Justification of the parameters of parts of a walnut cracking machine

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Abstract. The article describes the design of the working drum in a nut grinding machine and its design. Depending on the size of the nut and as a result of the experiments, the structure and dimensions of the parts of the nut grinder are determined and the basic procedure for preparing the parts in accordance with the structure is expressed. The rotation speed of the drum was determined taking into account the weight of the nut and centrifugal force. The speed with which the nut enters the device is calculated depending on the speed of rotation of the drum. The determination of this speed allows the machine to work normally, and at the same time increases its efficiency.

1. Introduction
Today, there are many types of fruits that are separated the kernel from the shell: walnuts, almonds, filberts, chestnuts, pistachios and cashews. Nuts have a high calorific value and a rich nutrient composition. The world has increased demand for the production and processing of walnuts and their exports. This is aimed at stimulating the use of arable land and further improving their efficiency, increasing the production of competitive walnuts in the domestic and foreign markets, building modern walnut plantations by attracting foreign investment and widespread adoption of evidence-based methods and intensive technologies. It is important to develop machines for planting walnuts to perform the above tasks. Walnut trees are widespread in Central Asia, with an average of 600,000 tons of nuts collected per year. This figure will almost triple in 3 years. Nuts should be stored mainly in dry places. For some reason, products that remain in moisture for extended periods become unusable.

The walnut is made up of 35-40 % seed, which is 60-65 % bark [1]. This will require the removal of grain from bark to reduce transportation costs when transporting or exporting nuts from one location to another. Moreover, as the walnut shell is hard, we can grind it and use powder to process the surface of the details in the machine. In addition, the firm, which separates pallets in the middle of the walnut grain, is used for the preparation of medicine from pharmaceutical materials [2]. Nowadays, when the walnuts are ripped at the same time, they are separated from the shell of the seed by the handwork [2]. A person grind maximum 14-15 kg nuts a day. It does busy by thousands people in 2-3 months for seasonal work. In this situation, the costs of walnut bells will increase the cost of the product. Nowadays the creation of walnut mechanism is one of the most important issue.

Purpose of the work is to develop and research the design of the device allowing the whole seeds to break through nuts in high productivity. The following objectives are required to achieve the set goal gathering information about existing nuts equipment, analyze learn conformity structures, development of its new structure. Installation of an improved flare mechanism for the new device.
2. Experimental part
To determine the parameters of the device for the nut-cutting device, to develop a device design that allows separating it in the form of a shell, ensuring its integrity without damaging the core during the process of deformation and breaking of the shell. Because walnut shells are made of a material that has a certain strength. It is known that the force acting on the cortex is likely to crush the nucleus, so the bite device must have a design that does not exert any force on the nucleus during the process of deforming and breaking the cortex with great force [3].

Since this work was related to design work, mainly design work was reflected in the drawing, and then its actions, work performed, and the magnitude values of some factors were theoretically studied using mathematical modeling methods [4]. Sorting nuts by size, the values of the breaking forces of the shell were determined experimentally, the parametric method was used to determine the physical parameters of the nut. Thus, theoretical, experimental, and parametric methods were used in the study.

![Figure 1. Walnut cracking machine.](image)

3. Theoretical and practical significance of the results
Because of theoretical research, the dimensions of the nut-cutting device and its adjustment and technological parameters were determined [5]. That is, a mathematical formula was developed that determined the dimensions of the device depending on the size of the nut. As a result, a new design of the nutcracker was developed and the nut core was completely separated. The working drum of the nut-cutting machine has the structure shown in figure 1.

The working drum of the nut-cutting machine (figure 1) is mounted on the frame by means of a threaded connection (3) with a bearing (2), which helps to move the shaft (4). The shaft is cylindrical at the junction with the bearing and prismatic in shape with eight sides in the middle. Bite devices (7) are attached to each side of the octagonal prismatic shaft. Figure 2 shows the cross section of the working part. The purpose of showing the shear is to illustrate how the nutcracker clamp (6) is mounted on the nutcracker. Hinges (12) and springs (13) were used to support the operation of the clamp.
As can be seen from the figure 3, the fastening device consists of fastening screws (1), the mounting frame (2), springs (3), hinges (4) and clamps (5). Since the chopping device is one of the main working bodies, it has a great responsibility. That is why the demand for its details will be high. Since the clamps are in direct contact with the nut, their working surfaces must be resistant to abrasion. Clamps should be made of carbon steel U8A, U10A and alloyed silicon-manganese steels. Such materials have high resistance to compression and bending along with bending [6].

During heat treatment of the prepared clamps, after its hardening, the hardness is allowed to NRS 35-45 according to Rockwell.

![Figure 2](image1.png)

**Figure 2.** Structure of the working drum of the nut-cutting machine. a) Work drum of walnut wicking device; b) Working state of the drum. 1) support roller of the work drum. 2) bearing 3) combination 4) eight prismatic valve 5) bearing torso 6) scratching step 7) scratching pincers 8) segment hindrance 9) screw connection 10) body part of device 11) spirally 12) speech 13) spring.

![Figure 3](image2.png)

**Figure 3.** Walnut sting mechanism. (1) Body part; (2) Spring; (3) Hinge; (4) pincers; (5) Nut.

One of the main indicators of the workability of the clamp is that it does not lose its properties during a given service life. This is called clamp durability. It is therefore advisable if the surface hardness in
the heat treatment is increased to NRS 45-55 so that the material of the clamp can retain its properties for a long time. In this case, the service life of the clamp will be slightly higher.

Since the clamp is movably attached to the frame part using a hinge, its hole should also be the main focus. Because the hole surface operates in a complex motion mode under the influence of the main load force and frictional forces. The bottom of the clamp shall have a recess in the size corresponding to the diameter of the spring to ensure constant adhesion to the spring, the depth of which shall not be less than 2 mm.

It is advisable to make the hinge detail from quality steel 45X. Such materials have high resistance to compression and bending. During heat treatment of the prepared hinge, after its hardening, the hardness is given a leave of NRS 35-45 on Rockwell. One of the main indicators of the workability of the hinge is that it does not lose its properties during a given service life. This is called the durability of the hinge. Therefore, in order to ensure that the material of the hinge can retain its properties for a long time, it is advisable to increase the stiffness of its frame part and clamping surfaces during heat treatment to NRS 45-55. In this case, the service life of the clamp will be slightly higher [7, 8].

It is recommended that the frame of the ignition device be made of less deformable materials as it absorbs all the forces acting on the mechanism.

Research on the cracking of walnut shells mainly focuses on the following three aspects: chemical, physical and mechanical properties of walnut shell; mechanical properties of the breaking force of the nut shell; nut shell breaking machines [9].

Determining the speed at which the nut enters the device will ensure that the machine operates at a normal pace, as well as justifying its performance.

If the speed of the drum is proportional to the speed of the nut falling from the bunker to the device, the machine will run smoothly.

The dimensions of the machine were used to determine the speed of the working drum. It is known that the number of revolutions of the working drum is \( n = 60 \) rpm, the radius of the drum is \( R = 0.5 \) m [10].

![Figure 4. Schema enter of walnut into the appliance in that case.](image-url)
\[ \mathcal{O} = \omega R ; \] 
(2)

(1) we enter values in the formula.

\[ \mathcal{O}_b = \frac{\pi n}{30} R = \frac{3.14 \times 60}{30} \times 0.5 = 3.14 \] 
(3)

The working drum has eight biting devices. When it was determined that the linear velocity of the drum was \( v = 3.14 \text{ m/s} \); the speed between each drum is calculated by dividing the total speed of the drum by eight, and the speed is found for a part of the drum (figure 1, 2).

\[ \mathcal{O} = \frac{\mathcal{O}_b}{8} = 0.39 \text{ m/c} \] 
(4)

In calculating the speed of falling the nuts on the beaker detector, the constructive parameters determined by experiment are used (figure 4):

- The length of the walnut deck is \( L = 0.7 \text{ m} \)
- The latitudinal slope \( \alpha = 45^\circ \)
- Walnut weight \( m = 10 \text{ g} \)
- Friction coefficient: walnut was rolled on steel and it was determined by experiment, that \( f = 0.01 \) is recommended.

The friction coefficient is dependent not only on the type of material but also on moisture, pressure and temperature. Several nuts were rolled in steel deck \((45^\circ)\) and friction coefficient was determined. The optimal value for the calculation was chosen [11, 12].

The nut is acted by the gravity \( P = mg \), the normal reaction force of the \( N \) plane and the friction forces of \( F_f = fN \). Vector \( P \) is discomposed to components \( P_1 \) and \( P_2 \) on the plane in the perpendicular direction [9-11]. In that case:

\[ P_1 = mg \sin \alpha , \ P_2 = mg \cos \beta \] 
(5)

will be. The normal reaction force

\[ N = P_2 = mg \cos \alpha \] 
(6)

and friction force

\[ F_f = fmg \cos \alpha \] 
(7)

is defined by formulas.

When using the theorem on the change of kinetic energy of walnut s through the road:

\[ \frac{m \mathcal{O}^2}{2} - \frac{m \mathcal{O}_0^2}{2} = P_1s - F_fs \] 
(8)

or
\[
\frac{m\vartheta^2}{2} - \frac{m\vartheta_0^2}{2} = mgs(\sin \alpha - f \cos \alpha)
\]  

(9)

From now on

\[
\vartheta = \sqrt{\vartheta_0^2 + 2mgs(\sin \alpha - f \cos \alpha)}
\]  

(10)

\[
\vartheta = \sqrt{2 \cdot 0.01 \cdot 10 \cdot 0.7(\sin 45^0 - 0.01 \cos 45^0)} = 0.35 \text{ m/s}
\]  

(11)

As a result of calculations, it is clear that the velocity of the apparatus passing through the walnut deck is \( \vartheta = 0.39 \text{ m/s} \), and the drum diameter is determined by the drum length, \( l = 0.3925 \text{ m} \). The deck walnut velocity is \( \vartheta = 0.35 \text{ m/s} \), given that the length of the deck is 0.7 m, it takes about 2 seconds to feed the nuts from the bunker to the apparatus [13, 14, 15, 16]. The nut must be accelerated to ensure that the nut will fall within the standard time frame. To do this, the machine will work in a rate due to a disk speed of \( \vartheta_0 = 0.9 \text{ m/s} \).

4. Conclusion

The world, attention is being paid to the technology of processing and brings up of walnut. The development of walnut split machines inexpensively facilitates manual labor and also it benefits the economy, that is why walnut split mechanism has planned. The work drum is mainly part planed of the walnut split mechanism. It is important that each element of the drum be developed precisely and qualitatively materials, therefore, the new design of the working drum was prepared and substantiated.

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