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PHYSICAL QUALITY OF ELEPHANT GRASS SILAGE UNDER DIFFERENT ADDITIVE COMBINATION TREATMENTS

Kualitas Fisik Silase Rumput Gajah dengan Berbagai Perlakuan Kombinasi Aditif

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Abstract

Ruminant livestock plays a crucial role in global food security and economic sustainability, yet feed availability remains a major constraint, particularly during the dry season. Elephant grass (*Pennisetum purpureum*) is a promising forage due to its high biomass yield, but its quality is strongly influenced by seasonal variation and preservation methods. Silage technology offers an effective solution to maintain forage availability, and its quality can be enhanced through the use of additives. This study aimed to evaluate the physical quality of elephant grass silage using combinations of rice bran, molasses, and EM4 at different levels. The experiment using a completely randomized design (CRD) consisted of three treatments (control, bran + EM4, and molasses + bran + EM4). Parameters observed included colour, aroma, texture, and pH, assessed by trained panelists and measured with a pH meter. Analysis of variance (ANOVA) revealed significant effects (P<0.05) of additive combinations on most parameters. The best results were obtained with the combination of 3% molasses, 5% bran, and 5% EM4, producing silage with a boiled-leaf green colour, firm texture, strong sour aroma, and low pH, indicating optimal fermentation. These findings suggest that the combination of molasses, bran, and EM4 can serve as a practical reference for farmers in silage production. However, this study is limited to physical quality assessment; therefore, future research should analyze nutrient composition to provide a more comprehensive understanding of the nutritional value of elephant grass silage.

Keywords: Additives, Elephant grass, Physical Quality, Silage

Abstrak

Ternak ruminan memainkan peran penting dalam ketahanan pangan global dan keberlanjutan ekonomi, namun ketersediaan pakan tetap menjadi kendala utama, terutama selama musim kemarau. Rumput gajah (*Pennisetum purpureum*) adalah pakan yang menjanjikan karena hasil biomassanya yang tinggi, namun kualitasnya sangat dipengaruhi oleh variasi musiman dan metode pengawetan. Teknologi silase menawarkan solusi efektif untuk menjaga ketersediaan

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pakan, dan kualitasnya dapat ditingkatkan melalui penggunaan aditif. Studi ini bertujuan mengevaluasi kualitas fisik silase rumput gajah menggunakan kombinasi dedak beras, molase, dan EM4 pada berbagai tingkat. Eksperimen menggunakan desain acak sepenuhnya (CRD) terdiri dari tiga perlakuan (kontrol, dedak + EM4, dan molase + dedak + EM4). Parameter yang diamati meliputi warna, aroma, tekstur, dan pH, yang dinilai oleh panelis terlatih dan diukur dengan meter pH. Analisis varians (ANOVA) mengungkapkan efek signifikan ($P<0.05$) dari kombinasi aditif pada sebagian besar parameter. Hasil terbaik diperoleh dengan kombinasi 3% molase, 5% dedak, dan 5% EM4, menghasilkan silase dengan warna hijau daun rebus, tekstur padat, aroma asam yang kuat, dan pH rendah, menunjukkan fermentasi optimal. Temuan ini menunjukkan bahwa kombinasi molase, dedak, dan EM4 dapat menjadi referensi praktis bagi petani dalam produksi silase. Namun, studi ini terbatas pada penilaian kualitas fisik; Oleh karena itu, penelitian di masa depan harus menganalisis komposisi nutrisi untuk memberikan pemahaman yang lebih komprehensif tentang nilai gizi silase rumput gajah.

Kata kunci: Aditif, Rumput gajah, Kualitas Fisik, Silase

INTRODUCTION

Ruminant cultivation presents a promising business opportunity for communities, especially in improving food security and economic stability. Ruminant aquaculture plays an important role in global food supply and contributes to human and planetary health (Rivero *et al.*, 2021). Ruminant livestock farming is able to sustain the livelihoods globally of around 1.3 billion people (Davison *et al.*, 2020). The livestock sector is highly dependent on feed as it has a direct effect on nutrient absorption as well as overall maintenance efficiency (Moorby & Fraser, 2021). Feed also has a great influence on livestock health, productivity and overall agricultural profitability. Inadequate feed availability, especially during the dry season, limits milk production and livestock performance (Duncan *et al.*, 2023).

Forage is the main feed that provides most of the energy and nutrients for ruminant livestock (Callaway *et al.*, 2022). The main feed for cattle and sheep in England is grass (Barbour *et al.*, 2022). Elephant grass is a potential forage for ruminant feed because it has high biomass production up to 72,000 kg ha-1 year-1 dry matter if properly fertilized (Botero-Londoño *et al.*, 2021). The leaf fraction of elephant grass was noted to have a higher biomass quality compared to the stem, which contains more lignin (Barbour *et al.*, 2022).

Feed provision is the main obstacle in the development of the ruminant industry. Feed cost is the biggest expense in the ruminant industry (Palangi *et al.*, 2022). The quality, quantity and continuity of forage are greatly influenced by the season. The quality and quantity of forage directly affect the performance of animals (Shabier *et al.*, 2022). Forage quality in general has better nutritional quality and growth in spring and early summer (Adair *et al.*, 2022). Forage quality tends to decline in autumn and winter (Colas *et al.*, 2022). Climatic conditions such as temperature and rainfall greatly affect forage production, so forage production is higher in the rainy season compared to the dry season in the tropics (Ruggieri *et al.*, 2020).

Silage is a grass forage or legume that is fermented and preserved in anaerobic conditions (Du *et al.*, 2022). Silage can provide highly nutritious, palatable and easily digestible animal feed for ruminant livestock in times of forage shortage (Herrera *et al.*, 2023), but the quality is greatly influenced by the use of additives. Silage made with effective additives can increase livestock production because it provides dry ingredients that can increase dairy cow milk production (Menezes *et al.*, 2022). Lactic acid bacterial (LAB) additives, glucose, and cellulase have been shown to improve the fermentation quality of silage (Ma *et al.*, 2023). The use of additives not only improves the quality of silage but can reduce the production of volatile organic compounds (VOCs) and greenhouse gas emissions during the ensilient process

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(Auerbach *et al.*, 2020). The use of molasses as an additive has been shown to improve fermentation quality by increasing lactic acid content and reducing pH levels, which is critical for maintaining the nutritional value of forage (Li *et al.*, 2022). The addition of lactic acid bacteria, such as those found in EM4, has been shown to improve the quality of silage fermentation by lowering pH and increasing lactic acid content, which helps preserve silage and inhibit decaying organisms (Ma *et al.*, 2023). The combination of rice bran with Lactobacillus plantarum improves the fermentation process and improves the structure of microbial communities, which can improve the quality of silage (You *et al.*, 2022).

The use of additives such as rice bran, molasses and EM4 in the manufacture of silage has been widely carried out because it is the easiest additive material to obtain, especially in the eastern part of Indonesia. Combinations of additives such as bran, molasses and EM4 are key factors in silage success, But information about the best combination between the three additives is still not widely found. This research activity is important because it can provide information about the physical quality of elephant grass silage by providing various kinds of additives. The combination of various additives in the manufacture of elephant grass silage can be tested to maximize the quality of silage products. The research aims to test the physical quality of elephant grass silage given additives with different combinations. The results of the study will be a reference for farmers in making elephant grass silage using additives consisting of rice bran, molasses and EM4.

RESEARCH METHODS

Study area

The research was conducted in the Teaching Farm of the Department of Animal Husbandry, Pangkep State Agricultural Polytechnic, Pangkep Regency. The research location has a tropical climate. The research was carried out in October in the dry season with an average temperature of 28.3°C.

Procedures

The materials used in this study are elephant grass forage, molasses, bran, water and EM4 according to the treatment. This study consisted of 3 treatments with 4 replicates. So that the total experimental unit is 12 units. The Research using a complete randomized design (CRD) with the following treatment arrangements:

P0: No additives

P1: Bran 5% + EM4 5%

P2: Molasses 3% + Bran 5% + EM4 5%

Research procedure

Elephant grass is chopped to a size of 3-5 cm. After that, each was mixed with bran, molasses and EM4 level according to the treatment. The percentage of ingredients is based on the main ingredient which is elephant grass. After mixing and homogeneously, it is put into jars until it is solid, then fermented for 21 days. The mixture is inserted by pressing so that most of the air escapes. After that, the silo is sealed using clear duct tape to make it airtight. The silo container used is a round plastic jar with a capacity of 500 grams. Furthermore, observations were made on color, aroma, texture parameters and pH checking.

Parameter measurement

The physical quality test was carried out by the panelist test method using 10 people. The panelists used are trained panelists namely livestock students who already understood the

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quality characteristics of silage products. To ensure the objectivity of the panelists, the assessment was given without knowing the experimental unit being tested by providing a code to each sample. All panelists were left to assess all experimental units. All the panelists' assessments in each experimental unit were collected and then averaged. pH measurement uses a ph meter dengan prosedur sebagai berikut : 25 g of silage was mixed in 100 mL of distilled water (25:100) for 1 min in a 200-mL beaker and using a glass stirring rod (Bolsen *et al.*, 1992). The pH was monitored at 0, 5, minutes after mixing by using an electrode (pen model pH ATC). Before pH reading, the electrode bulb was rinsed in distilled water to remove any salt crystals. After rinsing, a 3-point calibration (4.01, 7.01, and 10.01 buffers) was performed. Afterward, the electrode's calibration was ascertained by checking the slope and offset of the meter. DuringpH reading, the electrode was immersed in the solution and the beaker or bag was gently turned to make good contact between the solution and the electrode. Because the solution was unfiltered, we avoided contact between the electrode and silage particles. Afterward, the electrode was rinsed well with distilled water and then dabbed lightly with tissues to remove any film formed on the electrode. All procedures were performed in a room at 25 ± 1°C (Bernardes *et al.*, 2019). While other parameters are tested based on fermentation scoring standards according to table 1.

Data analysis

The mathematical model that explains each observation value is as follows:

$Yij = \mu + \tau i + \epsilon ij$

For i = 1,2,3,4,5

j = 1,2,3,4

Description :

Yij = observation value on the ith treatment, the j repeat

μ = general middle value

τi = effect of the i-treatment

ϵij = experimental error on the treatment to - i and repeat to j

The data obtained was analysis of variance (ANOVA). All data analysis uses the SPSS version 24 application. If the results of the ANOVA show a real influence at the level of 5% ($P<0.05$), a further test is carried out by Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Physical Quality and pH Value of Elephant Grass with Different Combinations of Additives

The results of the quantitative variable ANOVA test on the physical quality and pH value of elephant grass with different combinations of additives can be seen in table 2. It was seen that the treatment had a noticeable effect ($P<0.05$) on all parameters.

The physical quality and pH value of elephant grass silage with the use of different combinations of additives are presented in Table 3. Further tests showed that there was a marked difference between all the treatments on all parameters.

A decrease in pH occurred in treatment with a combination of additive molasses, bran and EM4. In line with the color, odor and texture parameters also showed an increase in value in the combination of additive molasses, bran and EM4 treatments.

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Discussion

Feed processing technology must be applied to overcome feed constraints in the ruminant industry. Physical, chemical and biological processing pla to increase the digestibility of plant cell walls so that it is able to optimize the utilization of energy in the body of ruminant livestock (Tedeschi & Vieira, 2022). Feed processing technology is inherently effective to optimize the utilization of low-quality biomass for livestock (Dou *et al.*, 2022). Feed processing must be carried out to guarantee the quality, quantity and continuity of elephant grass. The use of the additives Acremonium cellulase and Lactobacillus plantarum 149 has been shown to increase the degradation of lignocellulose and increase the lactic acid content, thereby improving the overall fermentation quality (Chen *et al.*, 2022). The quality of silage can be improved by providing additive materials with the right combination. The use of LAB and formic acid in the manufacture of silage can increase protein content and lower pH (Wei *et al.*, 2021).

The silage process, which only lasts for 21 days, requires more additives so the combination of bran, molasses and EM4 is very appropriate to apply. Molasses is a source of glucose that is easily fermented so that it can be quickly used for LAB growth so that lactic acid production increases and lowers pH (Dong *et al.*, 2022). The addition of bran serves to provide a substrate for microbial activity and maintain a balance of water content that is essential for effective fermentation (Pongsub *et al.*, 2022). EM4 is a source of microbial inoculants that contain beneficial bacteria that can improve the fermentation process by increasing the population of desirable microorganisms such as LAB (Wagali *et al.*, 2023).

The use of additives with a combination of molasses, bran and EM4 has been proven to improve the physical properties of elephant grass silage. The results of the study showed that the pH decrease occurred in treatment with a combination of three additives. Additives help the decomposition process in the ensilase process by lowering the pH. The addition of additive combinations is able to lower pH. A drop in pH can inhibit decaying organisms and help maintain the nutritional quality of silage. The addition of lactic acid bacteria and molasses to native grass silage results in a lower pH and higher crude protein content (Li *et al.*, 2022). The combination of several additives can have a synergistic effect. For example, the combination of lactic acid, glucose, and cellulase bacteria in corn straw silage significantly increases the dry matter content, crude protein, and lactic acid, while reducing fiber content and improving aerobic stability (Ma *et al.*, 2023).

The low pH produced in silage products is caused by the activity of lactic acid bacteria. LABs, such as Lactobacillus plantarum and Lactobacillus casei can be used as inoculants in silage to increase lactic acid production, which is important for reducing pH levels. This acidification process is essential to maintain the nutritional quality of the silage and prevent spoilage by inhibiting harmful microorganisms (Jiang *et al.*, 2020). The addition of LAB from EM4 not only lowers the pH but also changes the microbial community in silage. LAB becomes the dominant microorganism, defeating unwanted bacteria and fungi, which further contributes to the stability and quality of silage (Li *et al.*, 2022).

The best color assessment is in treatment with a combination of additive molasses, bran and EM4. The color produced in silage products is green boiled leaves while the texture is not easily damaged. This can indicate that forage preservation is taking place perfectly because it still resembles the original color and texture of the forage. The preservation of chlorophyll during the ensilase process is essential to maintain the green color of silage, especially in silage derived from leafy materials (Fan *et al.*, 2020). The fermentation process in silage involves lactic acid bacteria, which play an important role in maintaining the texture of plant material. An increase in lactic acid bacteria, such as Lactobacillus, during fermentation helps maintain the structural

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integrity of the silage, preventing it from becoming easily damaged (Wróbel *et al.*, 2023). The resulting odor is a strong acidic smell. The resulting odor is directly proportional to the pH that has been measured. The addition of vanylic acid and pyroligneic acid additives can alter the fermentation process and microbial communities that will potentially affect odor (He *et al.*, 2021). The manufacture of hemp silage using LAB inoculants results in lactic acid production and a decrease in butyric acid and improves the odor profile (Wróbel *et al.*, 2023). LAB is essential in silage fermentation, producing lactic acid, which lowers pH and inhibits decaying organisms. This acidification is a key factor in the development of the acidic odor associated with silage (Guo *et al.*, 2023).

The use of additives that only combine bran has proven insufficient to provide an energy source for the decomposing microbes present in EM4. Therefore, it can be seen that the silage production in the P2 treatment is better than in the P1 treatment. The addition of real molasses provides a complete energy intake for the decomposing microbes. Molasses is an abundant source of carbohydrates, especially sucrose, glucose, and fructose that can be easily utilized by microorganisms. This material provides energy that is quickly available and efficient, thus supporting increased growth and microbial activity (Wang *et al.*, 2023). The energy obtained from molasses can be optimally used by microorganisms, thereby encouraging an increase in their metabolic activity and accelerating the growth rate. This condition is especially crucial in environments with limited availability of energy and nutrients (Chakrawal *et al.*, 2022). The right combination is the use of feed additives consisting of 5% bran, 5% EM4 and 3% Molasses. However, the results of this study are limited to physical quality tests, so it is very necessary to conduct research to test the quality of nutrients from silage products.

CONCLUSIONS AND SUGGESTIONS

Conclusion

The combination of additives in the form of 3% molasses, 5% bran, and 5% EM4 is proven to produce the best physical quality and pH of elephant grass silage, with a green color of boiled leaves, a texture that is not easily damaged, a strong sour aroma, and a low pH that indicates that fermentation runs optimally so that it can be used as a practical reference for farmers in making silage.

Suggestions

This study has limitations because it only tests the physical quality of silage, so it is recommended in future studies to analyze the quality of nutrients to obtain a more comprehensive picture of the nutritional value of silage.

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Tables

Tabel 1 Fermentation Scoring Standards

Parameters	Characteristic	Score
Colour	Blackish brown	1-3
	Brownish yellow	4-6
	Boiled leaf green	7-9
Smell	Rotten	1-3
	Medium sour	4-6
	Strong sour	7-9
Texture	Soft	1-3
	Medium	4-6
	Not easily broken	7-9

Note: Score criteria: 1-3 is not good, 4-6 is quite good, 7-9 is good. Source: (McEllhiney, 1994).

Tabel 2. ANOVA test of quantitative variables on Physical quality and pH value of elephant grass with different combinations of additives

Variable	df1	df2	F Value	A= 5%	
				F Tabel	Significancy
pH	2	9	54.16	4.26	*
Colour	2	9	7.59	4.26	*
Smell	2	9	941.49	4.26	*
Texture	2	9	20.58	4.26	*

Table 3. Physical quality and pH value of elephant grass with different combinations of additives

Parameters	Treatment		
	P0	P1	P2
pH	5,67±0,21[b]	5,81±0,13[b]	4,64±0,17[a]
Colour	7,30±0,82[a]	7,00±0,51[a]	7,83±0,09[b]
Smell	4,20±1,82[a]	5,53±0,94[b]	7,80±0,16[c]
Texture	6,20±0,16[a]	7,33±0,21[b]	7,78±0,56[b]

Caption: Different superscripts on the same line show a real influence (P<0.05). P0: No additives; P1: Bran 5% + EM4 5%; P2: Molasses 3% + Bran 5% + EM4 5% .