SUBSTANTIATION OF TECHNOLOGICAL INDICATORS OF CORN GRAIN IN THE MANUFACTURE OF FODDER FOR ANIMALS AND POULTRY

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The research is aimed at solving the problems of increasing the efficiency of fattening animals, taking into account the factors affecting the quality of preparation and manufacture of the final product using grinding equipment. For the efficiency and quality of feed produced for animals and poultry, the most important and responsible processes are those that are responsible for the preparation of raw materials for processing to conditions that meet consumer properties. The solution of such problems depends on many factors, such as the properties of the raw material, its moisture content, the physical characteristics of the processing material, and others. Features of the use of processing equipment, technological modes and rational processing modes are the key to the manufacture of a high-quality final product. Understanding the external factors when interacting with the working bodies of the machine allows you to set the most appropriate processing modes according to the degree of grinding of raw materials for the most efficient use in the composition of feed mixtures for animals and poultry through the use of a disk grinder. Thus, the most difficult and important task is the need to select the optimal indicators of raw materials for processing and technological modes of operation of machines to effectively ensure the preparation of the material processed at each technological stage of processing.
Key words: corn, grain, grinding, indicator, coefficient.

Formulation of the problem. Corn grain was selected as the object of research, which after its preparation can be used both independently and as part of manufactured feed mixtures. Qualitative preparation of raw materials for the formation of the feed mixture requires the use of grinders for grinding grain. Taking into account the properties of grain and technological parameters of the equipment is a problem that needs to be solved.

Analysis of recent research and publications. Analytical empirical expressions are obtained to determine the coefficients of external and internal friction of the grain, taking into account their dependence on the parameters W and P, which are recommended in practical conditions. The dependence of the coefficients of external friction on the working surface, μk and internal fk of particles on the humidity W and the load P on the processing raw material, which was at the level of 0.5 ... 6.0 kPa, was also investigated. To determine the confidence intervals for the evaluation of the studied parameters, a series of 10 experiments were implemented at W = 14% and P = 3 Kpa. It is established that with the growth of relics W and P there is an increase in the values of the coefficients μk. Maize fodder for the production of roughage for ruminants with crushed cobs that are processed to the state of bran has become widespread. Further use of such feeds is advisable in combination with concentrated and succulent feeds. All components of corn have the necessary signs of good digestion by animals and are easily digested. The nutritional value of corn products is difficult to overestimate because these products meet the nutrient balance requirements in feed. It is clear that corn grain must be properly prepared for use in feed, so it is the grinding that is given much attention. Corn grain consists of endosperm, shield, embryo and shell and has a different consistency.

Table 1. **The ratio of parts of corn**

№	Part of	Content,%
1	grain	34
2	stems	26
3	leaf	30
4	core	10

The embryo is 15% of the rest of the grain [1,2] and it also includes the integumentary film (pericarp) and seed (spermoderma) shell, which change during the formation and growth of the plant [3].

Corn grain also contains endosperm, shield, while the germ and shell are significantly different and have different consistency. According to the existing search data, corn in the state of its final ripening has a certain ratio of the components of the aboveground parts of corn, which are shown in table 1, the ratio of parts of corn.

Based on the analysis of the total chemical composition of individual components of corn in the process of its maturation and development (Table 2) shows that the highest fodder value has corn leaves and grain directly.

Table 2. **Chemical composition of corn grain by phases of ripening**

Phase vegetation	humidity,%	Content				
		protein	squirrel	fat	fiber	nitrogen-free extractive
Grain						
Dairy	76,88	14,88	13,44	4,49	4,14	73,41
Milk-wax	58,54	11,38	11,13	5,24	3,55	77,42
Wax	45,09	12,19	11,50	6,00	3,05	76,9
Complete	35,02	11,31	10,94	5,66	2,23	79,0

Content of starch and water-dissolved carbohydrates in certain areas of corn grain by phases of development (in% for absolutely dry matter).

Table 3. **Starch and carbohydrate content**

fraction head	vegetation phase					
	starch			carbohydrates		
	dairy	wax	full	dairy	wax	full
grain	41,80	65,20	72,30	7,58	1,52	0,56

Presenting main material. The study of particle size distribution in the production of feed with the formation of powdered formations is associated with the use of effective methods of preparation of raw materials for feeding animals and poultry, which in turn has a significant impact on feeding efficiency and ability to absorb nutrients. Corn grain by nature has differences in shape and their geometric characteristics can be characterized by diameter. Thus, the degree of grinding can be determined by the degree of their average diameter. The size of the final particles after treatment has the form of a fine fraction. The advantages of such treatment are the factors that during use contribute to the absorption of nutrients by increasing the surface area of the processing material, there is an improvement in technological properties during the formation of mixtures. It should be noted that too fine grinding, for example for the use of poultry feed has certain limitations. Thus, it was found that reducing the size of less than 1 mm does not lead to benefits, and the use of feed with increased particle size causes overflow of the bird's stomach. Therefore, the solution of the problem of using a balanced particle size depends on the effective preparation of raw materials and technological performance of the shredder. Technological indicators during the processing of raw materials are influenced by various factors, one of which is the angle of natural slope αk and moisture content of the processing grain. Thus, studies have shown that an increase in grain moisture causes an increase in the angle α and a decrease in the final particle size distribution. Thus, with an increase in humidity from 8 to 20 percent led to an increase in natural slope almost to the level of 49o from the initial 41 degrees, ie the scope of variation is 8o. For processing of the investigated raw materials it is recommended to accept αk at the level of 45o, when processing in a disk shredder. Similarly to the angle of natural slope αk, the angle of external friction of the material of treatment on the working surface of the shredder φ, which increases with increasing humidity W.
Experimental studies, determining the coefficients of external and internal friction of particles, taking into account their dependences on the parameters of humidity and pressure, allow to recommend for practical purposes the following values: μk = 0.45 ... 0.50; fk = 0.5 ... 0.6; f. Processing of experimental data obtained the following empirical expressions:

$$\mu_{\text{к}} = -1{,}43 \cdot 10^{-3} W^2 + 6.32 \cdot 10^{-2} W - 9.93 \cdot 10^{-2}; (1)$$

$$f_K = -1{,}13 \cdot 10^{-3} W^2 + 6.35 \cdot 10^{-2} W - 9.57 \cdot 10^{-2}; \; (2)$$
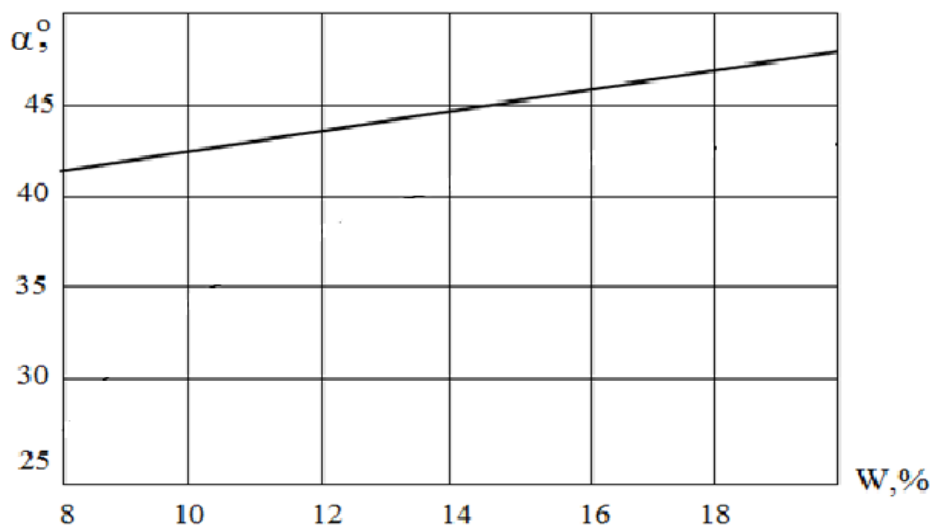
Fig. 1. The dependence of the angle αk on the moisture content of the product.

The dependence of the coefficients of external friction on the working surface, μk and internal fk of particles on the humidity W and the load P on the processing raw material, which was at the level of 0.5 ... 6.0 kPa, was also investigated. To determine the confidence intervals for the evaluation of the studied parameters, a series of 10 experiments were performed at W = 14% and P = 3 kPa.
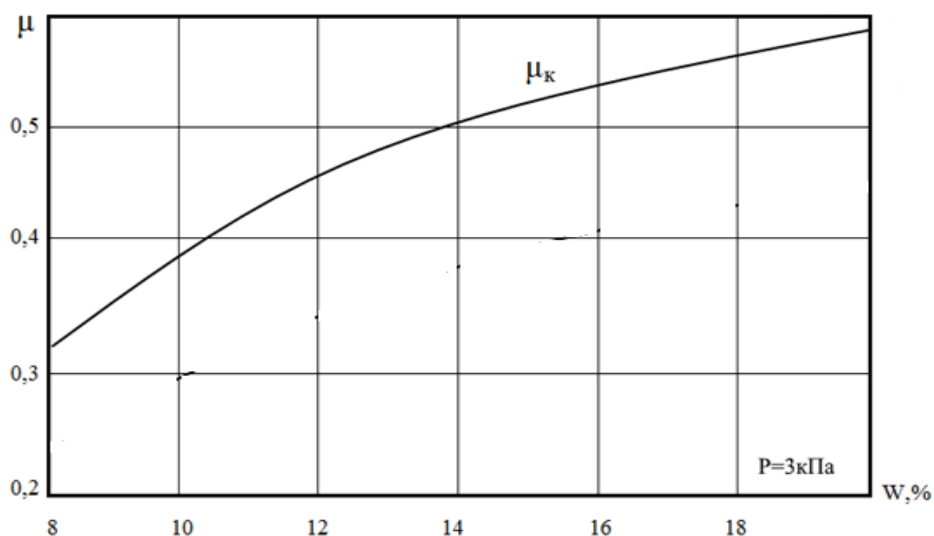
Fig. 2. The dependence of the coefficients of resistance to external shear of particles on the working surface μ k.

Conclusions. Based on the performed research, it is possible to recommend the degree of grinding of corn grain for poultry feeding at the level of 1 mm. The recommended value of the coefficients of external and internal friction of particles, taking into account their dependences on the parameters of humidity and pressure, is μk = 0.45 ... 0.50; fk = 0.5 ... 0.6; f.

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ОБГРУНТУВАННЯ ТЕХНОЛОГІЧНИХ ПОКАЗНИКІВ КУКУРУДЗЯНОГО ЗЕРНА ПРИ ВИГОТОВЛЕННІ КОРМІВ ДЛЯ ТВАРИН ТА ПТИЦІ

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Дослідження спрямовані на вирішення задач підвищення ефективності відгодівлі тварин за врахуванням чинників, що впливають на якість підготовки та виготовлення кінцевого продукту з застосуванням подрібнювального обладнання. На ефективність та якість кормів, що виготовлюють для тварин та птиці найважливішими та відповідальними процесами є такі які відповідають за підготовку сировини з метою її обробки до кондицій які відповідають споживчим властивостям. Вирішення таких завдань залежить від багатьох факторів, таких як властивості сировини, її вологість, фізичних характеристик оброблювального матеріалу та інших. Особливості використання оброблювального обладнання, технологічні режими та раціональні режими обробки є запорукою виготовлення якісного кінцевого продукту. Розуміння зовнішніх чинників при взаємодії з робочими органами машини дозволяє встановити режими найбільш доцільної обробки за ступенем подрібнення сировини, для найбільш ефективного використання у складі кормових сумішей для тварин та птиці, за допомогою використання дискового подрібнювача. Таким чином найбільш складною та важливішою задачею є необхідність вибору оптимальних показників сировини для обробки та технологічних режимів роботи машин для ефективного забезпечення підготовки матеріалу, який оброблюється на кожному технологічному етапі обробки.

Ключові слова: кукурудза, зерно, подрібнення, показник, коефіцієнт