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Abstract. At present time livestock, poultry and fish farming are being developed in Uzbekistan. In the feeding of livestock, poultry and fish, green feed ensures their rapid growth and reduces the accumulation of excess fat in them. For this reason, a chopper is developed for cutting green alfalfa, corn and legume stalks. Since the number of revolutions of the same transmission gears depends on the number of revolutions of the same feed to the feed chopping drum in the device, the number of revolutions of the feeders has been studied theoretically and experimentally. According to the theoretical studies, it was found that with the increase in the number of revolutions of the feed mills in the feed crusher, the work efficiency of the device increased and the cutting length decreased. In the experiments, the number of revolutions of the device chopping drum was set at 1500 rpm, and the number of revolutions of the jaws was varied from 100 rpm to 200 rpm. In experimental studies, the chopping quality of green corn and alfalfa stalks was at the demand level when the number of revolutions of the transmitters was 100 rpm to 175 rpm. However, when the number of revolutions of the transfer shafts was 100 rpm, the working efficiency of the grinder decreased by 1.3-1.4 times compared to the number of revolutions of the jaws 175 rpm. It is therefore advisable that the number of revolutions of the grinder bean be 175 rpm.

1.Introduction

The achievement of good results in feeding livestock, poultry and fish depends on the type and quality of feed given to them [1, 2, 3]. Dry roughage, green stalked feed, wet and succulent feed, concentrated feed, supplementary feed and other feeds are used in feeding livestock, poultry and fish [4, 5, 6, 7]. Although wheat, corn, sorghum and other cereals are grown in Uzbekistan [8, 9, 10], they are used as a concentrated feed from corn and sorghum, as well as wheat and sorghum from processed bran and shrot [11].

However, the excessive consumption of concentrated feeds leads to the accumulation of excess fat in animals. Among these foods, green foods promote the rapid growth of animals, poultry and fish and reduce the accumulation of excess fat in them. Green feeds include a variety of plants, including alfalfa, corn stalks, legumes, reeds and others. In order to rationally feed animals, poultry and fish with green feed, plants need to be cut and chopped [12, 13, 14, 15]. Taking this into account, by analyzing the existing chopping devices [16, 17, 18, 19, 20, 21, 22, 23, 24], research work was carried out to develop a green-stemmed feed chopper. As a result of the research, a chopper for preparing green stem feeds was developed (Figure1). In the developed device, the required amount of feed to the chopping drum

depends on the number of revolutions of the same feeder. Therefore, the number of revolutions of the feed chopper transmission gears was investigated.

2. Methods

The rules of higher mathematics and the laws of theoretical mechanics were used in the theoretical study of the number of revolutions of the feed choppers. In this case, it was assumed that the working surface of the supply rods was flat, and the rods were transferred to the rods of the same thickness. In theoretical studies, the effect of the number of revolutions of the transmission shafts on the performance of the copper and the cutting length of the feed was investigated.

The verification of the adequacy of the obtained theoretical research was carried out experimentally. In the experiments, the number of revolutions of the chopping drum was set to 1500 rpm and the number of revolutions of the pulleys was changed from 100 rpm to 200 rpm. Corn and alfalfa stalks were cut in a feed chopper. The working quality of the device was determined by the ratio of fractions in the cut feed content up to 5 mm in size, in the range of 5 - 10 mm and 10 - 20 mm, and in sizes larger than 20 mm. To do this, the chopped feed was divided into fractions of up to 5 mm in size, 5 to 10 mm in size, 10 to 20 mm in size and larger than 20 mm in the laboratory sieves, and their fractional composition was found in relation to the total crushed feed. According to the established requirements, the amount of fractions up to 5 mm in size in chopped feed for poultry and fish is more than 50%, the amount of fractions in the range of 5-10 mm is more than 30%, the amount of fractions in the range of 10-20 mm and larger is more than 20 mm. Not more than 20%.

3. Results and Discussions

As a result of the research, a grinder for crushing green stalks was developed (Figure 1):

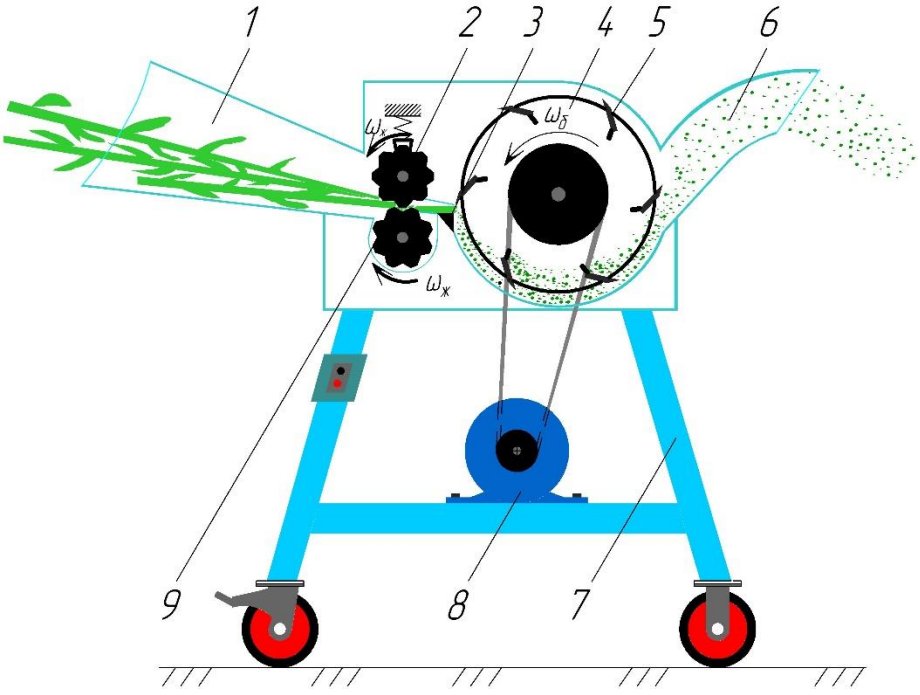

Figure 1. Green stalk chopper machine1-hopper; 2-top roller; 3- counter-cutting plate; 4-cutting drum; 5-cutting knife; 6-deflector; 7-frame; 8- electric motor; 9-bottom roller.

Chopping and feed cutting device consists of hopper 1, top and bottom roller 2 and 9, counter knife 3, cutting drum 4, cutting knife 5, deflector 6, frame 7 and motor 8. The operation of the equipment for coarse chopping unit is as follows (Figure1). The coarse chopping unit is capable of chopping green stalk feeds, and the stalk feeder passes hopper 1 to the roller 2 and 9. Then, rollers deliver to the cutting

drum 4 using a counter-cutting plate 3 and after completion of the chopping process, put in a special container.

The movement is transmitted by the transmission of the motor 8. It is possible to trim the stalks to the required length by varying the number of rotating shafts and cutting drum rotations. The operation of this device has no negative impact on the environment and nature. During the operation of the chopping device, it is important that the green-stemmed nutrients transmitted through the sloping roller are covered by the supply grooves and transmitted evenly to the chopping drum.

The main parameters of the rollers are their number of turns, width and the gap between the rollers. These parameters are mutually determined depending on the performance of the device. It is known that the mass permeability of the chopper, which corresponds to the efficiency of the chopper can be determined as follows

$$q = \eta S_j B_j V_{ut} \rho \tag{1}$$

where η – the coefficient of filling of the roller gaps;

B_r – width of rollers, m;

V_{pass} – velocity of the stem feeds pass between the rollers, m/s;

ρ – density of stem nutrients, kg/m^3.

Although the surface of the rollers is rough, but there is also a slight wear and tear during the transfer of stem feeds, the rate of passage of stem feeds between the stalks is as follows

$$V_{ut} = k_T \omega_j R_j \tag{2}$$

where k_s – coefficient of slipping;

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

R_r – radius of roller, m.

Thus, according to (2), (1) will be as following

$$q = \eta k_T B_j \omega_j R_j \rho \tag{3}$$

We will find angular velocity of the roller by formula (3)

$$\omega_j = \frac{q}{\eta k_T S_j B_j R_j \rho} \tag{4}$$

From another side

$$\omega_j = \frac{\pi n_j}{30} \tag{5}$$

where n_r – revolution number of roller, rpm.

By equating expressions (4) and (5), we determine the number of revolutions of the rollers

$$n_j = \frac{30q}{\pi \rho K_T S_j B_j R_j \rho} \tag{6}$$

In this expression, we obtain the radius R_r by the diameter D_r

$$n_j = \frac{60q}{\pi K_T \eta S_j B_j D_j \rho} \tag{7}$$

It can be seen from (7) the expression that the number of revolutions of the supply rollers is directly proportional to its productivity, and as the number of revolutions of the rollers increases, so does the productivity of the device. In addition, the number of revolutions of the feeders also affects the cutting length of the feed in the shredder. Depending on the length of the cut, the number of rotations of the supply rods will be as follows

$$n_j = \frac{900 N_n \omega_b l_{kir}}{\pi^2 k_T R_j} \quad (8)$$

where N_n – number of knives on drum, piece.

L_{cut} – cutting length of the stems, m;

$\omega_{dr.}$ – angular velocity of cutting drum, m/s.

It was found that the number of revolutions of the rollers should be 200 rpm according to the calculations on expression (7) and 150 rpm on expression (8). To verify the theoretical research carried out, an experiment was carried out by varying the number of revolutions of the feeders in the feed crusher from 100 rpm to 200 rpm. When crushing corn stalks, the number of revolutions of the stalks in the device was changed from 100 rpm to 200 rpm with 25 rpm. It was found that the amount of fractions from 10 to 20 mm increased from 1.1% to 10.8%, and the amount of fractions larger than 20 mm increased from 0.2% to 2.9% (Table 1).

Table 1. Variation in the degree of chopping of corn stalks depending on the number of rotations of the feeder

Fractional composition of crushed feed	Number of rotations of the rollers, rpm				
	100	125	150	175	200
Up to 5 mm, %	54.6	52.9	51.5	50.6	46.1
Up to 5-10 mm, %	44.1	42.8	41.9	40.8	40.2
Up to 10-20 mm , %	1.1	3.9	5.7	7.4	10.8
Older than 20 mm, %	0.2	0.4	0.9	1.2	2.9

When experimenting with the same method on alfalfa stems, the amount of fractions up to 5 mm decreased from 54.2% to 44.8%, the amount of fractions from 5-10 mm decreased from 44.1% to 31.6%, 10-20 It was found that the amount of fractions up to mm increased from 1.2% to 18.4%, and the amount of fractions larger than 20 mm increased from 0.5% to 5.2% (Table 2).

Table 2. Change in the degree of crushing of alfalfa stalks depending on the number of rotations of the supply stalks

Fractional composition of crushed feed	Number of rotations of the rollers, rpm				
	100	125	150	175	200
Up to 5 mm, %	54.2	52.9	52.4	50.2	44.8
Up to 5-10 mm, %	44.1	41.2	38.6	36.7	31.6
Up to 10-20 mm , %	1.2	4.8	7.4	10.7	18.4
Older than 20 mm, %	0.5	1.1	1.6	2.4	5.2

According to the results of the above experiments, the crushing quality of green corn and alfalfa stalks was determined when the number of revolutions of the shredder was 100 rpm to 175 rpm. At the same time, the content of fractions up to 5 mm in the chopped mass is 50.6-51.5-52.9-54.6% in corn, 50.2-52.4-52.9-54.2% in alfalfa. The amount of fractions up to 10 mm is 40.8-41.9-42.8-44.1 and 36.7-38.6-41.2-44.1%, those larger than 10 mm, namely up to 20 mm and the amount of fractions larger than 20 mm is 1.1-3.9-5.7-7.4% and 1.2-4.8-7.4-10.7%, respectively, and 0.2- 0.4-0.9-1.2 and 0.5-1.1-1.6-2.4%, which was found to be at the level of established requirements.

It was observed that when the number of revolutions of the chopper is 200 rpm, the quality of the chopper changes and does not meet the required level. The quality of crushing green corn and alfalfa stalks was in line with the demand level when the number of revolutions of the shredder was 100 rpm to 175 rpm, but it was found that the work productivity decreased by 1.3-1.4 times at 100 rpm to 150 rpm. Taking into account the results of the above experiment, the number of revolutions of the grinder was assumed to be 175 rpm.

4. Conclusions

1. According to the theoretical research, it was found that the increase in the productivity of the device and the decrease in the cutting length increased with the increase in the number of revolutions of the feeders in the feed chopper.

2. According to the experimental studies, the quality of chopping green corn and alfalfa stalks met the demand level when the number of revolutions of the transmitters ranged from 100 rpm to 175 rpm. However, when the number of revolutions of the transmission pulleys was 100 rpm, the working efficiency of the chopper decreased by 1.1-1.2 times compared to the number of revolutions of the pulleys 175 rpm. Therefore, the number of revolutions of the chopper should be taken as 175 rpm.

References

[1] Sadri H, Ghorbani G R, Alikhani M, Babaei M, Nikkhah A 2007 *Animal Feed Science and Technology* 195-204
[2] Ferreira F A, Passini R, Borgatti L O, De Souza RTYB, Meyer P M, Rodrigues PH M 2007 *Livestock Science* 151-160
[3] Dehghan-banadaky M, Corbett R, Oba M 2007 *Animal Feed Science and Technology* **137** (1-2)
[4] Bal M A, Shaver R D, Jirovec A G, Shinners K J and Coors J G *2000 Article in Journal of Dairy Scienc*e **6(83)** 1264-1273
[5] Zhang M, Sword M L, Buckmaster D R 2003 *Transactions of the ASAE* **46 (6)** 1503-1511
[6] Gapparov Sh, Karshiev F 2020 *IOP Conf. Series: Materials Science and Engineering* **883** 012158
[7] Gapparov Sh, Karshiev F, Astanakulov K, Makhsumkhonova A and Khudaynazarov D 2020 *IOP Conf. Series: Earth and Environmental Science* **614** 012158
[8] Astanakulov K 2020 *IOP Conf. Series: Materials Science and Engineering* **883** 012151
[9] Karimov M R, Khudaev I, Israilova D A, Astanakulov K D and Muradimova F B 2020 *IOP Conf. Series: Earth and Environmental* Science **614** 012141
[10] Fozilov G G, Kodirov B Kh, Astanakulov K D, Khudaev I, Shermukhamedov Kh and Umarova F 2020 *IOP Conf. Series: Earth and Environmental Science* **614** 012130
[11] Kurbanov N M, Adashev B Sh, Astanakulov K D, Fozilov G G and Boyturayev S A 2020 *IOP Conf. Series: Earth and Environmental Science* **614** 012129
[12] Zastempowski M, Bochat A 2014 *Applied Engineering in Agriculture* **3(30)** 4
[13] Agbetoye L A S and Balogun A 2009 *Proceedings of the 5th CIGR Section VI International Symposium on Food Processing, Monitoring Technology in Bioprocesses and Food Quality Management* 622-640
[14] Jibrin M U, Amonye M C, Akonyi N S and Oyeleran O A 2013 *International Journal of Engineering Inventions* **8(2)** 28-34
[15] Borotov A 2020 *IOP Conference Series: Materials Science and Engineering* **883** 012160
[16] Chen Y, Gratton J L and Liu J 2004 *Biosystems Engineering.* **4(87)** 417–424
[17] Momin M A, Wempe P A, Grift T E and Hansen A C 2017 *Transactions of the ASABE* **5(60)** 1551–1560
[18] Ge Yiyuan, Jiang Yongcheng, Li Yaqin, Liang Qiuyan, Wang Junfa, Du Shuang, Wen Xiaoxin and Zhang Jinbo 2018 *IOP Conf. Series: Materials Science and Engineering* **382** 032061
[19] Sridhar N and Surendrakumar A 2018 *International Journal of Agricultural Engineering* **11(1)** 3-29
[20] Thangdee D, Thangdee S 2019 *IOP Conference Series: Earth and Environmental Science* **301** 7
[21] Zastempowski M, Bochat A 2019 *MATEC Web of Conferences* **287** 01024
[22] Luxin X, Jun W, Shaoming Ch, Bosheng Z and Zizeng Y 2019 *Sugar Tech* **5(21)** 825–837
[23] Yiljep Y and Mohammed U 2005 *Agricultural Engineering International: the CIGRE Journal. Manuscript PM* **05** 004
[24] D Alijanov, Sh Abdurokhmonov, Y Jumatov and A Bozorboev 2020 *IOP Conf. Series: Materials Science and Engineering* **883** 012155