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Physicochemical Quality of Total Mixed Ration Silages Based on *Cynodon dactylon* and *Gliricidia sepium*

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ABSTRACT

A mixture of legumes with grasses has been shown to improve silage's physical and nutritional qualities. This study assessed the chemical composition and physical characteristics of *Cynodon dactylon* (CD) when mixed with different proportions of *Gliricidia sepium* (GS). Chopped and wilted leaves of CD and GS were mixed in the following combinations: P1: 0% GS + 78% CD; P2: 28% GS + 50% CD; P3: 39% GS + 39% CD; P4: 50% GS + 28% CD; P5: 78% GS + 0% CD. Each combination is enriched with 10% rice bran (RB), 10% Corn Feed (CF) and 2% molasses. A 750 g of the fresh materials were compressed into plastic jar silos and kept for 21 days. The physical characteristics and the loss of chemical composition of the silage were analyzed descriptively. pH value and the chemical composition data were subjected to analysis of variance (ANOVA) in a randomized complete design with five replications. Considering all physical and chemical characteristics, GS and CD can be combined as silage material. However, the study recommends including 28-39% GS (P2 and P3) as the most suitable in response to pH value, color, aroma, texture, and presence of fungus.

Keywords: Cynodon dactylon, Gliricidia sepium, Silage, Bermudagrass, Gamal

INTRODUCTION

South Kalimantan produces 584 tons of beef, which makes up 76.34% of the overall meat production on Kalimantan Island. The feed supply must be strengthened through adequate quality and quantity to achieve optimal productivity. A possible solution is to conserve forage through ensiling when there is high availability to use it during times of scarcity (Bueno et al., 2018). *Cynodon dactylon* (CD) or Bermudagrass is a viable species for roughage production in South Kalimantan. Fast-growing, disease-resistant, with numerous leaves, and highly palatable, CD is the preferred grass for cattle (Chen et al., 2023). According to Arriola et al. (2015), Cynodon species are often used for ensiling instead of hay-making due to reduced drying time. Avila et al. (2017) stated that milk composition and production of Holstein cows can be maintained by replacing CD hay with silage. However, the wild CD has a significant disadvantage as a fodder grass compared to a mature commercial hybrid (Li et al., 2021). Therefore, partially replacing poor roughage is essential to rescuing livestock production (Hills et al., 2015). According to Ahmed et al. (2018), a high fibre and protein content in fodder trees and shrubs could offer a solution for improving the quality and availability of feeds in ruminants that consume poor-quality roughage (Ahmed et al., 2018).

Moreover, mixing grass and legumes for high-quality forage production in terms of mixed silage has become increasingly popular to solve the imbalance of nutrients (Xue et al., 2020). Depending on availability and ease of finding by farmers, *Gliricidia sepium* (GS) or Gamal, a tropical legume that is drought-tolerant and grows well in tropical climates, can be used in the ensiling process (Miralestari et al., 2021). According to Santana et al. (2020), substituting soybean meal with GS silage in sheep's diet results in higher digestibility. Supplementing the mature goat basal diet of maize stover with GS improved the nutritional quality (Aregheore and Perera, 2004). Similarly, Rusdy et al. (2020) stated that the supplementation of GS in *Panicum maximum* basal diets increases dry matter and nutrient intake, digestibility, and nitrogen retention. Thus, the CD combined with GS is expected to be a solution for farmers in providing forages that can be available throughout the year. We hypothesize that adding GS simultaneously with CD will enhance the silage's physical and nutritional qualities. Thus, this study aimed to evaluate the effects of adding GS to CD at ensiling on the physical and nutritional quality of silage produced after 21 days of storage.

MATERIALS AND METHOD

Preparation of Fresh Forage

Gliricidia sepium (GS) and *Cynodon dactylon (CD)* leaves were harvested from the local area of the Pelaihari subdistrict district of Tanah Laut, South Kalimantan. Rice bran, corn feed, and molasses were purchased from local feed stores. After being wilted for 24 hours at 24-30°C, the fresh leaves were chopped to 2-5 cm. After chopping, 200 g of fresh forage was dried at 60°C for 48 h in duplicate. The dried material was ground to pass a 1mm screen and stored in glass bottles at room temperature (28±3°C) for chemical analysis (Table 1).

Table 1. Chemical composition of fresh materials

Component (%)	*Gliricidia sepium*	*Cynodon dactylon*	Rice Bran	Corn Feed	Molasses
Dry Matter	20.9	31,8	89.31	87.05	70.56
Crude Protein	18.1	7.27	11.14	8.5	4.33
Crude Fiber	23.9	30.89	16.71	2.57	0.15
Ether Extract	5.28	1.42	7.43	4.25	1.20

Ensiling Process

As required, chopped GS and CD were mixed with RB, CF, and molasses on a plastic mat. After mixing, approximately 750 g of the fresh materials were compressed into plastic jar silos (1000 ml capacity), with five jars per treatment. The jars fitted were sealed with plastic lids and then maintained at room temperature of 28-31˚C. The silage treatments and chemical compositions of each treatment were as follows (Table 2).

Table 2. Silage formulations and chemical compositions of each treatment

Ingredients	Treatments (%)				
	P1	P2	P3	P4	P5
Gliricidia sepium	0	28	39	50	78
Cynodon dactylon	78	50	39	28	0
Rice bran	10	10	10	10	10
Corn feed	10	10	10	10	10
Molasses	2	2	2	2	2
Chemical composition and pH of treatments					
Dry matter (%)	91.04	90.05	89.77	90.03	88.95
Crude protein (%)	7.48	8.76	8.78	11.35	11.37
Ether extract (%)	0.14	0.09	2.87	3.94	4.52
Crude Fiber (%)	26.76	25.82	18.65	21.11	12.16
pH	5.52	5.56	5.74	5.94	6.10

Analysis of chemical composition

The chemical composition of the initial materials and silage was analysed in the Laboratory of Feed Technology, Politeknik Negeri Tanah Laut. Before and after ensiling, A 200-g subsample from each treatment was placed in a paper bag and oven-dried at 60°C for 48 h for DM determination. Subsamples were ground to pass a 1-mm screen in a Waring (8010S acc to Thomas Scientific Cat. No 3390 D43) and were later analyzed for pre-ensiling pH and chemical composition. The pH was measured by weighing 1 g of the ensiled and silaged samples wet sample into a 50-mL beaker, adding 10 mL of deionized water, stirring, and then measuring using a La Motte pH five plus. Proximate analysis was conducted under the AOAC (2001). The parameters observed were dry matter (DM), crude protein (CP), ether extract (EE) and crude fibre (CF). The change in chemical composition was calculated by subtracting the post-ensiling from the pre-ensiling amount of nutrient, dividing it by the pre-ensiling amount and multiplying the value by 100%.

Physical assessment of the silage

After 21 days, the silos were weighed, opened, and the opening of the surface layer contaminated with fungi was removed. pH measurements of complete silage are done along with other physical quality assessments such as color, aroma, texture and the presence of fungus. The physical quality assessments were done through sensory evaluation, and the results were prepared based on the opinions of laboratory students of the Feed Technology Study Program, Politeknik Negeri Tanah Laut.

Statistical Analysis

The physical characteristics and the loss of chemical composition of silage were analyzed descriptively. The chemical composition data were arranged in a Randomized Complete design with three replications. After analysis of variance (ANOVA) using the Statistical Analysis System (SAS) program for Windows (Version 9.0, SAS Institute Inc., Cary, NC, USA), the differences ($p < 0.05$) between treatment means were compared using Duncan's New Multiple Range Test (DMRT).

RESULT AND DISCUSSION

pH and Chemical Characteristics of Silage

pH

The chemical characteristics of silage are shown in Table 3. The inclusion of GS significantly ($P<0.05$) affected the pH of CD silage. Treatment P1 and P5 exhibited the lowest pH values (3,76) and the highest (4.02). Generally, this indicated that increased levels of GS led to higher pH values. According to Chaikong et al. (2016), compared to low CP forages like grasses, high CP forages, such as legumes, contain a higher buffering capacity. As a result of lactic acid production during fermentation, the pH of the silage is lower (3.76 - 4.02) compared to the pre-ensiling form (5.52-6.10) (Figure 1). According to (Barboza et al., 2023), bacteria, yeasts, and pathogens cannot grow on surfaces with pH lower than 4.5. Research by Goeser et al. (2015) found that the pH range for grass-based silage stability is generally 3.5 to 4.5, whereas legume silage stability is 4.0 to 5.0. It indicates the optimal fermentation process of CD in this experiment, with or without the addition of GS. It could be due to the addition of rice bran and molasses, a common practice to enhance the quality of silage (Sarker et al., 2018; Sudarman et al., 2016). Sudarman et al. (2016) reported that compared to the control group, cassava leaf silage with additives (rice bran, molasses, and tapioca flour) had lower pH values.

Table 3. Chemical composition of silage after 21 days of storage

Treatments	Dry Matter (%)	Organic Matter (%)	Crude Fiber (%)	Ether Extract (%)	Crude Protein (%)	pH
P1	90.53±1.23^{a}	83.79±1.03^{a}	20.58±2.45^{a}	2.33±1.48	8.59±0.95^{c}	3.76±0.03^{c}
P2	89.14±2.97^{ab}	81.69±2.87^{a}	16.11±1.87^{b}	2.38±0.80	11.57±2.09^{b}	3.82±0.02^{c}
P3	86.15±4.32^{b}	76.73±3.69^{b}	13.36±1.14^{c}	3.45±0.33	13.14±1.74^{ab}	3.94±0,01^{b}
P4	89.96±2.01^{ab}	82.23±2.19^{a}	15.75±1.84^{bc}	2.82±0.77	12.98±2.59^{ab}	3.90±0,01^{b}
P5	90.31±2.42^{a}	83.33±2.13^{a}	10.27±1.89^{d}	2.84±2.03	15.25±1.46^{a}	4.02±0,03^{a}

P1: 0% GS + 78% CD + 10% RB + 10% CF+ 2% molasses; P2: 28% GS + 50% CD + 10% RB + 10% CF + 2% molases; P3: 39% GS + 39% GS + 10% RB + 10% CF + 2% molases; P4: 50% GS + 28% CD + 10% RB + 10% CF + 2% molases; P5: 78% GS + 0% CD + 10% RB + 10% CF + 2% molases.

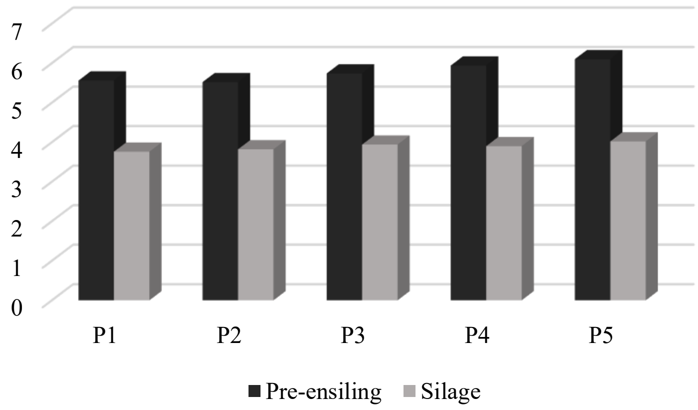

Figure 1. Changing pattern of pH values of different treatments

Dry Matter and Organic Matter

Table 3 showed that the inclusion of GS had a significant effect ($P < 0.05$) on DM and OM. Generally, the lowest DM and OM were observed on P3 and on average, 21 days of ensiling increased the dry and organic matter of the silages, except for a slight loss of 1.5% in P5 (Figure 2 A and B). Corresponding with the pH values indicates a good preservation of initial materials by the anaerobic condition. According to Ahmadi et al. (2019), the ensiled technique preserves fruit and vegetable waste with minimal dry matter and nutrient loss. During ensiling, the crop should be preserved so that its nutritional value remains as close as possible to its fresh value (Gouvêa et al., 2020)

Crude Fiber

The inclusion of GS significantly ($P<0.05$) affected the CF content of CD silage (Table 3). Corresponding to pre-ensiling material (Table 2), the lowest and highest CP content were obtained in P5 and P1, respectively. Crude fiber decreased by 10-37% in silage form compared to pre-ensiling (Figure 2. C). This result agreed with Al Koaik et al. (2014), who reported that fermentation of CD with rumen liquor reduced CF by up to 27%. The cell wall structure is changed during fermentation. By hydrolyzing lignocellulose and lignohemicellulose, microorganisms dissolve silica and lignin in fibre feed ingredients and break down their bonds (Sio et al., 2022).

Crude Protein

The inclusion of GS significantly ($P<0.05$) affected the CP content of CD silage (Table 3). The highest CP content was obtained in P5, followed by P3, P4, P2, and P1. Generally, according to the pre-ensiling material (Table 2), silage with a more significant proportion of GS had a higher crude protein content. Figure 2 showed that, on average, the CP content was increased by 14-49% after 21 days of fermentation. According to Barboza et al. (2023), due to amino acid degradation during fermentation, silage may have a higher CP content due to high ammoniacal nitrogen.

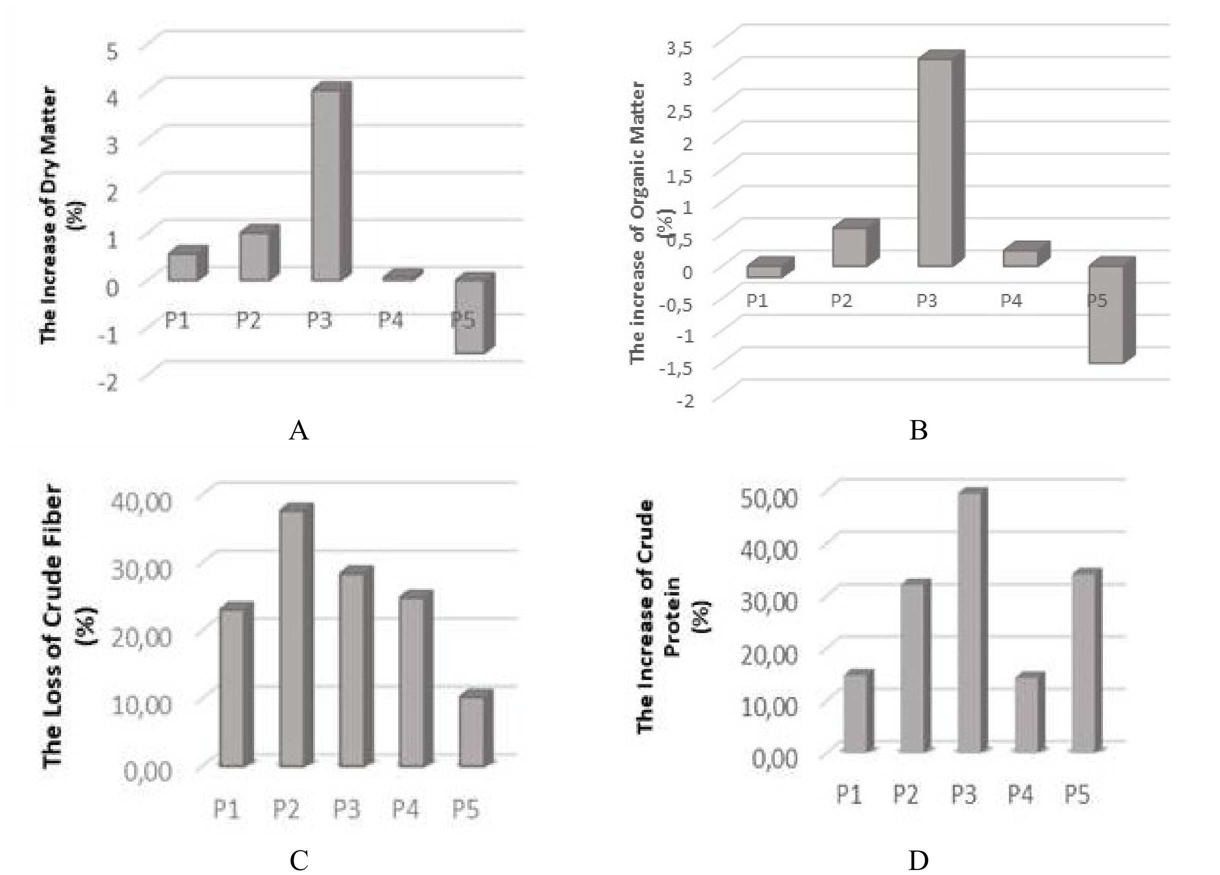

Figure 2. The change in Dry Matter (A), Organic Matter (B), Crude Fiber (C), and Crude Protein (D) after 21 days of storage.

Physical Characteristics of Silage

Table 4. The physical characteristic of silage is a combination of after 21 days of storage.

Variables	P1	P2	P3	P4	P5
Color	Brownish Yellow	Brownish Yellow	Brownish Yellow	Brownish Yellow	Brownish yellow
Texture	Relatively dry and coarse	Relatively dry and coarse	Relatively dry and coarse	Less dry and a bit soft	Less dry and a bit soft
Aroma	Sweet acidic	Sweet acidic	Sweet acidic	Acidic	Acidic
Fungus	None	None	None	Few on surface	Few on surface

P1: 0% GS + 78% CD + 10% RB + 10% CF+ 2% molasses; P2: 28% GS + 50% CD + 10% RB + 10% CF + 2% molases; P3: 39% GS + 39% GS + 10% RB + 10% CF + 2% molases; P4: 50% GS + 28% CD + 10% RB + 10% CF + 2% molases;P5: 78% GS + 0% CD + 10% RB + 10% CF + 2% molases

Color

Physical characteristics were evaluated to determine the effect of GS inclusion in CD silage during 21 days of storage. Silage containing 0-78% 5GS (P1-P5) was brownish yellow. According to (Tahuk et al., 2020), dark green to brownish-yellow silage indicates normal ensilage and is a good color indicator. Silage color is influenced by the use of different based ingredients (Tahuk et al., 2020) and the wilting process (Hapsari et al., 2016). Forage also turns light brownish due to molasses in the silage mixture (Hapsari et al., 2016).

Texture and Aroma

The extent of palatability of silage was possibly influenced by those materials' flavour, aroma, and texture. In terms of texture and aroma, none of the treatments showed any wet texture or unpleasant odour. However, silages containing 0-39% GS (P1-P3) had a drier texture and sweeter aroma than 50-78% GS (P4-P5). According to (Trisnadewi and Cakra, 2020), the source of fibre used for silage production determines the texture of the silage. In this experiment, silage containing 50-78% GS (P4 and P%) tended to be softer than that of P1, P2, and P3, probably due to the higher content of GS, whose texture is softer than CD. According to (Kung et al., 2018), because lactic acid is almost odourless, well-fermented silages shouldn't have a distinctively strong smell. Most silages, however, tend to smell like vinegar because acetic acid is formed by following lactic acid in the highest concentration, which is very volatile. The balance of sour and sweet aromas observed in silage containing 0-39% GS (P1, P2, P3) might indicate a better fermentation quality than P4 and P5.

Fungus

The presence of fungus was slightly observed in silages with GS inclusion up to 50% (P4 and P5). Legumes often have a higher pH than grass silages, and because of their more remarkable buffering ability, they ensile more slowly (Kung et al., 2018). These buffers neutralize part of the silage acids as they are created, decreasing the pH and increasing undesired mould. Legumes cannot be ensiled alone due to their high buffering capacity, low water-soluble carbohydrates, and risk of butyric acid formation.

CONCLUSION

Based on the results of the present study, it can be concluded that the inclusion of 29-39% *Gliricidia sepium* successfully enhanced the chemical composition and physical characteristics of *Cynodon dactylon* silage. Aside from the acceptable pH, color, aroma, texture, and the presence of fungus, the addition of *Gliricidia sepium* was also found beneficial to improve the protein content of the silage.

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REFERENCES

Ahmadi, F., Lee, Y.H., Lee, W.H., Oh, Y.K., Park, K., Kwak, W.S., 2019. Long-term anaerobic conservation of fruit and vegetable discards without or with moisture adjustment after aerobic preservation with sodium metabisulfite. Waste Manag. 87, 258–267. https://doi.org/10.1016/j.wasman.2019.02.010

Ahmed, M.A., Jusoh, S., Alimon, A.R., Ebrahimi, M., Samsudin, A.A., 2018. Nutritive and Anti-Nutritive Evaluation of Kleinhovia Hospital, Leucaena leucocephala and Gliricidia sepium with Respect to Their Effects on in Vitro Rumen Fermentation and Gas Production. Trop. Anim. Sci. J. 41, 128–136.

Al Koaik, F., El-Waziry, A.M., Khalil, A.I., Metwally, H., Al-Mahasneh, M.A., 2014. Evaluation of Conocarpus (*Conocarpus erectus*) leaves and Bermuda grass (Cynodon dactylon L.) using chemical analysis and in vitro gas production technique. Bulg. J. Agric. Sci. 20, 824–829.

Aregheore, E.M., Perera, D., 2004. Effects of Erythrina variegata, Gliricidia sepium and Leucaena leucocephala on dry matter intake and nutrient digestibility of maize stover, before and after spraying with molasses. Anim. Feed Sci. Technol. 111, 191–201. https://doi.org/10.1016/j.anifeedsci.2003.06.001

Arriola, K.G., Queiroz, O.C.M., Romero, J.J., Casper, D., Muniz, E., Hamie, J., Adesogan, A.T., 2015. Effect of microbial inoculants on the quality and aerobic stability of bermudagrass round-bale haylage. J. Dairy Sci. 98, 478–485. https://doi.org/10.3168/jds.2014-8411

Avila, A.S. De, Zambom, M.A., Faccenda, A., Inês, E., 2017. Tifton 85 bermudagrass (*Cynodon sp.*) fodder replaces Tifton 85 hay to feed lactating cows. Brazilian J. Anim. Sci. 46, 766–772.

Barboza, N., Brenes-Guillén, L., Uribe, L., WingChing-Jones, R., 2023. Silage quality and bacterial diversity of silages inoculated with Listeria monocytogenes and Lacticaseibacillus paracasei_6714. Rev. Biol. Trop. 71. https://doi.org/10.15517/rev.biol.trop..v71i1.50692

Bueno, A.V.I., Jobim, C.C., Rossi, R.M., Gritti, V.C., Leão, G.F.M., Tres, T.T., 2018. Wilting whole crop black oat with glyphosate for ensiling: Effects on nutritive, fermentative, and aerobic stability characteristics. Rev. Bras. Zootec. 47. https://doi.org/10.1590/rbz4720170142

Chaikong, C., Saenthaweesuk, N., Sadtagid, D., Intapim, Arunrung Khotakham, O., 2016. Local silage additive supplementation on fermentation efficiency and chemical components of Leucaena silage. Livest. Res. Rural Dev. 29.

Chen, J., Fan, S., Li, S., Cui, X., Amombo, E., Ji, M., Liu, X., Fu, J., 2023. Diversity analysis of agronomic and nutritional traits of hybrid offspring of forage bermudagrass. Front. Plant Sci. 14, 1–13. https://doi.org/10.3389/fpls.2023.1165707

Goeser, J.P., Heuer, C.R., Crump, P.M., 2015. Forage fermentation product measures are related to dry matter loss through meta-analysis. Prof. Anim. Sci. 31, 137–145. https://doi.org/10.15232/pas.2014-01356

Gouvêa, V.N., Vendramini, J.M.., Sollenberger, L.., Leite de Oliveira, F.., Dubeux Jr, J.C.., Moriel, P., Cecato, U., Soares Filho, C. V, Sanchez, J.M.., Yarborough, J.., Kuhawara, F., 2020. Inoculant effects on fermentation characteristics, nutritive value, and mycotoxin concentrations of bermudagrass silage. Crop. Forage, Turfgrass Manag. 1–7. https://doi.org/10.1002/cft2.20054

Hapsari, S.S., Suryahadi, Sukria, H.A., 2016. Improvement on the nutritive quality of napier grass silage through inoculation of Lactobacillus plantarum and formic acid. Media Peternak. 39, 125–133. https://doi.org/10.5398/medpet.2016.39.2.125

Hills, J.L., Wales, W.J., Dunshea, F.R., Garcia, S.C., Roche, J.R., 2015. Invited review: An evaluation of the likely effects of individualized feeding of concentrate supplements to pasture-based dairy cows. J. Dairy Sci. 98, 1363–1401. https://doi.org/10.3168/jds.2014-8475

Kung, L., Shaver, R.D., Grant, R.J., Schmidt, R.J., 2018. Silage review: Interpretation of chemical, microbial, and organoleptic components of silages. J. Dairy Sci. 101, 4020–4033. https://doi.org/10.3168/jds.2017-13909

Lima, R., Lourenço, M., Díaz, R.F., Castro, A., Fievez, V., 2010. Effect of combined ensiling of sorghum and soybean with or without molasses and lactobacilli on silage quality and in vitro rumen fermentation. Anim. Feed Sci. Technol. 155, 122–131. https://doi.org/10.1016/j.anifeedsci.2009.10.008

Miralestari, M., Sudarman, A., Suharti, S., Sofyan, A., 2021. Enhancing Physical-chemical Quality and Palatability of King Grass (Pennisetum Hyrid) Silage Treated by Combination of Water Soluble Carbohydrate and Legume Sources, in: 3rd International Conference of Computer, Environment, Agriculture, Social Science, Health Science, Engineering and Technology. pp. 270–275. https://doi.org/10.5220/0010041602700275

Rusdy, M., Yusuf, M., Ismartoyo, 2020. Utilization of Leucaena leucocephala and Gliricidia sepium as supplements by goats fed Panicum maximum basal diet. Trop. Anim. Health Prod. 52, 541–545. https://doi.org/10.1007/s11250-019-02040-8

Santana, J.C.S., Da Silva Morais, J.A., Dos Santos Difante, G., Ítavo, L.C.V., Gurgel, A.L.C., Da Silva Oliveira, V., Rodrigues, M.J.S.T., 2020. In vitro digestion characteristics of various combinations of elephant grass hay, gliricidia hay or silage, soybean meal and corn meal in rations for sheep. Trop. Grasslands-Forrajes Trop. 8, 147–152. https://doi.org/10.17138/TGFT(8)147-152

Sarker, L.R., MRI, K., MM, R., 2018. Ensiling of Wet Rice Straw using Biogas Slurry and Molasses in Monsoon of Bangladesh. J. Anim. Sci. Livest. Prod. 02, 1–5. https://doi.org/10.21767/2577-0594.100012

Sio, S., Bira, G.F., Batu, M.S., Pardosi, L., Mau, R.J., Klau, M.O., Hoar, J., 2022. Organoleptic Quality and Nutrition of Rice Straw Silage Utilizing Local Microorganisms of Cattle Rumen Fluid at Different Inoculum Levels. J. Adv. Vet. Res. 12, 36–41.

Sudarman, A., Amalia, R.N., Astuti, D. apri, 2016. Effect of molasses, rice bran and tapioca flour as additives on the quality and digestibility of cassava leaf silage. J. ISSAAS 22.

Tahuk, P.K., Bira, G.F., Taga, H., 2020. Physical Characteristics Analysis of Complete Silage Made of Sorghum Forage, King Grass and Natural Grass. IOP Conf. Ser. Earth Environ. Sci. 465, 8–14. https://doi.org/10.1088/1755-1315/465/1/012022

Trisnadewi, A.A.A.S., Cakra, I.G.L.O., 2020. Physical Characteristics, Nutritional Qualities and In Vitro Digestibility of Silage From Various Sources of Fiber. Pakistan J. Nutr. 19, 166–171. https://doi.org/10.3923/pjn.2020.166.171

Xue, Z., Wang, Y., Yang, H., Li, S., Zhang, Y., 2020. Silage fermentation and in vitro degradation characteristics of orchardgrass and alfalfa intercrop mixtures as influenced by forage ratios and nitrogen fertilizing levels. Sustain. 12. https://doi.org/10.3390/su1203087