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INTERNATIONAL JOURNAL OF PROGRESSIVE RESEARCH IN ENGINEERING MANAGEMENT AND SCIENCE (IJPREMS)
(Int Peer Reviewed Journal)
Vol. 05, Issue 01, January 2025, pp : 1500-1506
e-ISSN : 2583-1062
Impact Factor : 7.001

OPTIMIZATION OF SILAGE PRODUCTION FROM ELEPHANT GRASS (*PENNISETUM PURPUREUM*) WITH ADDITION OF STRAW AND RICE BRAN AS A PRESERVED ANIMAL FEED

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DOI: https://www.doi.org/10.58257/IJPREMS38318

ABSTRACT

Silage is a preserved animal feed from the process of storing and fermenting animal feed ingredients in airtight conditions with mixture of nutrients from lactic acid bacteria. The process of making silage requires the main ingredients, one of which uses elephant grass *(Pennisetum purpureum),* and uses additional ingredients that are often used, namely rice bran and straw with the aim of improving or maintaining the quality of silage. This study aims to determine the value of moisture content, pH, protein content and dietary fiber in a mixture of elephant grass with additional ingredients, namely rice bran and rice straw with the optimal ratio. Research methods includes four stages, namely 1) chopping elephant grass, 2) making silage with the addition of molasses and EM4 nutrients, 3) adding nutrients in the silage (rice bran and straw) in airtight conditions and 4) silage analysis. The variables in this study were the weight ratio of rice bran and straw (10:2, 10:3, :4, 10:5, and 10:6 g/g) and the weight ratio of straw and rice bran (3:8, 3:9, 3:10, :11, and 3:12 g/g). The silage results obtained a sour aroma (lactic acid bacteria), brownish green color, and quite smooth in texture. The silage moisture content of silage value was 30% of the weight of the entire silage and the average pH values of silage 4.5 (acidic). The optimum value of straw addition and rice bran addition in silage was obtained at a composition of 6 grams of straw and 10 grams of rice bran with protein values ranging from 3.5-4.7% and total dietary fiber values ranging from 14.5-17.3%.

Keywords: dietary fiber, elephant grass, protein, rice bran, silage.

1. INTRODUCTION

The shortage of fresh forage as animal feed has long been felt by farmers in Indonesia. Often farmers overcome this by providing makeshift feed that is easily obtained from the surrounding environment. Poor quality forage greatly affects livestock productivity, as seen from slow growth or minimal increase in body weight (BW). In the rainy season, there is sometimes an abundance of Forage of Animals so that the preservation of fresh forage called silage is expected to be one solution to overcome the problem of fresh forage shortages in the season of feed difficulties [1].

The principle of making silage is the fermentation of forage by microbes that produce a lot of lactic acid. Lactic acid produced during the fermentation process will act as a preservative so as to prevent the growth of putrefactive microorganisms. According to Hanafi [2], the preservation principle is based on the process of fermentation in the storage (silo). Plant cells for a while time will continue live and use the oxygen in the silo. When the oxygen has been used up, there is an anaerobic condition in the storage area that does not allow for the growth of mold or fungus. Acid bacteria will develop rapidly and will convert the sugars in the forage into organic acids such as acetic acid, milk acid, and alcohol.

With increasing acidity, the activities of other bacteria such as spoilers will be inhibited. At a certain degree of acidity (pH = 3.5) lactic acid bacteria can no longer react and the silage making process has been completed. One example of material for animal feed is elephant grass (*Pennisetum purpureum)* can be seen in Figure 1.

Figure 1: Elephant grass (*Pennisetum purpureum).*

Elephant grass is favored by ruminants because of its wide leaves, fine leaf surface hair, and soft stems, elephant grass is widely planted by farmers because it is dry-resistant, high productivity and has a high nutritional value (PK 7-13%) digestibility value (55-70%), so it has the potential to be used as preserved forage in the form of silage. Elephant grass also contains crude protein, which is 9.66%, but elephant grass contains high crude fiber, which is 30.86%. Excess elephant grass production can be utilized to anticipate the gap in forage production in the rainy season and dry season, besides that it can utilize excess production during the best growth. The elephant grass can be preserved, because it is a good animal feed ingredient to be preserved [3].

Elephant grass can be increased in nutritional value through fermentation, because fermentation can increase protein digestibility, reduce crude fiber content, and improve the taste and aroma of feed ingredients. Therefore, rice bran and ground corn are needed in making silage to maintain other nutrient content and reduce crude fiber. Fermentation is the process of breaking down complex compounds contained in feed ingredients into simpler compounds with the help of enzymes that take place in a controlled atmosphere.

In the fermentation process, preservatives are needed that are high in carbohydrate content such as fine bran, which functions to improve the aroma of silage, increase the digestibility of dry matter and accelerate the occurrence of an acidic atmosphere. According to Rasyaf [4], rice bran contains enough energy and protein and vitamins, but its weakness is that it has a high crude fiber content, perfect amino acids and low content of some vitamins and minerals. The protein content of fine bran is 12%-13%, fat content is quite high at 13% and crude fiber is 12%. Therefore, rice bran is used on a limited basis between 18-26% of the total ration.

The purpose of this study was to optimize the making of silage from elephant grass with the addition of straw and rice bran on protein content and food, and compare the silage with silage from other materials.

2. METHODOLOGY

2.1 Materials and tools

Materials used were elephant grass in Gunungkidul, Yogyakarta, molasses, EM4 (effective microorganism), rice bran and straw. Tools used were analytical balance, chopper, container, plastic, vacuum machine, pH meter, and oven.

2.2 Silage production stages

a. Preparation stages

The elephant grass material was withered in the sun for 15 minutes to reduce its water content. The withered grass was cut into 5 cm leaves using a knife and then weighed as much as 100 grams. The sample was then mixed with rice bran and straw with variables (10:2, 10:3, 10:4, 10:5, and 10:6) g/g, then repeated in the same ways for the second variable with straw and rice bran with variables (3:8, 3:9, 3:10, 3:11, and 3:12) g/g.

b. Mixing and fermentation stages

The nutrients mixture was made by adding nutrients from molasses 20 mL, effective microorganisms (EM4) as much as 20 mL in 1 L of water. The sample in stage (a) were added 5% nutrients from the weight of elephant grass sample then mixed until homogen. All samples were then put into plastic and vacuumed so that no air is contained in the plastic, after which they were pickled and put into a container or jar and then close the container tightly. After 14 days, the samples have become silage and they were observed.

2.3. Silage analysis

a. Physical appearance analysis

After conducting the fermentation process for 14 days, then each sample was observed visually with changes in color, texture, aroma and the presence of mold. The analysis of aroma, color, texture and mold followed the instructions according Soekanto et al. [5]. Assessment of aroma is done through the sense of smell (sour or rotten). Assessment of color is based on the degree of darkness or discoloration of the silage. Assessment of texture is done by palpating the texture (smooth, medium, or rough). The percentage of mold presence on the silo surface is obtained by separating the damaged silage, then weighing the weight with the following formula:

b. Moisture content

Determination of moisture content in silage is done by gravimetric method or method using a moisture meter such as a dryer. The first step in the gravimetric method is to take a sample of silage to be tested and weigh it accurately. The sample is then dried in an oven at 105-110^{o}C for 60 minutes. The sample is then removed and placed in a desiccator until the temperature drops. The dried sample then accurately weighed. Moisture content can be calculated using the formula:

$$\text{Moisture Content (\%)} = \frac{(initial\ weight\ of\ sample - dry\ weight)}{initial\ weight} \times 100 \quad (1)$$

c. pH analysis

The pH value was analyzed and measured using a digital pH meter

d. Protein Content Analysis

Crude protein content can be determined by the Kjeldahl method. This method consists of three stages, namely destruction, distillation and titration SNI ISO 1871:2015 [6].

e. Food Fiber Content Analysis

Analysis of food fiber content was carried out using the method enzymatic-gravimetric based on AOAC Official Methods 991.43 [7]. This method can directly measure total dietary fiber, soluble fiber, and insoluble fiber separately. The main process in this method is the removal of starch and protein enzymatically, precipitation of water soluble fiber components with ethanol, separation and weighing of dietary fiber residues, and protein and correction factors ash in the residue [8]. This method is relatively fast, easy, and makes it possible to analyze large numbers of samples automatically. This method has also been adopted by several countries as the official method for analysis of dietary fiber [9].

3. RESULTS AND DISCUSSION

3.1 Physical appearance results (in color, aroma, texture and presence of mold)

Silage color is one measure of silage maturity in the fermentation process. According to Ridla et al. [10], color changes are caused by the influence of temperature during the fermentation process and are also influenced by the type of raw material. Silage color is also influenced by the anaerobic atmosphere achieved in the silage making process. According to Saun and Heinrichs [11], good quality silage will produce a color that almost matches the color of the plant or feed before it is fermented, the color of silage can describe the results of fermentation, the dominance of acetic acid will produce a yellowish color while the slimy green color is triggered by the high activity of Clostridia bacteria that produce high amounts of butyric acid. Figure 2 is shown the silage results after 14 days.

Figure 2: Silage appearance after 14 days

The smell of silage turns sour because rice bran contains easily digestible carbohydrates that are utilized as an energy source by lactic acid bacteria, causing the silage to smell sour. The more the level of rice bran is increased, the more active the LAB is in producing lactic acid because the added rice bran is able to stimulate microbes so that they can digest soluble carbohydrates that cause the silage to smell sour.

Texture changes are caused by moisture content, silage texture is influenced by the moisture content of the material at the beginning of fermentation, silage with high moisture content (>80%) will show a slimy and soft texture, while silage with low moisture content (<30%) has a dry texture.

For the presence of mold, there is usually a tear in the silage wrapper. According Ratnakomala et al. [12] stated that failure in making silage can be caused by several factors including the wrong silage making process, silo leakage so that it does not reach an anaerobic state, the unavailability of soluble carbohydrates, and low initial dry weight which causes the silage to be too wet, triggering the growth of unexpected organisms. The results of the physical appearance silage with straw addition and rice bran addition were shown in Table 1 and Table 2.

Table1. Results of physical appearance silage with straw addition

Straw	Rice bran	Color	Texture	Aroma	Mold presence (%)
0 g	10 g	Green	Smooth	No	5
2 g	10 g	Green	Medium	No	15
3 g	10 g	Brownish green	Medium	Acidic (slight alcohol odor)	15
4 g	10 g	Brownish green	Medium	Acidic (slight alcohol odor)	15

5 g	10 g	Brownish green	Medium	Acidic (slight alcohol odor)	20
6 g	10 g	Brownish green	Medium	Acidic (slight alcohol odor)	15

Table2. Results of physical appearance silage with rice bran addition

Straw	Rice bran	Color	Texture	Aroma	Mold presence (%)
3 g	**0 g**	Light green	Smooth	No	5
3 g	**8 g**	Light brown	Smooth	Acidic (slight alcohol odor)	10
3 g	**9 g**	Light brown	Medium	Acidic (slight alcohol odor)	15
3 g	**10 g**	Light brown	Medium	Acidic (slight alcohol odor)	15
3 g	**11 g**	Dark brown	Rough	Acidic (slight alcohol odor)	20
3 g	**12 g**	Dark brown	Rough	Acidic (slight alcohol odor)	30

From Table 1 and Table 2, the average color in several samples showed a light brown color or brownish green. They are the addition of straw to silage with composition 3:10 until 6:10 g/g and the addition of rice bran to silage with composition 3:8 until 3:10 g/g. According opinion of Hermanto [13] that a good silage color is light yellowish brown. The darker the color of the silage produced, the lower the quality of the silage [14]

Furthermore, for changes in texture, all variables showed an average of medium texture. The silage texture value in this study was lower than that of Alvianto et al. [15], who added rice bran, cassava flour, and molasses of 10% each as a source of carbohydrates in vegetable waste silage.

In changes in aroma, a number of variables produce a sour aroma, this is in line with the opinion of Kojo et al. [16] which states that the sour aroma produced by silage is due to the process of making silage anaerobic bacteria actively working in producing organic acids so as to cause acidic conditions.

As for the presence of mold with an average value of 15%, this results were relatively higher than the research of Septian et al. [17] on the quality of market vegetable waste silage enriched with various additives and lactic acid bacteria with mold presence value of 3% (no mold).

1.2. Water content

Dry matter is one of the parameters in the palatability assessment of feed used in determining the quality of a feed, changes in dry matter can occur due to the process of substrate decomposition and changes in water content [18]. Changes in water content occur due to evaporation, substrate hydrolysis or metabolic water production. In the research results for moisture content showed a value of 30%, this result is lower than the results reported by Felly and Kardaya [19] which is 86.57 - 91.64% which conducted research on market vegetable silage enriched with various additives and lactic acid bacteria. The level of research results is also lower than the research of Risma [20] which is 30.14-32.18% about the nutritional content of pineapple crown silage fermented with the addition of various levels of bran.

1.3. pH levels

The formation of anaerobic conditions causes lactic acid bacteria to grow and develop and produce lactic acid so that the pH of the silage drops. Moran [21] states that the greater the content of lactic acid produced during the fermentation process, the lower the pH so as to inhibit the growth of spoilage bacteria and result in a longer shelf life of silage. The pH values of silage were shown in Table 3 and Table 4.

Table 3. pH values of silage with straw addition and rice bran constant

Straw sample	Rice bran (constant)	pH value
0 g	10 g	6
2 g	10 g	5
3 g	10 g	5
4 g	10 g	4
5 g	10 g	4
6 g	10 g	4
Average pH		**4,667**

Table 4. pH values of silage with rice bran addition and straw constant

Rice bran sample	Straw (constant)	pH value
0 g	3 g	6
8 g	3 g	4
9 g	3 g	4
10 g	3 g	4
11 g	3 g	4
12 g	3 g	4
Average pH		**4,333**

From Table 3 and Table 4, the average values of pH levels of 12 samples were at 4,5 (pH acid). This data indicates that silages were categorized as good, because according to Sandi et al. [22] that the quality of silage is classified into four categories, namely very good (pH 3.2-4.2), good (pH 4.2-4.5), moderate (pH 4.5-4.8) and bad (pH> 4.8).

1.4. Protein content and total dietary content

According to Reaves [23], during the ensilage process, lactic acid bacteria present in the forage will utilize the forage as an energy source and produce organic acids, especially lactic acid, so that the protein is broken down.

Dietary fiber is different from crude fiber. Dietary fiber consists of complex carbohydrates found in many plant cell walls that cannot be digested by digestive enzymes and cannot be absorbed by the human digestive system. Meanwhile, crude fiber is part of the fiber that cannot be hydrolyzed by chemicals such as H_2SO_4 and NaOH. Although it cannot be digested and absorbed by humans, dietary fiber has a function for health as a prevention of various degenerative diseases.

This research used 2 variations, namely straw addition and rice bran addition in silage. Figure 3 shows the profile of protein and dietary fiber content in silage with straw addition and Figure 4 shows the profile of protein and dietary fiber content in silage with rice bran addition.

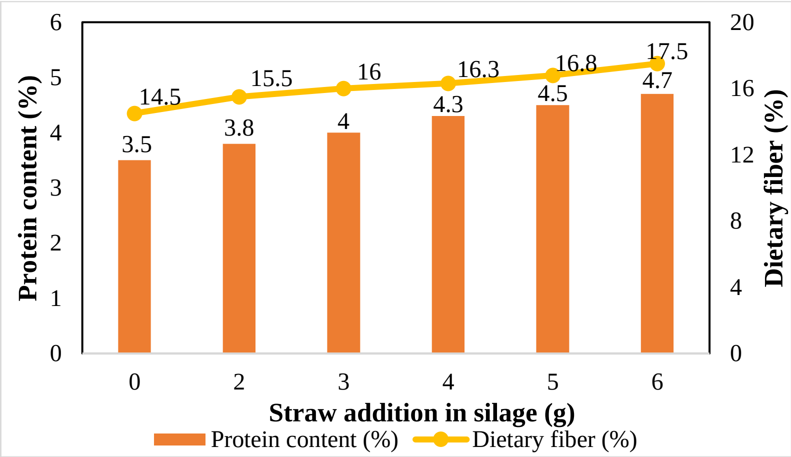

Figure 3: Protein content and dietary fiber profile of silage with straw addition and rice bran constant

From Figure 3, the optimal protein content was obtained at 4.7% and dietary fiber at 17.3% with the addition of 6 g straw and 10 g rice bran. This proves that more rice bran added into silage can increase of two parameters.

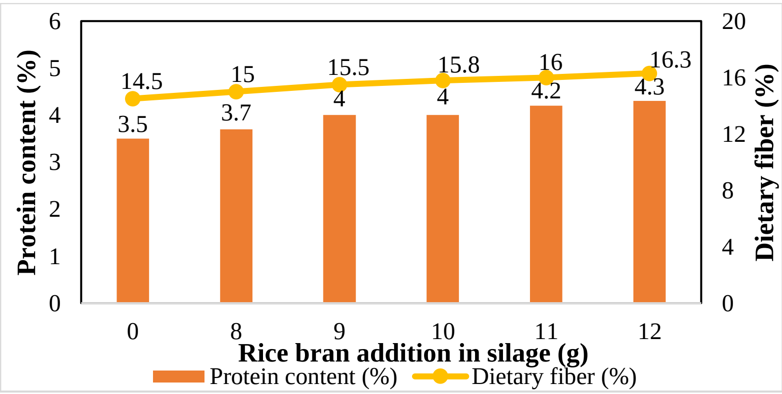

Figure 4: Protein content and dietary fiber profile of silage with rice bran addition and straw constant

From Figure 4, the optimal protein content was obtained at 4.3% and dietary fiber at 16.3% with the addition of 12 g rice bran and 3 g straw. This proves that more rice bran added into silage can increase of two parameters. The results of protein content in silage from Figure 3 and Figure 4 showed a range of 3.5%-4.7%. These results were higher than the Noviadi et al. [24] from 2.4% - 3.6%. For dietary fiber in silage with straw addition and rice bran addition, the results showed a range from 15%-17.5%. The results of dietary fiber in silage with straw addition and rice bran addition has met the minimum requirement, namely 13% [25]. The optimum composition of straw and rice bran addition in silage was obtained at a composition of 6 grams of straw and 10 grams of rice bran.

4. CONCLUSION

The results of silage from elephant grass with the addition of straw and rice bran showed a good physical appearance characterized by a brownish green color, a sour or alcoholic aroma and 15% mold. The moisture content of the silage was 30% and the average pH value was 4,5 (good silage). The highest protenin content in silage was obtained 4.7% and the highest dietary fiber in silage was obtained 17.5%. The optimum composition of straw and rice bran addition in silage was obtained at a composition of 6 grams of straw and 10 grams of rice bran.

ACKNOWLEDGEMENTS

The author would like to thank the Directorate of Research and Community Service, Universitas AKPRIND Indonesia for funding this research program.

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