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Physical and Chemical Quality of Bento Rayap Grass Haylage (*Leersia Hexandra*) Supplemented with Water Mimmosa (*Neptunia Oleracea*)

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Abstract. The effect of water mimmosa addition on the physical and chemical quality of Bento Rayap grass haylage was evaluated. The haylage material was fermented for 21 days and the physical quality of the resulting product was analyzed through organoleptic test and proximate analysis. Research variables consist of several treatments i.e. A0 (100% Bento Rayap grass), A1 (90% Bento Rayap grass + 10% water mimmosa), A2 (80% Bento Rayap grass + 20% water mimmosa) and A3 (70% Bento Rayap grass + 30% water mimmosa). The parameters observed were (1) physical quality includes color, aroma, texture, fungus and temperature while (2) chemical quality includes dry matter (DM) content, organic matter (OM), crude protein (CP), crude fiber (CF), and acidity (pH). The analysis result shows the addition of water mimmosa improved the physical quality of haylage from Bento grass. Water mimmosa addition also affects the chemical quality of Bento grass haylage confirmed by variance analysis result which gave statistically significant difference ($P<0.05$). The property affected were DM, OM, CP, CF and pH. It was concluded that the addition of water mimmosa improved the physical and chemical quality of Bento Rayap grass haylage.

1. Introduction

The fluctuating availability of forage in the tropics is determined by the availability of land and season, in the rainy season the production is abundant and in the long dry season the production decreases so that there is a scarcity of forage sources [1]. In general, livestock business in Indonesia is still traditional and still relies on natural food sources so that it will affect the appearance of productivity that is not as expected. To overcome these problems, it is necessary to provide alternative forage sources from swamps.

Swamp forage is one of the feed ingredients that can be used to overcome the shortage of forage for livestock due to limited land availability. In addition, swamp forage can also provide a variety of feed ingredients for ruminants [2]. In connection with these conditions, technology is needed that can provide sustainable and quality animal feed. Several ways of forage preservation to provide forage throughout the year, such as making haylage (process of preserving forages using anaerobic fermentation technology). Anaerobic fermentation technology is more suitable to be applied in the provision of feed, this condition is because haylage has a low moisture content of 40-50% which

makes the haylage technology more durable. By making haylage, it can improve digestibility and feed efficiency and have good nutritional content [3].

Swamp grass forage that can be used as a feed ingredient for haylage is Bento Rayap grass (*Leersia hexandra*) and aquatic water mimmosa (Neptunia oleracea Lour). Bento Rayap grass (*Leersia hexandra*) is a source of fiber, has lower nutrients compared to swamp legumes [3[. Bento Rayap grass (*Leersia hexandra*) contains 11.98% crude protein (CP), 1.62% crude fat (EE), 27.39% crude fiber (CF), 82.15% NDF (Neutral Detergent Fiber), ADF (Acid Detergent Fiber) 51.60 % [4]. Water mimmosa legume is a type of swamp legume that has high nutritional content. The nutritional composition of water mimmosa (Neptunia oleracea Lour) consists of 28.02% CP, 2.02% EE and 17.25% CF [4]. Optimizing the use of swamp forage in the form of haylage can be done by combining swamp grass with protein sources such as legume, because the protein content of legume is quite high, so it is expected to be able to meet the nutritional needs of feed when given to livestock. Ridwan et al. [5] confirmed that Leguminosae addition on grass silage enhance physical quality and nutrient content. The aimed of this research are to evaluate the addition of water mimmosa (*Neptunia oleracea*) and its effect on the physical and chemical quality of Bento Rayap grass haylage and to obtain the effective formula on increasing haylage quality.

2. Methodology

2.1. Location and Duration

Place and Time his study was conducted in the Laboratory of Animal Nutrition and Feed, Faculty of Agriculture, University of Sriwijaya for 3 months.

2.2. Ensilage

The Bento Rayap grass (*Leersia hexandra*) and water mimmosa (*Neptunia oleracea*) was withered for 24 hours prior process to reduce its water content (±40%). Size reduction of samples were conducted by using chopper to obtain 3 cm in length. Molasses was acquired from sugar cane processing industry at Cinta Manis and added into silage as additive. The Bento Rayap grass combined with water mimmosa legume and molasses 5% was prepared according to research variables (w/w) design. Completely randomized design was used in silage making and comprise of four treatments and four replicates i.e. A0 (100% Bento Rayap grass), A1 (90% Bento Rayap grass + 10% water mimmosa), A2 (80% Bento Rayap grass + 20% water mimmosa) and A3 (70% Bento Rayap grass + 30% water mimmosa). All of materials prepared was placed in plastic tank (silo) of 5 kg capacity, compressed and closed to create anaerobic condition. The incubation process was conducted in room temperature (± 28 °C) for 21 days. During certain period of time, analysis on physical and chemical quality of product was carried out.

2.3. Haylage Sample Preparation

The haylage result after incubated for 21 days was split into two parts, the first part was dried and grinded to process further for proximate analysis while the second part was used for physical quality analysis (organoleptic) and pH determination.

2.4. Physical Quality Observation of Haylage Product

The physical quality of haylage was assessed through organoleptic test comprise of 15 panelists i.e. students and lecturer with food technology competence. The result of aroma, color and texture observation as well as fungus number on haylage were subjected to descriptive analysis [6].

2.5. Chemical Quality Determination of Haylage Product

The determination of pH were carried out using liquid extracted from haylage. The extraction procedure is as follows, samples (20 g) were placed in Erlenmeyer flask, 300 mL distilled water were added and then stirred for 30 minutes. The suspension was left for 24 hours [7]. Standard method was used to determine dry matter, organic matter, crude protein and crude fiber [7].

2.6. Data Analysis

Data obtained in this research was subjected to analysis of variance, the difference found out will be treated further using Duncan test using software SPSS 13.0 [8].

2.7. Observed Parameters

The observed parameters in this work were physical quality i.e. color, aroma, texture, fungus and temperature whereas chemical quality was assessed through dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF) and pH.

3. Result and Discussion

3.1. The Physical Quality

Physical observation carried out by 15 panelists, the haylage product displays good physical quality indicates by its aroma (sour smell or typical fermentation aroma no bad odor), solid texture (no clot, no mucus or crumb), yellowish green, a view fungi, harvest temperature below the environment (Table 1).

Table 1. The effect of water mimmosa addition on the physical quality of Bento Rayap grass haylage

Treatment	Aroma	Color	Texture	Fungi (%)	Temperatur (° C)
A0	Fermentation aroma	Yellowish green	Solid	3.5	27
A1	Fermentation aroma	Yellowish green	Solid	3.7	27
A2	Fermentation aroma	Yellowish green	Solid	5.3	28
A3	Fermentation aroma	Yellowish green	Solid	5.6	28

Note: A0 = 100% bento rayap grass, A1 = 90% bento rayap grass + 10% water mimmosa, A2 = 80% bento rayap grass + 20% water mimmosa, A3 = 70% bento rayap grass + 30% water mimmosa.

a) Aroma

The results showed that the Bento Rayap grass haylage termites obtained all displayed a fermented aroma. Fermentation aroma is affected by lactic acid bacteria activity and other heterofermentative bacteria. According to McDonald et al. [9], heterofermentative silage produce not only lactic acid but also acetic, propionic, butyric and alcohol. Sour smell shows that the silage is in good quality. Saun and Heinrichs [10] reported that good silage smells like milk due to lactic contained does not has strong aroma. Another factor affects the silage aroma is the addition of 5% molasses. Molasses contains water soluble carbohydrate such as sucrose. This disaccharide compound is easy to consume by microbe during ensilage process to produce high lactic acid and creates strong fermentation aroma.

b) Color

Throughout ensilage process, forage experience discoloration which depends on raw material type and temperature effect. High temperature at the ensilage process convert haylage color into brown as the Maillard reaction occurred [11]. The Bento Rayap grass haylage obtained, all display yellowish green or almost as green as should be. Macaulay [12] recommended that good quality of silage has color of light green to yellow or brownish green depends on silage raw material. McDonald et al. [9] described that good visual display, sour smell, color as similar as its raw material and low pH (3.9-4.1) expresses well fermented silage.

c) Texture

Haylage texture observation on each treatment after 21 days ensilage show all result have solid texture, compact and no mucus. No damage observed such as dry (moldy) and broken texture means all treatment produced good quality of haylage. The Bento Rayap grass withering prior the treatment made it has suitable water content approximately 40-50% for fermentation process. Macaulay [12] reported that water content of raw material influences the initial step of ensilage. High water content (>80%) will result in slimy texture, soft and moldy whereas low water content (<30%) produce dry

texture and moldy. Despal et al. [13] explained silage added with accelerator (molasses) displays intact texture, soft and no mucus, which designate minor damage of silage result during ensilage process.

d) Fungi

The presence of fungi on haylage process is a good indication of a successful process. The analysis showed that a few fungi were found in the treatment, namely 3.5-5.6%. The water mimmosa legume addition in general able to maintain the good quality of haylage result. This result confirmed by Bento Rayap grass haylage pH at 3.23 – 4.13 (Table 2). At this pH, the growth of decay bacteria can be suppressed. Water mimmosa legume addition into Bento Rayap grass haylage made no drastic change in pH and still maintain the ideal condition for haylage process. The legume added in the raw material also enhance silage material density due to its crude fiber lower than the Bento Rayap grass, so it affected the solidification level. High solidification level prevent air trapped in a silo and repressed undesirable fungus and microbial spores to grow. According to Donald et al. [14], the presence of fungi is related to the existence of air trapped in silo both at initial stage of ensilage and the silo leaks during storage.

e) Temperature

Average value of silage temperature during harvest process is at 27-28 °C. This is a good condition for silage production because it below environment temperature (± 29 °C). Ridwan et al.[5] reported the temperature range of harvest silage result is between 26 to 28 ° C and consider good as long as below open-air temperature. Temperature above the environment by 5-10 °C presumed silage contaminated by microorganism such as mold and fungus. As the ensilage process move forward, it triggers the air-tight within material and stimulates the lactic acid bacteria to produce lactic acid and prevent prolonged heat hence the temperature stabilized.

3.2. The Chemical Quality

The chemical quality observed on Bento Rayap grass haylage with the addition of water mimmosa is shown on Table 2.

Table 2. The effect of water mimmosa addition on the chemical quality of Bento Rayap grass haylage

Parameters	Treatments			
	A0	A1	A2	A3
Dry matter (%)	30.20^{a} ±0.65	31.02^{b} ± 0.64	31.23^{b}± 0.75	32.05^{c} ± 0.53
Organic matter (%)	28.09^{a} ± 0.71	28.73^{b} ± 0.62	29.19^{b} ±0.89	29.85^{c}± 0.39
Crude protein (%)	13.59^{a} ± 0.87	$17,85^{b}$ ± 1.08	18.24^{c} ±1.48	20.80^{d}± 0.76
Crude fiber (%)	24.21^{c} ± 0.45	22.9^{b} ± 0.67	22.66^{ab} ±0.64	22.33^{a} ±0.49
pH	$3,23^{a}$ ± 0.09	$3,72^{b}$ ± 0.29	3.82^{b} ± 0.29	4.13^{c} ± 0.37

Note: The numbers in the same row followed by different letters indicate significantly different at test level 5%. A0 = 100% bento rayap grass, A1 = 90% bento rayap grass + 10% water mimmosa, A2 = 80% bento rayap grass + 20% water mimmosa, A3 = 70% bento rayap grass + 30% water mimmosa.

a) Dry Matter and Organic Matter Content

The addition of water mimmosa at 10% (A1), 20% (A2) and 30% (A3) significantly difference ($P<0.05$) on DM and OM, while treatments between A1 and A2 shows no statistical significance different ($P>0.05$). This result means that water mimmosa addition increase the DM and OM content of haylage due to the higher DM and OM content of water mimmosa compare to Bento Rayap grass. Ridwan et al. [5] reported that increase amount of *C. Colothyrsus* added in *P. Purpureum* grass would enhance DM and OM content and it is also reduced NDF and ADF of the silage product. McDonald et al. [9] suggested that decrease in DM and OM content during ensilage is affected by nutrient contained in raw material and microorganism involved.

b) Crude Protein Content

The addition of water mimmosa at 10% (A1), 20% (A2) and 30% (A3) affects CP content significantly ($P<0.05$). Further test result indicates A1, A2 and A3 treatments statistically significance different with A0. The treatments also statistically significance among A1, A2 and A3. High nutrient content within water mimmosa legume improve microbial growth involved in haylage process hence increase its population. The microbe itself is single-cell protein resource thus it caused the increase of crude protein within silage as reported by Lima et al. [15].

c) Crude Fiber Content

The addition of water mimmosa at 10% (A1), 20% (A2) and 30% (A3) significantly difference ($P<0.05$) on CF. Legume added in haylage material caused decrease in CF content compare with result without legume. High nutrient of water mimmosa legume as discussed previously enhance the ensilage process to produce haylage, this event was accompanied by increase of cellulose and hemicellulose degradation. Schroeder [16] suggested that heterofermentative bacteria convert simple glucose to organic acids (acetic, lactic, propionic and butyric) which cause the decrease in CF content.

Crude fiber content obtained by A3 treatment provide best result among other treatments. In general, Water mimmosa legume added to haylage forage decreases the CF content of the materials.

d) pH Value

Statistic calculation result confirmed the addition of water mimmosa significantly difference ($P<0.05$) on the Bento rayap grass haylage pH (Table 2). Low pH shows better quality of silage [16]. Measurement result shows the average value of pH is 3.23 – 4.13. Low pH value obtained on haylage without the addition of water mimmosa legume (3.23) whereas high pH (4.13) obtained at legume addition by 30% (A3). The increase level of legume addition also tends to increase pH. water mimmosa legume has buffering capacity higher than grass. This buffering capacity climbs up during ensilage process due to the production of organic acids such as nitric and sulfuric acid which drove the pH to higher value [16]. Bento Rayap grass haylage in general has pH which resemble good quality of fermentation. According to Macaulay [12], silage quality can be classify based on pH by 4 types i.e. excellent (3.2 – 4.2), good (4.2 – 4.5), medium (4.5 – 4.8) and poor (pH > 4.8). Water mimmosa legume addition into Bento Rayap grass haylage made no drastic change in pH and still maintain the ideal condition for haylage process. The buffering capacity of legume can be suppressed by the presence of water-soluble carbohydrate from Bento Rayap grass. Lactic acid bacteria can still growth to produce lactic acid and lower the product pH [17].

4. Conclusion

It was concluded that the addition of water mimmosa improved the physical and chemical quality of Bento Rayap grass haylage.

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