J. Farm Sci., 35(4): (508-510) 2022

RESEARCH PAPER

Physical and engineering properties of animal feed mixture for development of pelletizer

SHRUTI THANEER[1], K.V. PRAKASH[1], DEVANAND MASKI[1], SUSHILENDRA[1] AND J. N. SREEDHARA[2]

[1]Department of Farm Machinery and Power Engineering
[2]Department of Veternairy Sciences
University of Agricultural Sciences, Raichur - 584 104, Karnataka, India
E-mail: shruthithaneeru03@gmail.com

(Received: November, 2021 ; Accepted: October, 2022)

Abstract: Feeding the livestock with feed mixtures play a very significant role in animal productivity, body health and milk yield of the animals. Imbalanced feeding and high cost of conventional feed, the productivity of the animal is decreasing. In order to overcome imbalanced feeding, the compound cattle feed in the form of pellets has to be fed. Pellets are produced by using pelletizer machine by studying physical and engineering properties of feed mixtures which will served as a baseline in design and development of pelletizer machine. In this present study, the properties considered are particle size, moisture content, bulk density, static coefficient of friction and angle of repose. The results showed that particle size, moisture content, bulk density, static coefficient of friction and angle of repose are found to be 2.5 mm, 9.5 per cent, 0.582 g cc^{-1}, 0.546, 36.44 degrees of feed mixture, respectively.

Key words: Compound cattle feed, Feed mixture, Milk yield, Pelletizer

Introduction

Feed mixture is any substances which is used for feeding the milch animals that consists of maize (35 %), wheat bran (25 %), groundnut cake (25%), mineral mixture (2%), molasses (10%) and salt (1%). Feed plays a very crucial role in animal feed industry and accounts for up to 70% of the total cost of livestock operation (Makkar *et al*., 2017). Feeding is the foundation of livestock systems as it directly or indirectly affects the entire livestock sector, including animal productivity, health, welfare and environment (Garg *et al*., 2014).

Physical and engineering properties are important for processing of feed mixture for design and development of pelletizing machine. Properties like bulk density and angle of repose play a significant role in free flow behavior and also important in determining and designing the hopper capacity. Bulk density is also useful in determing storage capacity. Further angle of repose determines power requirement of screw conveyor system of pelletizer because if there is more variation in angle of repose may lead to differences in internal frition that is, if higher the angle of repose more the internal friction and vice versa. Coefficient of friction plays an important role in the power requirements and material selection for equipment used in handling and storing agricultural commodities (Nyendu *et al.,* 2014).

Information and data on physical and engineering properties of feed mixture is quite low so far (Syamsu *et al*., 2015). Therefore it is essential to evulvate the physical and engineering properties of feed mixture which will serve as a baseline in designing and development of pelletizer machine. In view of pelletizer machine all the properties are studied as per the requirements to carry out the experiment. So, the physical and engineering properties of selected feed mixture are studied according to the standard procedures.

Material and methods

I. Physical and engineering properties of feed mixture

The physical and engineering properties of the feed mixture play a major role in design and development of pelletizer for making pellets. It is essential to determine the following parameters are explained in following sub headings

1. Particle size

Particle size is the second factor which influence about 20 per cent of pellet quality

(Reimer,1992). As a rule, the finer the particle is ground, the higher the quality of pellet obtained (Anon, 2017). As per National dairy development board Anand Gujart, the different feed ingredients used for making compound cattle feed in the form of pellets are mixed together in a suitable proportion as per feed formulation. The mixed feeds are ground to uniform particle size of 3 mm. Before feeding to the pelletizer machine, the ground material is further mixed. To obtain uniform particle size of 3 mm of feed mixture. The ANSI/ASAE Standard method S319.3 (ASABE Standards, 2008) was performed with screen size of 3 mm. The average particle size of feed mixture particles was obtained was 2.5 mm. The measurement was carried out and the mean values were reported.

2. Moisture content

Moisture content plays a significant role during pelleting. It is an important parameter for conditioning the feed mixture during pelleting process. The moisture content of feed mixture was determined by weighing the wet sample initially and this feed mixture is placed in electric oven at 103°C for 24 h and later the weight of dry feed mixture was noted after cooling (Abo-Habaga *et al*., 2017). The measurement was done and the mean values were reported.

$$MC(W_b\%) = \frac{\text{weightof wetsample - weightof drysample}}{\text{weightof wetsample}}$$

Where,

MC (W_b%) = moisture content in wet basis

3. Bulk density

The bulk density is the ratio of mass of material to total volume of the material. The bulk density was determined by measuring the cylinder with known mass and the volume. The container was filled with material to full volume without compaction and excess material was leveled off and weighed (Subramanian and Viswanathan, 2007). The measurement was taken and the average values were reported.

4.Static coefficient of friction

The static coefficient of friction of feed mixture is only determined because for any material with given moisture content the static coefficient of friction is higher than dynamic coefficient of friction. The coefficient of static friction was calculated (Subramanian and Viswanathan, 2007). The static coefficient of friction was determined given in Plate 1. The measurement was done and the mean values were reported.

$$\mu = \frac{F_2 - F_1}{N}$$

Where,

ì = Coefficient of static friction

F_1 = Force to cause sliding of empty container, N

F_2 = Force to cause sliding of filled container, N

N = Weight of sample, N

5. Angle of repose

Angle of repose is the angle made between base and slope of the cone formed on a free vertical fall of feed mixture on to a horizontal plane. It was determined by following the method described by Sahay and Singh (1994). The apparatus consisted of a hopper filled with mixture and circular iron platform supported by iron legs. The mixture was allowed to flow from the hopper over the circular iron platform. A heap of feed mixture was obtained on a circular iron plate. From the height and diameter of feed mixture heaped in natural pile, the angle of repose was calculated by using the following formula. The determination of angle of repose was given in Plate 2. The measured values were taken and the mean values were reported.

$$\Phi = 2 \tan^{-1} \frac{H}{D}$$

Where,

Ö = Angle of repose, degrees

H = Height of heap, mm

D = Diameter of heap, mm

Results and discussion

The physical and engineering properties of feed mixture, which are essential and necessary for the pelletizer machine design and development are found out using the procedure explained and presented in Table 1.

1. Particle size (mm)

The particle size of feed mixture before pelleting was determined. The average value of particle size was 2.5 mm

2. Moisture content (%)

The moisture content of feed mixture was determined. The moisture content with average value was found to be 9.5 per cent.

Table 1. Physical and engineering properties of feed mixture

Properties	Mean	SD	CV
Particle size (mm)	2.50	0.26	10.4
Moisture content of raw feed mixture (%)	9.50	0.31	3.26
Bulk density (g cc^{-1})	0.582	0.023	4.03
Coefficient of static friction, at 40 (%) moisture content	0.546	0.040	7.32
Angle of repose (degrees), at 40 (%) moisture content	36.44	0.750	2.06

Plate 1. Measurement of static coefficient of friction

Plate 2. Measurement of angle of repose

3. Bulk density (g cc^{-1})

The average bulk density of raw feed mixture was found to be 0.582 g cc^{-1}.

4. Static coefficient of friction

The average static coefficient of friction of feed mixture at 40 per cent moisture content were found to be 0.546.

5. Angle of repose

The average angle of repose of feed mixture at 40 per cent moisture content was observed to be as 36.44 degrees.

Conclusions

Physical and engineering properties of feed mixture play a significant role in design and development of pelletizer. Hence, for design and development of pelletizer the physical engineering properties are essential and required parameters as they serve as baseline. The average particle size, moisture content, bulk density, static coefficient of friction and angle of repose 2.5 mm, 9.5 per cent, 0.582 g cc^{-1}, 0.546, 36.44 degrees of feed mixture respectively.

References

Abo-Habaga M M, Bahnassi A F, Shabrawy T H and Haddad A W, 2017, Performance evaluation of pellets forming unit in local feed pelleting machine. *Journal of Soil Sciences and Agricultural Engineering*, 8(9): 431-435.

Anonymous, 2017, Improving pellet quality, available from https:// www.allabout feed. net/animal/feedprocessing/improving pelletqualitythekeyfactors/

ASABE standards, 2008, Method of determining and expressing fineness of feed materials by sieving. St. Joseph, Milch: ASABE.

Garg M R, Sherasia P L, Phondba B T and Hossain S A, 2014, Effect of feeding a balanced ration on milk production, microbial nitrogen supply and methane emissions in ûeld animals. *Animal production science*, 7(18): 1657-1661.

Makkar H P S, 2018, Feed demand landscape and implications of food-not feed strategy for food security and climate change. *Animal*, 12(8): 1744-1754.

Nyendu G C, Pflun S, Schmacher P, Bern C J and Brumm T J, 2014, Friction coefficients for dried distillers grains on eight structural surfaces. *Applied Engineering in Agriculture*, 30: 673-678.

Reimer L, 1992, Northern crops institute feed mill management and feed manufacturing technology short course. *California Pellet Mill Co. Crawfordsville, IN*.

Sahay K M and Singh K K, 1994, Unit operations of agricultural processing. *Vikas Publishing House Pvt Ltd,* New Delhi.

Subramanian S and Viswanathan, 2007, Bulk density and friction coefficients of selected minor millet grains and flours. *Journal of Food Engineering*, 81:118-126.

Syamsu J A, Yusuf M and Abdullah A, 2015, Evaluation of physical properties of feedstuffs in supporting the development of feed mill at farmers group scale. *Journal of Advanced Agricultural Technologies,* 2(2): 147-150.