Characteristics of Wafer Originated from Coffee Waste as Ruminant Animal Feed

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Abstract. Coffee waste is a by-product from processing coffee beans which has the potential to be used as a reinforcing feed material (concentrate) for ruminants. The waste of coffee fruit is physically quite large in composition, that is 48% of the pulp and the rest is waste. The disadvantages of this coffee waste to be used as feed are its high fiber content (21%), caffeine and tannin and its voluminous physical form. But all this can be overcome by fermentation using Aspergius Niger so as to increase its nutritional value. This research was carried out by making a feed composition including: P0 = 0% coffee husk waste (control) and 98.75% rice bran, P1 = 30% coffee husk waste and 68.75% rice bran, P2 = 60% coffee husk waste and 38.75 rice bran and P3 = 90% coffee husk waste and 8.75% rice bran. The variables observed were the physical characteristics of the feed wafer including: aroma, color and density and palability. Data was collected and analyzed using ANOVA and Duncan Range Test. The results showed the use of coffee husk waste should be used at a level of 30%, because it has a high palability value and low density and crumbs so it is easier for ruminant animals to consume.

Keywords: animal feed wafers, coffee husk waste, ruminant livestock, fermentation, composition (ratio)

1. Introduction

Feed has a very important role in livestock life. The cost of feed is the largest cost of the total production cost, reaching 70-80%. Feed limitations cause the capacity of livestock in an area to decrease or can cause disruption to normal production and reproduction. This can, among other things, be overcome if the potential of agriculture / industry and its waste are taken into account in the livestock business. Feed is one of the most important components for livestock growth. Because livestock require good food qualitatively and quantitatively to increase metabolic yield which can affect the development and growth of livestock. Utilization of agricultural and plantation waste is one way to find alternative sources of material. Efforts are being made to optimize these benefits as animal feed. One example of plantation waste that can be utilized is coffee husk waste.

Coffee is class of plants that produce large waste from processing. The waste is in the form of coffee husks, the amount of which ranges from 50-60% of the harvest. The nutritional content of good coffee husk can be used as ruminant animal feed, but it cannot be utilized optimally because there is a high crude fiber content of 21% [1]. Besides the obstacles faced in the use of coffee waste as animal feed is its voluminous nature, so it is still not widely used as animal feed.

One of the technologies applied to improve the benefits of coffee husk is to make it a source of fiber in the form of wafers. Wafer is a source of natural fiber feed which in its manufacturing process
experiences compaction with pressure and heating so that it has the same shape and length and width [2]. In addition, it has nutritional content and uses relatively simple technology so that it is easily applied as an alternative to ruminant feed. Ruminant livestock is one of the cattle that has a complex digestive system compared to other livestock. This can be seen from the ability of ruminants to produce microbial protein in the rumen. Where microbial protein plays a major role in the availability of total protein available to livestock that will be used for the needs of livestock itself [3]. According to (Khalil, 2016), giving ammoniated coffee husk waste by 15% for 42 days can increase the body weight of boiler chicks [4], as well as giving 30% fermented coffee husks and giving leguminosa (gamal and calliandra) 70% provide growth which is good in PE goats [5]. Through the fermentation process, several high-fiber wastes including coffee husks can be increased in nutritional value. With Aspergillus niger inoculants, coffee husk protein levels can be increased from 9.8% to 12.43%. So that it can substitute for the needs of bran which has been widely used as reinforcing feed, but must be imported from outside the location and the price is relatively expensive. Plantation wastes such as coffee, cocoa and fermented cashew waste can be used as a source of concentrated feed ingredients for livestock. Coffee plant waste has the potential to be used as a reinforcing feed material (concentrate) for livestock. Through the process of processing the nutritional content of coffee waste can be increased, especially the protein content [6].

Diversification of the use of by-products which are often considered as waste from agricultural and plantation activities has been carried out. (Milawarni, 2017) has stated that coffee husk can be used as particle board material [7] [8] and block compost making technology [9]. At present coffee husk can be utilized as feed that can encourage the development of ruminant livestock agribusiness in an integrated production system with agricultural and plantation patterns through environmentally friendly biomass recycling or known as ‘zero waste production system’. The development of the upstream agribusiness sector, such as the feed industry, is one of the supporters in the development of ruminants which will directly help solve the problems of farmers in terms of feed availability. The reality on the ground shows that there are still many farmers who provide raw food without regard to quality requirements, quantity and efficiency of their supply. As a result, livestock productivity is not optimal, even many of the farmers who suffer losses due to inadequate feed.

In addition to have a large influence on livestock productivity, feed is also a significant production cost in livestock business. Thus producing feed is not only required for the feasibility of aspects of the quality and adequacy of nutrition, but also how to produce feed that is economical, cheap and affordable by the ability of farmers. For this reason, it is necessary to do an effective way to feed ruminant animals, namely food preservation and feeding in the form of wafers. The physical properties of the wafer affect the quality of the feed and the device design process. [10] [11]. Testing the physical properties of the wafer is used to design a processing, storage and transformation device for the processing of feed ingredients. This study aims to determine the physical characteristics of the wafer including: color and aroma, density and palatability.

2. Material and Methods

Material used for making wafer feed consists of: coffee husk waste, rice bran, mollases, urea, NPK, salt (NaCl) and water. Treatment in wafer form was as follows: P0 = wafer with 0% coffee waste (control), P1 = wafer with 2.5% coffee waste, P2 = wafer with 5% coffee waste, P3 = wafer with 7.5% coffee waste.

The equipment used to make feed in the form of wafers is: wafer press machine, pressurized 200-300 kg / cm3, chopper machine, scales, media (where to mix the wafer feed ingredients) and tarpaulin. The composition of the treatment ingredients are: P0 = 98.75 Rice bran and 0% coffee husk, P1 = 30% coffee husk and 68.75% rice bran, P2 = 60% coffee waste and 38.75% rice bran, P3 = 90 % coffee husk and 8.75% rice bran.

2.1. Production of Wafer based Feed

The procedure for making feed wafers is as follows: (a) Coffee husk is fermented using the fungus Aspergillus niger. This fungus is dissolved with water, added mollasis, urea and NPK, then incubated for 24 hours. Fermentation is carried out on floors covered with beons, with tile roofs. Waste that is ready for fermentation is sprinkled on the surface of the media as thick as 5-10 cm. Furthermore, watered
with Aspergillus solution evenly. Watering is done with a shower (fat). Piles of material that has been watered again sprinkled with coffee waste 5-10 cm thick and watered back in the solution. And so on, so that the material has been piled up and splashed with Aspergillus niger liquid. Piles of coffee husks are covered with a clean tarpaulin that is tightly closed and incubated for 5 days. After 5 days disassembled and dried. (b) Next to the reduction stage, the finished feed is reduced in size using a chopper, so that the size is homogeneous and easy to print. (a) Feeds that are already small in size are inserted into a rectangular wafer mold measuring 20 cm x 2 cm x 5 cm. After that hot pressing is carried out at a temperature of 1500°C with a pressure of 200-300 kg/cm² for 5-10 minutes, then (d) the cooling process of the wafer by placing the open air for at least 24 hours until the water content and weight are constant. (e) Wafers are stored or packaged.

2.2. Design Experiment
The experimental design applied was a Completely Randomized Design (CRD), consisting of 4 treatments and 4 replications. The treatment is P0 = Wafer with coffee waste 0% (control), P1 = wafer with 30% coffee waste, P2 = wafer with 60% coffee waste, P3 = wafer with 90% coffee waste. The data obtained were analyzed by analysis of variance (ANOVA) and if it gave tangible results it was followed by the Duncan Test. Variables observed were the physical properties of the wafer consisting of color, aroma and density indigo.

3. Results and Discussion

3.1. Physical Properties of Feed Wafers:
The physical properties of the wafer are the basic properties of a feed ingredient. Testing the physical properties of the wafer is used to design a processing and storage device as well as the transportation of the wafer material processing industry. The physical properties of materials are much influenced by the water content and particle size of the material. Besides that, it is also influenced by the particle size distribution, shape and surface characteristics of a material. Material properties and changes that occur in feed can be used to assess and determine feed quality. In addition, knowledge about physical properties is also used to determine the coefficients of a process of handling, processing and storage. The shape, size and color of the wafers made from coffee waste are shown in Figure 1.

![Fig 1](image1.png)

Figure 1. The physical form of feed wafers made from waste coffee

In this study, wafers made from raw coffee waste produced are light brown to brown. This is due to the large amount of coffee waste composition used as wafer preparation. The more use of coffee waste as a wafer preparation material, the color produced will also be more brown. Especially for wafers that
contain 90% coffee waste composition. The brown color of the wafer that results from the non-enzymatic browning reaction is the reactions between organic acids with reducing sugars and between amino acids and reducing sugars. This wafer is a special fragrant-scented ingredient of coffee husk. Pressure and heating on the raw material can cause a Maillard reaction, so that the resulting wafer has a distinctive aroma of the wafer base material.

3.2. Feed Wafer Density Value
Wafer density is a measure of compactness of the particles in the sheet and is very dependent on the density of the raw material used and the amount of pressure applied during the wafer width. Wafers that have a high density will provide a dense and hard texture making it easy to handle, both storage and shaking during transportation and is expected to be more durable in storage. On the other hand, low-density feed will show a form of wafer that is not too dense and texture that is softer and hollow (porous), so it is estimated that it can only survive in storage for some time. The average value of wafer density made from coffee waste from the four treatments is shown in table 1.

Results of variance showed that the density of wafers made from raw coffee husk waste there was a significant difference (P <0.05) between treatments. Based on Duncan's test the difference in the value of the wafer density is in the treatment of P0 with P1, P2 and P3, but P1 is equivalent to P2 and P2 is equivalent to P3. The higher the use of coffee waste as a constituent of wafers, the more influence the value of the wafer density. The highest average wafer density value (0.73 ± 0.05) contained P3 treatment (90% coffee husk waste) and the lowest (0.54 ± 0.03) in P0 treatment (0% coffee husk waste).

Density greatly influences the physical form of the wafers produced and shows the density of wafers in the manufacturing technique. Raw material density is very dependent on the amount of compression given during the manufacturing process. Pressing pressure is carried out to create a bond between the surface of the adhesive and the adhesive material with the aid of a pressing device.

Table 1. Value of feed wafer density

| Repetition | Treatment | P0 | P1 | P2 | P3 |
|------------|-----------|----|----|----|----|
| 1          |           | 0.57| 0.58| 0.62| 0.73 |
| 2          |           | 0.51| 0.57| 0.64| 0.72 |
| 3          |           | 0.58| 0.55| 0.62| 0.78 |
| 4          |           | 0.52| 0.51| 0.57| 0.70 |

Average 0.54±0.03a 0.55±0.04b 0.65±0.03c 0.73±0.05c
Note: Average values with different superscripts on the same line show significantly different effects (P <0.05). P0 = wafer feed 0% coffee husk waste, P1 = wafer feed 30% coffee husk waste, P2 = wafer feed with 60% coffee husk waste and P3 = wafer feed 90% coffee husk waste.

Wafers with low density will have more free space or contact area between particles resulting in a large water absorption ability. Wafer density determines dimensional stability and physical appearance of wafer feed. The wafer density plays an important role in calculating the volume of space required for a material with a certain weight, for example filling silos, elevators and automatic dosing accuracy.

The wafer density can also be affected by the particle size value of the wafer compilation material. The density will increase with the increasing number of fine particles in a wafer feed. The high P3 and P4 density values are also due to the small particle size, while the large particle size in the P1 treatment causes the wafer density value to decrease.
3.2.1. Palatability of Feed Wafers

Palatability value of wafer made from raw coffee waste in this study is used as a support or indicator to find out how much ruminants (cattle) like the feed in the form of the wafer. This palatability test is carried out for 1 (one) month with ad lithium wafers. Palatability test results for wafers made from raw coffee waste can be seen in table 2.

The results of variance showed that there were significant differences (P <0.05) on the value of the feed wafer palability. Table 2 shows the P0 treatment has a higher palability of 4475.0 ± 66.1b g / head) when compared to other treatments. Except with the P1 treatment there is no significant difference. The high palability in the P0 treatment was due to the value of the density of the feed wafer that it had in the P0 treatment was lower than the other treatments, making it easier for consumption by ruminants.

| Repetition | Treatment | P0  | P1  | P2  | P3  |
|------------|-----------|-----|-----|-----|-----|
| 1          |           | 4300| 4275| 4240| 4210|
| 2          |           | 4270| 4270| 4300| 4250|
| 3          |           | 4340| 4340| 4235| 4235|
| Average    |           | 4303.3±66.1b | 4295.0±76.4ab | 4258.3±38.2a | 4231.67±25.0a |

Note: Average values with different superscripts on the same line show significantly different effects (P <0.05). P0 = wafer feed 0% coffee husk waste, P1 = wafer feed 30% coffee husk waste, P2 = wafer feed with 60% coffee husk waste and P3 = wafer feed 90% coffee husk waste.

The density of wafer feed can affect the palatability of livestock. Feed wafers that are too hard with high densities will cause the difficulty of livestock in consuming wafers directly so that it needs to be added with water when they are given and livestock in general prefer feed with low density. The results of this study indicate that the palatability of the wafer produced for all treatments is significantly different. This is likely to be greatly influenced by the type and composition of different coffee husks as a constituent of ruminant animal feed wafers.

4. Conclusion

Based on the physical test results of coffee wafers made from raw coffee waste and its palatability in ruminants (cattle), it was concluded that feed wafers containing 60% and 90% coffee husk waste had higher density values compared to the control treatment, so as to reduce the palability value. The use of coffee husk waste should be used at a level of 30%, because it has a high palability value and low density and crumbs making it easier for ruminant animals to consume.

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