

Particle size and physical characteristic of corn milling results using hammer mill as poultry feed ingredients

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Abstract

Feed ingredients used in poultry feed, generally require size reduction before being used in mixing rations, such as corn. The process of reducing the size of corn is the initial process that must be carried out for ration production. The machine that is commonly used to reduce the size is the hammer mill. This study aims to determine the particle size and physical characteristics of corn as a poultry feed ingredient by grinding using a hammer mill. The study was arranged using a completely randomized design with four treatments of amount of corn milled with three replications. The treatments were P1 = 5 kg, P2 = 10 kg, P3 = 15 kg, and P4 = 20 kg. Parameters observed were particle size and degree of fineness of milled results, bulk density, and specific gravity, angle of repose, capacity and efficiency of hammer mill machine performance. The results showed that the largest particle size was P4 at 3.167 mm with a fineness degree of 4.927 and the smallest particle size was P1 at 2.810 mm with a fineness degree of 4.756. Overall, the category of corn milling results using a hammer mill is the category of coarse milling results. The results of the analysis of variance showed that the amount of corn milled treatment had no significant effect on the angle of repose, specific gravity and bulk density of corn milled using a hammer mill. The difference in the number of milled corn does not affect the difference in the particle size of the corn produced from the milling results, so it does not affect the angle of repose, specific gravity and bulk density.

Keywords: Corn; Feed; Hammer mill; Particle size; Physical characteristics

1. Introduction

Poultry farming is mostly 60-70 percent of the cost of production is the cost of feed. Therefore, poultry farmers or feed producers are being challenged to find cost-effective ration nutrition and feed processing strategies to remain profitable [1]. Most of the ingredients used in poultry feed require size reduction before being used as feed ingredients, for example, corn.

Reducing the particle size of corn is the first step in the feed production process. The feed milling process is one of the most important activities and requires about 70% energy (power) compared to other processes in feed mills [2]. The general method that is widely used to reduce the particle size of the grain or feed material to a finer size is to use a roller mill and hammer mill.

Generally, hammer mills are used more often because of lower maintenance costs and simpler operations [3],[4], and are corn milling technology that works on the principle of impact [5]. Milling of feed ingredients using a hammer mill, one way to change the particle size by changing the size of the sieve (screen) with a smaller or larger hole diameter [6].

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Particle size is an important study material in relation to the digestive process and nutrient absorption by livestock, where in the digestive process there is a change in the ration particle size and solubility both mechanically and chemically [7]. Reducing the size or grinding of corn causes the surface area of the material to increase so that there is more interaction between digesta and digestive enzymes, as well as mixing uniformity (mixing), and reducing the separation of materials after mixing [8]. This study aims to determine the particle size and physical characteristics of corn as a feed ingredient by grinding using a hammer mill.

2. Material and methods

The research was conducted at the Feed Technology and Industry Laboratory, Faculty of Animal Science, Universitas Hasanuddin, Makassar, Indonesia. The study was arranged using a completely randomized design with four treatments of amount of corn milled with three replications. The treatments were P1 = 5 kg, P2 = 10 kg, P3 = 15 kg, and P4 = 20 kg. Corn was ground using a hammer mill with engine type specifications RD 85 DI-2S, capacity of 200 kg/hour, diesel motor 7.5/2200 HP/rpm, dimensions 46 cm x 32 cm x 31 cm, number of beaters 60 hammers, and 5mm sieve size (Figure 1).



Figure 1 Hammer mill machine used in research

The corn used was obtained from Takalar Regency as much as 150 kg which was divided into 4 (four) parts for each treatment, namely P1 = 15 kg, P2 = 30 kg, P3 = 45 kg, and P4 = 60 kg. The corn milling process with the corn procedure is put into the hopper of the hammer mill machine according to each treatment. Then the hammer mill machine is turned on and the milling time is recorded until the corn in the hopper is completely ground. The milled results were accommodated in a storage container (sack) and the weight of the milled corn was weighed and samples were taken for analysis of the research parameters.

Parameters observed in this study were particle size and degree of fineness of the milled results [9],[10], bulk density and specific gravity [11], angle of repose [12], and capacity and efficiency hammer mill machine performance [13]. The data obtained were analyzed using variance using Microsoft Excel Data Analysis [14].

3. Results and discussion

The degree of fineness and the average particle size of corn milled using a hammer mill are as shown in Table 1. The average degree of fineness is 4.834 with an average particle size of 2.973 mm. The largest particle size is P4 of 3.167 mm with a degree of fineness of 4.927 and the smallest particle size is P1 of 2.810 mm with a degree of fineness of 4.756. Overall, the category of corn milling results using a hammer mill is the category of coarse milling results.

The results of the mill in the coarse category use less energy or power in the grinding process than the results of the fine mill [15]. The finer particle size can decrease intestinal peristalsis and increase feed consumption and transfer rate, thereby reducing feed digestibility [16]. Coarse feed structure has been shown to positively affect nutrient digestibility and livestock performance [17].

Table 1 Degree of fineness and particle size of corn milling results using hammer mill

Treatment	Degree of Fineness (Modulus of Finenes)	Particle Size (mm)	Milling Results Category
P1	4.756	2.810	coarse particle size
P2	4.811	2.924	coarse particle size
P3	4.843	2.990	coarse particle size
P4	4.927	3.167	coarse particle size

Table 2 Average of angle of repose, specific gravity and bulk density of of corn milling results using hammer mill

Treatment	Parameters		
	Angle of repose (°)	Specific Gravity (kg/m ³)	Bulk Density (kg/m ³)
P1	29.8	1382.3	672.3
P2	26.9	1646.0	642.7
P3	28.8	1494.7	671.3
P4	30.2	1535.3	625.3

Table 3 Theoretical and Actual Performance Capacity, Hammer Mill Machine Efficiency in Corn Milling

Treatment	Theoretical Performance Capacity (kg/min)	Actual Performance Capacity (kg/min)	Efficiency of The Hammer Mill Machine (%)
P1.1	6.93	6.87	99.00
P1.2	8.54	8.46	99.00
P1.3	7.22	7.15	99.00
P2.1	10.00	9.95	99.50
P2.2	10.00	9.95	99.50
P2.3	10.91	10.85	99.50
P3.1	16.16	16.16	100.00
P3.2	15.99	15.99	100.00
P3.3	15.62	15.57	99.67
P4.1	19.91	19.86	99.75
P4.2	19.93	19.93	100.00
P4.3	19.94	19.94	100.00
Average	13.43±5.04	13.39±5.07	99.58±0.40

The degree of fineness indicates the uniformity of the grinding results or the distribution of coarse and fine fractions [10]. The larger the mesh size and the longer the sieving time, the smaller the particle size obtained. Feed particle size

is a critical point to measure feed digestibility and feed mix uniformity [18]. The difference in particle size in a milling process using a hammer mill is influenced by the type of grain used, the level of grain hardness, grain moisture content, screen size, motor speed and blade level used [1].

The average of angle of repose, specific gravity and bulk density of of corn milling results using hammer mill, can be seen in Table 2. The results of the analysis of variance showed that the amount of corn milled treatment had no significant effect on angle of repose, specific gravity, and bulk density of corn milling using a hammer mill. The difference in the number of milled corns did not affect the difference in the particle size of the corn produced from the milling results (Table 1), so it did not affect the angle of repose, specific gravity, bulk density.

The results of the calculation of the theoretical performance capacity, actual performance capacity and performance efficiency of the hammer mill machine in corn milling are as shown in Table 3. The average number of milled corn is 12.50 kg with an average corn milling time of 0.87 minutes and the weight of milled corn was 12.47 kg.

The theoretical performance capacity of the hammer mill machine is 13.43 kg/minute and the actual performance capacity is 13.39 kg/minute with a machine performance efficiency of 99.58%. The performance efficiency of the hammer mill machine of 99.58% is included in the high efficiency category. Performance efficiency 80%, meaning that the efficiency of using the machine is high, and if the efficiency of the machine's performance is below 80%, it means that the efficiency of using the machine is low [19]. The efficiency of the hammer mill machine performance in the corn cob milling process is between 90-99% [20].

4. Conclusion

The treatment of the amount of corn milled did not significantly affect the angle of repose, bulk density, the specific gravity of corn milled using a hammer mill. Corn feed ingredients that are ground using a hammer mill are categorized as coarse milled.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest.

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