U.T.Taghiyev, G. Allahverdiyeva. (2022). Analysis of the main design and operating parameters of the device for the fermentation of bird droppings / EUREKA: Physics and Engineering, 5, 00–00. https://doi.org/10.21303/2461-4262..002306 link_1 or link_2 https://journal.eu-jr.eu/engineering/issue/view/217

[7] R.M Haciyev, K.Salmanova, G. Mammadov, U.T.Taghiyev. (2022). Application of intensive technologies for improved production processes in poultry farms./ Eastern-European Journal of Enterprise Technologies, 4 (1 118), (2022) pp.90-102. doi: https://doi.org/10.15587/1729-4061.2022.262999

[8] R.M Haciyev, K. R.A.Saidov, G.B.Mammadov, U.T.Taghiyev, G. Allahverdiyeva. (2022). Utilization of

poultry droppings in terms of non-waste technology farms./ Eastern-European Journal of Enterprise Technologies, 3 (10 (117)), 37- 46. doi: https://doi.org/10.15587/1729-4061.2022.258493

[9] R.M Haciyev, M.R.Huseynova, U.T.Taghiyev, G.B. Mammadov, G. Allahverdiyeva, (2024). The study of the efficiency evaluation of the ventilation system of the poultry house in the summer./EUREKA: Physics and Engineering, 5, 00-00. https://doi.org/10.21303/2461-4262..002306 link_1 or link_2 https://journal.eu-jr.eu/engineering/issue/view/217

[10] Cristiana Delprete, Raffaella Sesana, (2014) Mechanical characterization of kernel and shell of hazelnuts: Proposal of an experimental procedure,/Journal of Food Engineering, Volume 124, 2014, pp 28-34, ISSN 0260-8774,

[11] https://doi.org/10.1016/j.jfoodeng.2013.09.027.

[12] Levent Şen, Selma Okur, (2014) Effect of hazelnut type, hydrocolloid concentrations and ultrasound applications on physicochemical and sensory characteristics of hazelnut-based milks, Food Chemistry, Volume 402, 2023, 134288,

[13] ISSN 0308-8146,https://doi.org/10.1016/j.foodchem.2022.134288.

[14] N. Bernat *et al.* (2015) Effect of high pressure homogenisation and heat treatment on physical properties and stability of almond and hazelnut milks. LWT - Food Science and Technology

[15] L. Gentile (2020) Protein–polysaccharide interactions and aggregates in food formulations Current Opinion in Colloid and Interface Science

[16] N. Göncüoğlu Taş *et al.* (2017) Maillard reaction and caramelization during hazelnut roasting: A multiresponse kinetic study Food Chemistry

[17] O. Gul *et al.* (2017) Effect of high pressure homogenization (HPH) on microstructure and rheological properties of hazelnut milk. Innovative Food Science and Emerging Technologies

[18] M.C. Iorio *et al.* (2019). A case study on the use of ultrasound for the inhibition of Escherichia coli O157:H7 and Listeria monocytogenes in almond milk. Ultrasonics Sonochemistry

[19] A.R. Jambrak *et al.* (2009). Physical properties of ultrasound treated soy proteins

[20] Journal of Food Engineering.

[21] C. Liang *et al.* (2006).Effect of hydrocolloids on pulp sediment, white sediment, turbidity and viscosity of reconstituted carrot juice.Food Hydrocolloids

[22] J.T. Martins *et al.* (2012).Synergistic effects between κ-carrageenan and locust bean gum on physicochemical properties of edible films made there of Food Hydrocolloids

[23] T. Patra *et al.* (2021). The physical stability of plant-based drinks and the analysis methods there of Food Hydrocolloids