A theoretical method of the reception of blue stem feed by the feeders and transfer to the grinding drum

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Abstract. Uzbekistan pays a lot of attention to fisheries, poultry and animal husbandry. In fish farming, poultry and livestock rearing, it has been recommended to give green feed as a supplementary feed, which reduces the accumulation of excess fat in fish. In this regard, a grinder was produced for cutting plants with blue content. The number of rotations of the feeders was studied theoretically and experimentally in order to meet the demand of the prepared feeds. According to the theoretical research, the cutting length of blue stalk feed is achieved by changing the number of revolutions of the shredder drum depending on the feed speed Vuz and the number of blades in the drum N p , and the number of revolutions of the feeder blades when the feed is transferred at an angle of 27O is 101-207 r/ in the range of min, when the number of blades is in the range of 4-6 pieces, it is recommended that the number of rotations of the shredder drum be greater than 1358 r/min and 1478 r/min to ensure a cutting length of up to 10 mm.

1 Introduction

Achieving good results in the breeding of fisheries, poultry and livestock depends on the quality of the feed provided to them. The following nutritional feeds, concentrated feeds and additional feeds are used in the feeding of fisheries, poultry and livestock [1, 2, 3, 4, 5, 6].

Fisheries, poultry and livestock farms in excess of the norm, because excess fat accumulation is observed in fish. The use of the above-mentioned blue feed helps in the development of fisheries and rapid growth. Fish and poultry feed should be crushed. Taking into account the above, the analysis of today's available devices [7, 8, 9, 10, 11, 12, 13, 14, 15, 16] was carried out to create a small and compact blue stem feed grinder. According to the research results, a feed grinding device for fisheries and poultry was developed.

2 Methods

Food grinder used in the study of the laws of the nutrient feeder installed in the device.

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Verification of the compatibility of the obtained theoretical studies was carried out experimentally. In the experiment, alfalfa and corn stalks were crushed. The working quality of the device was determined by the ratio of fractions in the cut feed up to 5 mm , between 5 - 10 mm and 10 - 20 mm, and larger than 20 mm. For this, the processed feed was divided into parts with a size of up to 5 mm, a size of 5 mm to 10 mm, a size of 10 mm to 20 mm, and a size larger than 20 mm, and their fractional composition was determined on laboratory sieves. According to the specified requirements, ground feed for fish and poultry should contain more than 50% of fractions with a size of up to 5 mm, more than 30% of fractions between 5-10 mm, and more than 20% of fractions with a size of 10-20 mm and larger.

3 Results and discussions

It is important that during the operation of the grinding device, the green stem feeds transmitted through the inclined rod are received through the supply grooves and evenly transferred to the grinding drum. For this reason, the work of the supply chain was studied (Figure 1).

In order to consider the process of absorption and transfer of blue stem nutrients by the plants in a simpler case, we will first consider it as an example of plants with a flat surface.

When the stems are received by the joists, they are affected by the normal pressure force N_j and friction forces F_{ishk}.

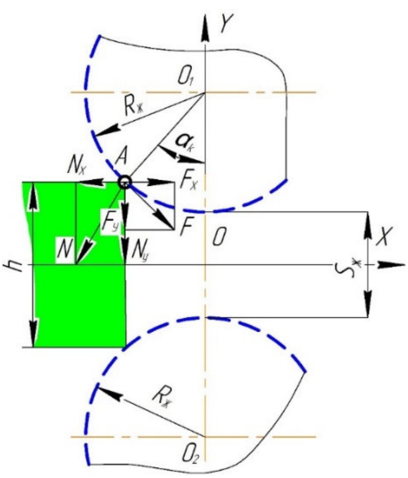

Fig. 1. Acceptance of digested food by the sows.

The pressure force N of the beams on the stems is always perpendicular to its surface. Separating the forces according to the compression of the stems and the direction of movement, we determine the N_x component of the normal pressure force N and the components of the friction force F_u. In this case, the component of the normal pressure force N_x serves to pull the stems out of the working slot of the grooves, and the frictional force N_u serves to pull the stem mass into the gap between the grooves.

Now let's consider the effect of these forces.

According to the scheme, the forces acting on the stem mass by one joist.

$$\begin{cases} N_x = N \sin \alpha_\kappa \\ N_y = N \cos \alpha_\kappa \end{cases} \quad (1)$$

$$\begin{cases} F_x = F\cos\alpha_\kappa \\ F_y = F\sin\alpha_\kappa \end{cases} \quad (2)$$

in which α_κ - angle of coverage of beams, grad.

If we take into account the pair of transmission blades in the device, then the total normal pressure force *N* exerted by a pair of blades on the stem mass tries to push the transmitted stem mass back out of the receiving zone, while the total frictional force F_{is} directed to the rotating side of the blades, receiving the stem mass inward, tries to pull into the compression zone. The total friction force of the grains F_u must be greater than the total normal pressure force N_u so that the grains receive the crushed stalks and transfer them from the working slot to the crusher drum.

Total normal compressive strength according to the scheme

$$N_y = 2N\sin\alpha_\kappa \ . \quad (3)$$

We write it as follows

$$N_y^2 = 2N^2\sin^2\alpha_\kappa \ .$$

or

$$\sin^2\alpha_\kappa = \frac{1-\cos 2\alpha_\kappa}{2} \ .$$

from being

$$N_y^2 = 2N^2\left(1-\cos 2\alpha_\kappa\right) \ . \quad (4)$$

We write down the total frictional force of the joints as follows

$$F_y^2 = 2f^2N^2\left(1+\cos 2\alpha_\kappa\right) \ . \quad (5)$$

(4) and (5), expression (6) will be as follows.

$$2f^2N^2\left(1+\cos\alpha_\kappa\right) > 2N^2\left(1-\cos 2\alpha_\kappa\right) \ . \quad (6)$$

or

$$f^2 > \frac{1-\cos 2\alpha_\kappa}{1+\cos 2\alpha_\kappa} \ . \quad (7)$$

(7) expression can be reduced to the following form

$$f^2 > \frac{1-\cos^2\alpha_\kappa + \sin^2\alpha_\kappa}{1+\cos^2\alpha_\kappa - \sin^2\alpha_\kappa} = \frac{\sin^2\alpha_\kappa}{\cos^2\alpha_\kappa} = tg^2\alpha_\kappa \ , \quad (8)$$

since $f^2 = \text{tg}^2\varphi$

$$tg^2\varphi > tg^2\alpha_\kappa \text{ or } \varphi > \alpha_\kappa . \quad (9)$$

(8), the friction angle φ must be greater than the angle of reception of the grains a_k in order for the grains to receive the blue stem feed and bring it to the working slot .

As mentioned above, the minimum friction angle of corn and alfalfa stalks in the blue state is $\varphi_{\min} = 25-28^{\circ}$ in the interval, the reception angle of the beams is also a k =30O should be.

In order to drag the stem mass covered by the grooves through the gap between the grooves, the traction force $T_{tor} > 0$ or the total frictional force F_u should be greater than the total normal compressive force $N_{u,}$ i.e.

$$T_{mop} = F_y - N_y > 0 \ . \quad (10)$$

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Can be seen from the expression (10) that the traction force that carries blue stem feed from the gap between the grooves is equal to the difference between the total frictional force F_u and the total normal pressure force.

Total friction force F_u and the total normal pressure forces into the expression (10).

$$T_{mop} = 2fN\sqrt{\frac{1+\cos 2\alpha_\kappa}{2}} - 2N\sqrt{\frac{1-\cos 2\alpha_\kappa}{2}} =$$

$$= 2fN\cos\alpha_\kappa - 2N\sin\alpha_\kappa = 2N\left(f\cos\alpha_\kappa - \sin\alpha_\kappa\right). \quad (11)$$

the friction coefficient f in the expression (11) by the friction angle φ *, i.e.*

$$f = tg\varphi = \frac{\cos\varphi}{\sin\varphi}. \quad (12)$$

(12) into account, performing some operations, we write the expression (11) in the next form

$$T_{mop} = \frac{2N}{\cos\varphi}\left(\sin\varphi\cos\alpha_\kappa - \cos\varphi\sin\alpha_\kappa\right). \quad (13)$$

or

$$T_{mop} = \frac{2N\sin\left(\varphi - \alpha_\kappa\right)}{\cos\varphi}. \quad (14)$$

Can be seen from the expression (14) that the transfer of blue stem feed through the grooves to the grinding drum depends on the normal pressure force of the grooves, the angle of reception and the friction of the stems on the grooves.

Increasing the angle of stem acceptance in turn leads to an increase in grain diameter or metal consumption, while increasing the normal pressure force is not optimal from the point of view of crushing blue stem feeds.

For this reason, in order to improve the friction or adhesion properties of the blades, their working surface is corrugated, corrugated or covered with rubber material.

Although different types of fluted working surface saws have good pick-up and mixing characteristics, they are not optimal for use in blue-stalk feed grinders because they pre-shear or crush the blue-stalks with their edges. Making them from rubber is expensive.

For this reason, we will select the supplier's jaws with a corrugated surface for use in the device and conduct a theoretical study of them (Figure 2).

The forces acting in the opposite direction on receiving blue stem feed on a corrugated mill with a working surface are as follows

$$N_y^{г} = N_1\sin\alpha_1 + N_2\sin\alpha_2. \quad (15)$$

$$F_{ишк}^{г} = f(N_1\cos\alpha_1 + N_2\cos\alpha_2), \quad (16)$$

where f is the friction coefficient.

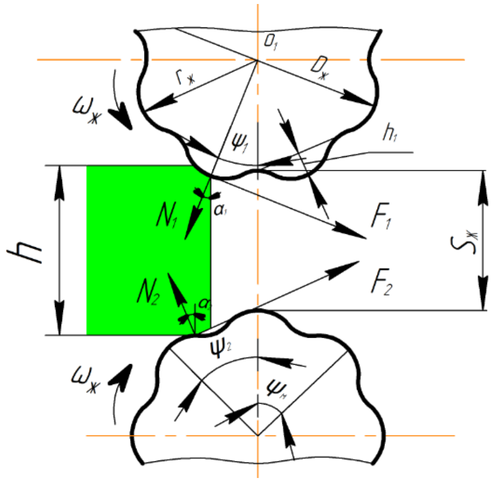

Fig. 2. The reception of blue stem feeds with the working surface of corrugated boards.

In this case, it is a condition that the stem mass is received by the corrugated joints

$$f(N_1\cos\alpha_1 + N_2\cos\alpha_2) > N_1\sin\alpha_1 + N_2\sin\alpha_2 . \tag{17}$$

Expressing the coefficient of friction through the angle of friction, we write the above expression as follows

$$tg\varphi > \frac{N_1\sin\alpha_1 + N_2\sin\alpha_2}{N_1\cos\alpha_1 + N_2\cos\alpha_2} . \tag{18}$$

(18) although the normal compressive forces of the upper and α_2 lower beams are not equal $N_1 \neq N_2$, α_1 i.e.

$$N_1\cos\alpha_1 = N_2\cos\alpha_2 . \tag{19}$$

In addition $\frac{\alpha_1+\alpha_2}{2} = \alpha,$, it can be considered as an average coverage angle $\cos\alpha_1 + \cos\alpha_2 \approx 2\cos\alpha$

α_1 and α_2 at small values of the angle the following condition is valid

$$tg\alpha_1 + tg\alpha_2 \approx 2tg\alpha < 2tg\varphi . \tag{20}$$

the stems are accepted by the plants $\psi_1 = \alpha_1$, then

$$\psi_2 = \alpha_1 + \frac{\psi_M}{2}, \tag{21}$$

in this ψ_1 and ψ_2 - of the gophers exposed to blue stem feed
the angle of deviation relative to the axis of the drum, grad;

ψ_M - the central angle describing the pitch of the corrugations, grad.

According to the scheme

$$\cos\psi_1 = \frac{D_j + S_j - h_r}{D_j + h}, \tag{22}$$

in which D_j - the diameter of the grooves, m;

S_j - gap between the grooves, m;

h_g is the height of the corrugations, m.

Also the following attitude is appropriate

$$D_j = h\cos\alpha - S_j + h_r + R_j(\cos\psi_1 + \cos\psi_2) - r_z(\cos\psi_1 + \\ + \cos\psi_2) + 2r_z\cos\alpha \tag{23}$$

where r_g is the radius of the corrugations, m.

If $\psi_2 = \psi_1$ and $\cos\psi_1 > \cos\psi_2$ taking into $\cos\psi_1 + \cos\psi_2 = 2\cos\psi_1$ account that, the expression (23) can be written as follows

$$D_j \le h\cos\alpha - S_j + h_g + 2(R_j - r_g)\cos\psi_1 + 2r\cos\alpha \tag{24}$$

If we put the value of the expression (22) into the expression (24).

$$D_j \le h\cos\alpha - S_j + h_g + \frac{2(R_j - r_g)(2R_j + S_j + h_g)}{2R_j + h} + 2r_g\cos\alpha \cdot \tag{25}$$

(25) by performing some operations, we find the diameter of the beams in terms of corrugations

$$D_j \le \frac{\left(h^2 + 2hr_g\right)\cos\alpha - (S_j - h_g)(h + 2r_g)}{(h + 2r_g)(1 - \cos\alpha)}, \tag{26}$$

where h_g=0.01 m; h = 0.02 m; C_j=0.01 m; r_g=0.01 m; If α= 35-40 ^{O}, it turned out that D_j should be ≤ 6.5 cm.

The main parameters of the groove are also its number of turns, width and gap between the grooves. These parameters are mutually determined depending on the performance of the device.

It is known that the mass transfer capacity of sawdust suitable for the performance of the grinding device can be determined as follows

$$q = \eta S_j B_j V_{ut} \rho, \tag{27}$$

where η - the coefficient of filling of the interval of j;

V_j – the width of the grooves, m;

V_{ut} - the speed of the stalk feed passing through the grooves, m/s;

ρ - the density of stem nutrients, kg/m ^{3}.

Although the surface of the grooves is corrugated, but due to the fact that there is a slight slippage during the transmission of stem nutrients, the speed of the stem nutrients passing between the grooves is as follows

$$V_{ut} = k_T \omega_j R_j, \tag{28}$$

where k_T is the sliding coefficient;

ω_j – angular velocity of the beam, rad/s;

R_j is the radius of the beam, m.

(28), (27) is as follows

$$q = \eta S_j B_j k_T \omega_j R_j \rho. \tag{29}$$

(29), we find the angular velocity of the beams

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$$\omega_j = \frac{q}{\eta S_j B_j k_T R_j \rho}. \tag{30}$$

On the other hand

$$\omega_j = \frac{\pi n_j}{30}, \tag{31}$$

where n_j is the number of revolutions of the gears, r/min.

By equating the expressions (30) and (31), we determine the number of rotations of the

$$q = \frac{n_j \pi \eta k_T S_j B_j R_j \rho}{30 k_{uz}}. \tag{32}$$

Expressing the radius R_j of the groove in this expression by the diameter D_j, we get the following

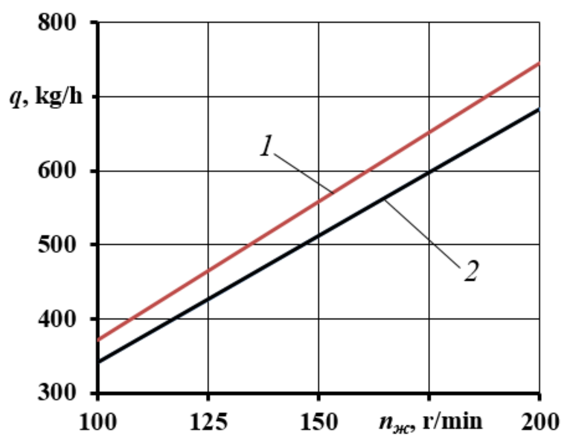
$$q = \frac{n_j \pi \eta k_T S_j B_j D_j \rho}{60 k_{uz}}. \tag{33}$$

It can be seen from the expression (33) that the number of rotations of the feed mill is directly proportional to its productivity, k_T, S_j, V_j, D_j and inversely proportional to the density of the ground food ρ.

The equation (33) determines the interrelationship between the number of revolutions of the grinding device and other parameters of the grinding device.

Based on this expression q =0.142 kg/s; $k_{uz} = 0,5 - 0,8$; $\eta = 0,7 - 0,8$; $k_T = 0,8 - 0,9$; C $_j$ = 0.01 m; B $_j$ = 0.2 m; D $_j$ = 0.06 m; Based on the fact that it is $\rho = 118,2$ kg/m^3, a graph was built showing the effect of the number of turns of the feeder on the productivity of the device, taking into account the density of corn and alfalfa stalks to be ground (figure 3).

As can be seen from the graph, depending on the density of corn and alfalfa stalks, to ensure the productivity of the device of 600 kg/h, S_j = 0.01 m; B_j = 0.2 m; When $Д_j$ = 0.06 m, k_{uz} = 0.5 – 0.8; η = 0.7 – 0.8; Considering that k_T = 0.8 – 0.9 varies, it was found that the number of revolutions of the gears should be in the range p_j = 101-207 r/min.



1 – corn stalk; 2 – clover stem

Fig. 3. The effect of the number of revolutions of the grinding device feeder on the performance.

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4 Conclusions

The transmission speed of the stalks transmitted to shredding to ensure the cutting length of blue stalk feed at the level of the specified requirements is achieved by changing the number of revolutions of the shredder drum depending on the number of knives in the drum V_{uz} and the number of knives in the drum, and the number of revolutions of the feeder blades when the feed is transferred at an angle of 27^{O} is in the range of 101-207 r/min , the number of revolutions of the shredder drum should be greater than 1358 r/min and 1478 r/min to ensure a cutting length of up to 10 mm when the number of blades is in the range of 4-6 pieces.

The time change of the speed of movement of the cut stem piece along the blade under its influence when the radius of the drum is 75, 100, 125 and 150 mm shows that the speed of the stem pieces constantly increases during its movement along the blade towards its upper part and 4.5-6 from the upper part of the blade It shoots out with a speed of m/s.

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