INVESTIGATION OF CUTTING LENGTH OF STEMS IN CROPPING DEVICE

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https://doi.org/10.5281/zenodo.8240639

Abstract. The article presents the results of theoretical and experimental researches to determine the cutting length of stems in a drum grinder and according to the obtained formula, in theoretical observations to determine the cutting length of stemmed fodder, it is determined that with an increase in the speed of rotation of the feed rollers or conveyors, the length of and the number of knives on the drum, the cutting length is reduced. In experimental studies carried out on a drum grinder at a constant rotation frequency of the grinding drum 1000 min^{-1} with an increase in the rotation frequency of the feed rollers from 100 min^{-1} to 200 min^{-1}, it was determined that in the composition of the crushed mass fraction with a length of up to 5 mm decreases by 1.7-2.0 times, and fractions with a length of up to 2 cm increase by 1.5 times, and fractions longer than 2 cm are given up to 1.7 times and this shows that the results of theoretical research are in sufficient agreement with practice.

Key words: green stalk-forage, chopper, knife, roller, transporter, drum, rotation speed, length of cutting.

Introduction. Special attention is paid to the development of livestock, poultry and fisheries in Uzbekistan. It is important to introduce modern technology and innovative developments in the fields.

In today's conditions, it is urgent to create universal constructions of feed material grinders that provide resource-efficient, low-power and reliable operation, as well as the ability to grind stem feed to the required size. Based on this, research is being carried out on the development of a grinder that is used in the grinding of blue stem feeds in livestock, poultry and fishery farms and cuts blue grass to the required size for each of their categories [1, 2].

One of the main indicators of stalk feed shredders is the quality of shredding, which depends on the cutting length. Depending on the size of livestock, poultry, fish and other creatures, it is necessary to cut the stems from 5 mm to 10 cm in length [1, 2]. This is achieved by choosing the optimal type of grinding apparatus, which is the main working part of the grinders. The results of the study of existing devices showed that this requirement is met by crushers with a drum with more blades [5, 6]. For this reason, it is important to theoretically and experimentally study the cutting length of stalked feedstuffs in feed grinding equipment with a drum-type grinding device.

Literature analysis and problem statement. The development, research and determination of the quality indicators of grinding devices have been carried out a lot of research, and new methods and devices have been developed.

M.A. Bal and others researched the effect of silage prepared by crushing corn stalks on milk yield and productivity of dairy cows, and found that crushing the stalks into smaller sizes leads to an increase in their yield.

A.F. A group of researchers led by Eduardo studied the effect of the period of cutting elephant grass on the amount of hay made from this grass and pointed out that if the grass is not harvested and chopped in time, the number of cuts and the roughness of the grass stalks will decrease the quality and quantity of the harvested hay [4]. M. Zastempowski and A. Bochatlar compared different construction drums and found out that the drum, inside of which the blades are slanted in relation to the cut stem, cuts the stems evenly without crushing them. In practice, in addition to fodder crops, researches have been conducted on the development of devices for crushing the stalks of sugarcane, banana, rice and other crops, and on determining their performance indicators, and certain positive results have been achieved [3, 4, 5].

A number of researchers were also engaged in determining the cutting length in stalk shredders, and obtained significant results on the interaction of the stalk shredder with drum blades, ensuring the required cutting and determining the cutting length.

One of the main indicators when chopping stalks is the length of the cut. In the design of grinders, a number of expressions have been proposed to determine the cutting length depending on the type of grinding apparatus [6, 7]. But in these expressions, the cutting length of the feed is determined depending on the work of the grinder, the density of the feed being crushed, the height and width of the transfer, and if they change, the length of the cutting also changes, and uncertainties arise in its determination.

Based on this, it is of great importance to obtain an analytical relationship that allows determining the cutting length of blue stem feed in drum grinding devices, and to verify and justify it experimentally.

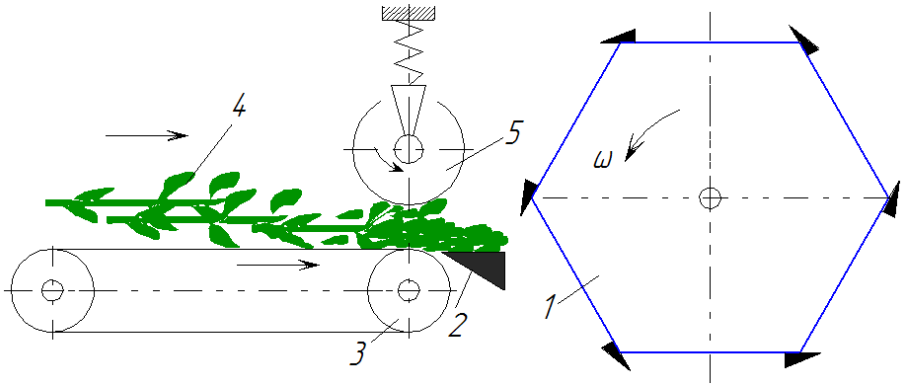
Research methods. Analytical link, which allows to more accurately determine the cutting length of blue stem feed in drum grinding devices, was determined by mathematical analysis of the process of transferring stalks to cutting and grinding them in drum grinders, taking into account the parameters of the working parts of the grinding device that affect the cutting length.

The accuracy of the analytical bond to determine the shear length was determined by comparing the correlation between the shear length of stems determined experimentally in a drum mill device.

GOST R ISO 11448-2002 "Mobile shredders and crushers with automatic transmission. The methods given in the methodical manual "Work quality indicators and test methods" were used [6]. Size-mass indicators and moisture content of crushed stems before experiments GOST 20915-2011 "Selskokhozyaystvennaya tekhniki. It was determined on the basis of "Metody opredeleniya uslovii ispytaniy" [7]. In order to increase the reliability of the results, the results of the experiments were analyzed based on the methods of mathematical statistics, their statistical values were determined, and their reliability was ensured [8].

Experiments were conducted on corn and alfalfa stalks, and the length of the corn stalk was 179.8 cm on average, and the length of the alfalfa stalk was 73.4 cm. During the experiments, the number of rotations of the drum of the crushing device was set at 1500 min-1, and the number of rotations of the shafts transmitting shafts was set at 100 min-1 and 200 min^{-1}.

Research results. We use the following scheme to determine the cutting length of blue stem feeds in drum crushing devices (Fig. 1). In the crushing device, the stalks 4 are partially compacted and transferred to the crushing drum with the help of a belt conveyor 3 and a groove 5 installed on its upper part. In some cases, a conveyor is also equipped with a coulter, and the stalks are conveyed to the crushing drum by a pair of coulters. The shredder drum grinds the stalks with blades 6 on the counter cutting plate 2.



1-knife drum; 2-counter shear plate; 3-transporter; 4-stalks; 5-row.

Figure 1. Schematic diagram of a blue stem feed grinder

The cutting length of stalks, which are transferred to the crushing machine by a conveyor, conveyor or any other transmission mechanism, is generally as follows

$$l_к = V_{уз} t_n . \quad (1)$$

in this $V_{уз}$ – stem transfer speed, m/s;

t_n – stalk transfer speed, m/s; time taken for successive blades in the drum to arrive and cut the stalk, m;

The time it takes for the blades of the shredder to come and cut the stem in a row is equal to the following

$$t_n = \frac{\pi D_б}{Z_n V_б} = \frac{2\pi}{Z_n \omega_б}. \quad (2)$$

in this $D_б$ – crusher drum diameter, m;

$V_б$ – drum rotation speed, m/s;

Z_n – the number of blades in the drum, pcs.;

$\omega_б$ – angular speed of the drum, s^{-1}.

Taking into account the time taken by the successive blades in the drum to cut the stem, expression (1) becomes

$$l_к = V_{уз} \frac{2\pi}{Z_n \omega_б} . \quad (3)$$

In this expression, the unknown component is the speed of cutting the stems, and we determine it through the parameters of the transmitting working parts. If we consider that the transmission mechanism in the crusher being designed consists of a conveyor-groove or double-groove transmission mechanism, in such a transmission mechanism, the movement of

stalks during the passage between the compression grooves is variable, and the time taken for their passage [9]

$$t = \frac{2\alpha_o}{\omega_{ж}}. \quad (4)$$

in this α_o - the angle of covering the stems of the beam, degrees;

$\omega_{ж}$ – angular velocity of the beam, s^{-1}.

The distance of the stems between the grooves is equal to the following [9]

$$S_M = 2(R_{ж} + r_n)\sin\alpha_0. \quad (5)$$

in this $R_{ж}$ – radius of the beam, m;

r_n – radius of the stem, m.

According to (5) and (6), the speed of the stalks passing between the beam and the conveyor is as follows [10]

$$V_{уз} = \frac{2(R_{ж} + r_n)\sin\alpha_0}{\frac{2\alpha_0}{\omega_{ж}}} = (R_{ж} + r_n)\omega_{ж}\frac{\sin\alpha_0}{\alpha_0}. \quad (6)$$

Substituting the value of (6) into expression (3), the length of cutting stems in a drum chopper is

$$l_к = \frac{2\pi}{Z_n\omega_б}(R_{ж} + r_n)\omega_{ж}\frac{\sin\alpha_0}{\alpha_0}. \quad (7)$$

According to the research of S.V. Melnikov, the speed of the feeder is greater than the speed of the conveyor in order to better transfer barley stalks to the crushing drum, i.e.

Vj > Vtr and this ratio should be in the range of Vj=(1.25 – 1.35) Vtr.

According to N.E. Reznik, the millet slides while transferring the stem, and the speed of the stem transfer is always lower than the millet's speed, and this speed is proportional.

Given this information, then the expression for determining the length of cutting stalks in a drum chopper looks like

$$l_к = 0{,}9\frac{2\pi}{Z_n\omega_б}(R_{ж} + r_n)\omega_{ж}\frac{\sin\alpha_0}{\alpha_0}. \quad (8)$$

This expression makes it possible to determine the cutting length of the stalks during the shredder operation, depending on the speed of the conveyor or the conveyor and the speed of the shredder drum and the number of blades in it. According to this expression, as the speed of the conveyor increases, the length of stalk cutting increases, and when the speed of the shredder drum and the number of blades in it increase, the length of stalk cutting decreases.

In order to determine the correctness of this connection, experiments were conducted on a drum crusher device. In this case, the number of revolutions of the drum of the crushing device was set to 1000 min^{-1}, and the number of revolutions of the stalks transmitting the stalks was changed from 100 min^{-1} to 200 min^{-1}, with an interval of 25 min^{-1}, and corn and alfalfa stalks were crushed alternately.

According to the results obtained in the experiments, the number of revolutions of the drum is 1000 min^{-1}, and the number of revolutions of the shafts conveying the stems is from 100 min^{-1} to 200 min^{-1}, that is, when it is doubled, the content of the mass of crushed stems is

up to 5 mm and up to 1 cm. the amount of fractions decreased, up to 2 cm and the amount of fractions above 2 cm increased.

In particular, when the number of revolutions of the knife drum is 1000 min^{-1}, and that of the mill is 100 min^{-1}, the amount of the fraction up to 5 mm long in the composition of the crushed corn stalks is 39%, the amount of the fraction up to 1 cm is 25%, the amount of the fraction up to 2 cm long is 21 %, the amount of the fraction longer than 2 cm was 15%, while the amount of the fraction up to 5 mm in the length of the crushed corn stalks decreased by 19%, the length up to 1 cm, up to 2 cm, when the number of revolutions of the mills was 200 min^{-1} and fractions above 2 cm increased to 28%, 31% and 22%, respectively.

To the number of rotations of the grinding drum and the transmission shaft depending on the change in the degree of crushing of stems

Grinding stem type	**Amount of length fractions of stalks in ground mass, %**			
	5 up to mm	**1 up to cm**	**2 up to cm**	**2 above cm**
The number of revolutions of the knife drum is 1000 rev/min, and that of the jaws is 100 min^{-1}				
Corn	39	25	21	15
Alfalfa	38	33	18	11
The number of revolutions of the knife drum is 1000 rev/min, and that of the jaws is 125 min^{-1}				
Corn	36	26	22	16
Alfalfa	35	35	17	13
The number of revolutions of the knife drum is 1000 rev/min, and that of the jaws is 150 min^{-1}				
Corn	30	27	26	17
Alfalfa	31	30	22	17
The number of revolutions of the knife drum is 1000 rev/min, and that of the jaws is 175 min^{-1}				
Corn	24	29	28	19
Alfalfa	26	33	23	18
The number of revolutions of the knife drum is 1000 rev/min, and that of the jaws is 200 min^{-1}				
Corn	19	28	31	22
Alfalfa	22	32	27	19

The same situation was observed when grinding alfalfa stalks in a drum grinder. In this case, when the number of revolutions of the bladed drum is 1000 min^{-1}, and the number of revolutions of the transmission blades is increased from 100 min-1 to 200 min^{-1}, the amount

of the fraction up to 5 mm in length in the crushed alfalfa stalks is reduced by 1.7 times, and the amount of the fraction up to 2 cm in length It can be seen that the fraction with a length greater than 2 cm has increased by 1.5 times and by 1.7 times.

This fully corresponds to the law that the cutting length of the stalks increases with the speed of the transmission shaft determined according to the above expression (8) and shows that the obtained analytical expression for determining the cutting length correctly represents the process.

Conclusions. A new analytical expression was obtained to determine the length of stalk cutting in a drum grinder, and according to this expression, the length of stalk cutting increases with the increase of the speed of the conveyor, and the length of stalk cutting decreases when the speed of the grinder drum and the number of blades in it increase. In order to check the correctness of this connection, the number of revolutions of the drum of the grinding device was set to 1000 min^{-1}, and the number of revolutions of the shafts transmitting the stalks was changed from 100 min^{-1} to 200 min^{-1}, with an interval of 25 min^{-1}. The amount of the fraction up to 5 mm decreased from 39% to 19%, and the amount of fractions up to 1 cm, up to 2 cm and above 2 cm increased by 28%, 31% and 22%, respectively, and in the content of crushed alfalfa stems, the length of 5 It was found that the amount of the fraction up to mm decreases by 1.7 times, the amount of the fraction up to 2 cm in length increases by 1.5 times, and the amount of the fraction with a length of more than 2 cm increases by 1.7 times, and the theoretical studies showed a sufficient agreement with the experimental studies.

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