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Quality and fermentation characteristic of corn stover - rubber cassava (*Manihot glaziovii* M.A) combination silage

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Abstract. Utilization of agricultural by-products as animal feed has enormous potential. The abundant availability and low prices make it a potential source of feeding commodities. However, seasonal availability and low quality of feed ingredients from agricultural waste becomes an obstacle to making it a quality feed with continuous availability. This research was conducted using Corn Stover (CS) combined with Rubber Cassava Leaves (RC) with different proportions (90: 0, 80:10, 70:20, and 60:30) as Silage and yellow corn (CY) as additives of the remaining 10%. Silage fermented by using a 1-liter silo tube model for 21 days of fermentation. The parameters observed were silage pH, dry matter content (DM), Fleigh score and crude protein content (CP). The results showed that the use of RC affects the pH and CP silage produced. The pH of silage becomes more acidic when there is an RC combination compared to the control due to WSC availability, as the BAL energy source substrate enough contained in the RC. It also occurs in CP content that linearly increases (8.47-16.04) when the proportion of RC increases because RC has a high CP content. Meanwhile, the use of RC up to 30% level did not affect the content of DM silage which resulted in the perfect silage Fleigh score (94.7-98.8). Thus, the use of RC as a CS silage combination material will be able to improve the quality of silage so as to increase the quality feed from agricultural by-products.
Keywords – silage, characteristic, quality, fermentation, fleigh.

1. Introduction

Utilization of agricultural by-products as animal feed has enormous potential. The abundant availability and low prices make it a potential source of feeding commodities. However, seasonal availability and low quality of feed ingredients from agricultural waste become an obstacle to making a quality feed with continuous availability. Therefore, it is necessary to process the agricultural waste material so it can improve the quality of its nutrients. Improving the quality of agricultural waste nutrients can be done through feed processing technology that has been widely used. Making silage as a feed preservation technology is not enough, this is because most of the agricultural waste has low quality and requires additional other ingredients that can improve its quality. Forage plant species suitable as silage feedstock should have high dry matter production in the field, high digestibility, low buffering capacity, and higher water-soluble carbohydrate (WSC) content [1].

The combination of Corn Stover with Cassava leaves has high protein content for silage materials and will be able to improve the quality and continuity of feed from corn farming. However, the use of forage feed that has a high protein (N) content, as a silage material, has the potential to constrain buffering capacity, where the pH of the silage will be difficult to decrease due to the alkali character of N. Buffering capacity refer to the

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number of moles of H^+ that must be added to 1 L of solution to decrease the pH by 1 unit [2]. Forages buffering capacity can be defined as the degree to which forage material resists changes in pH. All forages have different buffering capacities. Fresh forage with a high buffering capacity will require more acid to reduce its pH than forage with a low buffering capacity. Buffering capacity in forage and protein concentrate are 5.6 and 4.1 times higher than BC in grains [3].

This study was conducted to evaluate the Quality and Fermentation characteristic of Silage from Corn Stover and Cassava Leaves (*Manihot glaziovii* M.A.) combination.

2. Materials and Methods

Corn stover and rubber cassava leaves were chopped about ± 2 cm and wilted for ± 24 hours to reduce moisture content up to 60% [4], which is the optimal moisture content for fermentation. The DM content which is less than 20% will cause the risk of higher decay and loss of DM during ensilage process [5].

Table 1. Nutrient information of silage materials*.

Materials	Nutrient	
	Dry Matter (DM) %	Crude Protein (CP) %DM
Corn Stover (CS)	31.90	8.30
Rubber Cassava Leaf (RC)	22.37	26.44
Yellow Corn Meal (CY)	87.36	7.58

*Nutrition and Feed Science Laboratory Proximate Analysis of Animal Science Faculty, UHO 2018.

The material that has been mixed is put into a jar (silo tube) and compacted with to reduce oxygen levels in silo, so that the aerobic respiration phase gets shorter. The silos were closed and tightened using duct tape to be air tight (anaerobic). Silages were stored in a storage room that is protected from direct sunlight for 21 days [6], in general the lowest pH of the silage has been reached (phase V) [7].

This research was conducted using 80 days old Corn Stover (CS) combined with rubber Cassava Leaves (RC) (*Manihot glaziovii* M.A.) with different proportions (90: 0, 80:10, 70:20, and 60:30) as silage and yellow corn (CY) as additives of the remaining 10%. The research was design based on Complete Randomized Design, using 4 replications for each treatment. The data obtained were tabulated and analyzed using variance analysis. If the treatment has a significant effect, it will be continued with different test treatments using the Duncan Multiple Range Test (DMRT) posttest [8]. The observed parameters were:

1. Silage pH, obtained by juicing 5 grams of silage sample on 50 mldistilled water
2. Dry matter content (DM), obtained through proximate procedures,
3. *Fleigh* score (FS), calculated using the formula:
   $FS = 220 + [(2 \times DM\ (\%)) - 15] - (40 \times pH)$ [9],
4. Crude protein content (CP), obtained through proximate procedures.

3. Results and Discussions

3.1. Silage pH

Silage is one of the techniques of forage preservation at a certain moisture content levels through a microbial fermentation process by lactic acid bacteria called ensilage in a place called silo [10]. The degree of acidity or also called pH is one indicator to determine the quality of silage. The results showed that the inclusion of RC leaves significantly ($p < 0.05$) affected the pH of silage (Table 2.). CS silage combined with RC leaves has a lower pH compared to CS silage (4.45; 4.36; 4.40 vs. 4.75). A good silage pH is between 3.5 and 4.5 [11]. Addition of rubber cassava leaves to CS silage simply provides a substrate for lactic acid bacteria (LAB) to produce lactic acid, so therefore a decrease in pH occurs. A lower pH value is said to be due in the addition of RC with different percentage levels.

Rubber cassava leaves have high WSC (8.93% of DM) [12], which can be used by LAB as an energy source during the ensilage process. Low pH levels will inhibit the growth of undesirable bacteria (*Clostridium* and *Enterobacterium*), yeast and fungi that can cause damage [13].

3.2. Silage Dry Matter

The combination of corn stover and rubber cassava leaf levels did not have a significant effect ($p > 0.05$) on the silage DM content. The average of silage DM content of combination corn stover and rubber cassava leaves respectively CS 35.33%; CSRC1 36.65%; CSRC2 35.78% and CSRC3 35.80%. The result of this study proves that the fermentation process occurs in good conditions. This is indicated by the same value of silage DM content or relatively the same value between control and silage treatment.

The stable DM content in the range of 35-36% is considered to be influenced by the pH level of silage which is classified as an ideal pH so that the ensilage process will occur normally. Faster of pH decline, more silage dry matter will be maintained during the fermentation process [14].

3.3. Silage Fleigh Score

Fleigh score is a characteristic index of silage fermentation based on silage DM content and pH. *Fleigh* score between 85 -100 indicated silage in very good; 60 - 80 is good; 55 - 60 is moderate, 25-40 is fair, and less than 20 is low quality [9]. The combination of CS and RC in different levels did not have a significant effect ($p > 0.05$) on the *Fleigh* score. This is suspected as the implication of the DM content in all treatments that are relatively the same range (35.33 - 36.65%) and fairly stable pH of about 4, so that made the silages *Fleigh* score relatively the same. This phenomenon explained that the *Fleigh* score will be high if the silage has high of DM content and low of pH [15]. Silage DM content which reaches 36.65% reflects that the ensilage process is able to maintain and preserve the material, while the low pH value will give an idea that the ensilage process is in normal condition. The result of *Fleigh* score's calculation is in the range of 94.7 - 98.8, it is explained that silages are classified as very good quality.

Table 2. Silage Quality and Fermentation Characteristic

Parameters	Treatments			
	CS	CSRC1	CSRC2	CSRC3
pH	4.75 ± 0.14^{b}	4.45 ± 0.14^{a}	4.36 ± 0.14^{a}	4.40 ± 0.15^{a}
DM (%)	35.33±2.25	36.65±2.93	35.78±2.44	35.80±1.22
Fleigh	94.7±7.70	98.8±13.90	97.6±11.90	97.6±4.70
CP (%)	8.47 ± 0.50^{c}	12.93 ± 1.20^{b}	12.2 ± 1.60^{b}	16.04 ± 1.40^{a}

Different superscript in the same line means significantly different ($p<0.05$).
CS: 90% Corn Stover + 10% Corn Meal, CSRC1: 80% Corn Stover + 10% Corn Meal + 10% Rubber Cassava Leaves, CSRC2: 70% Corn Stover + 10% Corn Meal + 20% Rubber Cassava Leaves, and CSRC3: 60% Corn Stover + 10% Corn Meal + 30% Rubber Cassava Leaves.

3.4. Silage Crude Protein

Important events in the aerobic phase are proteolysis of forage protein which reaches 50% become amino acids, ammonia and amines. The enzyme's activity on proteolysis would stop when the acidity level increases. This phase should be passed as quickly as possible to preserve the silage nutritional content [16]. A significant increase in the CP content of silage proves that the higher the percentage of RC leaf inclusion linearly will increase the silage CP content. The increase in CP has thought due to the addition of non-legume protein sources forage such as rubber cassava leaves into corn stover silage. The low pH of silage (pH no more than 4) is successful in preventing CP from proteolysis in ensilage, which could reduce the activity of protein degradation by protein-degrading enzymes. The rate of proteolysis depends on the rate of decrease of pH in ensilage [16]. The acidic environment in silage will reduce the activity of protein-degrading enzymes. The pH value that goes

down at the start of ensilage is very useful to prevent the protein degradation. Optimal protease activity is at pH 4-7 depends on the used material [17]. The proteolysis process occurs during the ensilage if the level of acidity has not been achieved [18]. Crude protein content decreased from 0.8% to 0.6% at the beginning of the ensilage process [19].

4. Conclusion

Based on the research results, it was found that the combination of corn stover silage (60%) and rubber cassava leaves (30%) did not only increase the value of crude protein, *Fleigh* score and dry matter silage but also it has a lower pH than other treatments.

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