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QUALITY OF SORGHUM (*Sorghum bicolor*)-CALOPO (*Calopogonium mucunoides*) SILAGE WITH ADDITIONAL OF ORGANIC LACTIC ACID

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ABSTRACT

Sorghum is a forage that has low protein content and used as source of energy, whereas calopo is a protein source feed. If sorghum and calopo are fermented, it makes it difficult to lower the pH so that the nutrient content is easily damaged. The aim of this study was to evaluate the physical and chemical quality of fermented silage in combination between sorghum (*Sorghum bicolor*) and calopo (*Calopogonium mucunoides*) which were added with different levels of lactic acid. The ratio of the combination of sorghum and calopo as ingredients for silage was 40: 60%. Silage was made in 1 liter silo which was fermented for 21 days. This study used a completely randomized design (CRD) with 5 treatments (control and 4 levels of lactic acid addition, namely 1, 2, 3 and 4%) and 4 replications. Parameters observed included color, aroma, texture, pH, dry matter (DM), and fleigh value (FV). The results showed that the increase in the percentage of lactic acid use showed good physical quality (brown yellow color, citrus aroma and crumb texture) of silage. Chemically, the higher the level of addition of lactic acid to the sorghum-calopo silage, the DM content increased from 17.84% to 20.53%, decreased pH from 4.93 to 4.0 and increased FV from 43.33 to 86.0. The conclusion in this study was the use of lactic acid up to 4% in the silage of the combination of sorghum and calopo still showed good quality as indicated by FV 86 and pH 4.00.

Keywords: Silage; Sorghum; Calopo; Organic Lactic Acid

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INTRODUCTION

Sorghum is a forage that can be an alternative source of animal feed. Sorghum is drought tolerant compared to other forages and can grow in almost all types of soil. Sorghum can be developed to support animal feed needs because it has a fairly high biomass. Biomass from primary sorghum plants reached 43.0 ton ha^{-1} and in the first ratoon it was 22.6 ton ha^{-1} (Efendi *et al*, 2013). However, sorghum has a low crude protein (CP) content of 7-8% (Kurniawan *et al,* 2019[a]) and a high starch content as an energy source (Hidayat, 2021; Sukria *et al*, 2022), so if it is preserved in silage it must be combined with other forages so that the nutritional quality is better.

Forage preservation in the form of silage can be combined with using forages with low and high CP content so that the resulting silage has high nutritional value. Forages that have a high CP content and can be used as silage material are legumes. One of the legumes that has the potential to improve the quality of silage is calopo. However, the high CP (nitrogen) content in calopo can be alkaline and affect the carrying capacity (silage pH is difficult to lower due to the alkaline nature of nitrogen) (Kurniawan *et al,* 2019[b]).

Tropical forages generally contain high dry matter, easily degradable protein content, low sugar content, and high buffering capacity (Yahaya *et al,* 1999). One of the ways to reduce (low) the pH and nitrogen (N) content in silage is by adding organic lactic acid in making silage (Kurniawan *et al,* 2019[a]). Making silage using lactic acid has been carried out to improve the nutritional quality of feed, including the provision of 3% lactic acid in elephant grass fermentation (Antaribaba *et al,* 2014), administration of 3% lactic acid on elephant grass and Bengal silage (Santoso *et al,* 2009[a]), superior tropical grass resulting from silage with lactic acid bacteria from fermented grass extract (Santoso *et al,* 2009[b]), silage of sugarcane shoots (Saccharum officinarum, Linn) with the addition of 0.3% *Lactobacillus plantarum* (Lamid *et al,* 2012), silage combination of elephant grass (*Pennisetum purpurium*) - *Indigofera zollingeriana* (Arianto *et al,* 2021), a combination of kume grass and gamal leaves (Ndun *et al,* 2015), odot and lamtoro grass (Astati *et al*, 2022), a combination of elephant grass and lamtoro (Rasuli *et al,* 2022). The purpose of making silage were to preserve feed ingredients and maximize the nutrients in feed ingredients (Anwar *et al*, 2020). In this regard, it is necessary to conduct research on the chemical quality and nutrient production of the combined silage of sorghum (*Sorghum bicolor*) and calopo (*Calopogonium mucunoides*) with the addition of organic lactic acid at different levels so that it can improve the quality and quality of the silage and can be an alternative feed source of livestock especially during the dry season

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MATERIAL AND METHOD

This research was conducted in two stages. The first stage of making silage was carried out at the Feed Technology Unit Laboratory and the second stage of silage quality evaluation was carried out at the Feed Nutrition and Technology Laboratory, Faculty of Animal Husbandry, Halu Oleo University. The research materials consisted of: whole sorghum plants (*Sorghum bicolor*) aged 71 days in the first year; leaves and steam of Calopo (*Calopogonium mucunoides*), both young and old as well as organic lactic acid which has been diluted from a concentration of 90% to 20%. The equipment used includes: a 1 liter capacity jar as a silo, plastic plaster, and a chopper.

Silage was made by chopping whole sorghum and calopo (all young and old leaves and stems) with a size of 2 - 3 cm, then withering for 24 hours to reduce the water content to 50%. Then sorghum and calopo were mixed with lactic acid solution according to the treatment. The lactic acid solution used previously was diluted from a

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concentration of 90% and then diluted again to 20% by transferring 22.2 ml of 90% lactic acid into a test tube and then adding 77.8 ml of distilled water. A total of 100 ml of the solution was taken and put into a bottle then stirred until homogeneous. Next, the silage process was carried out by putting all the mixed ingredients into the silo, then compress it by hand and using a wooden tool for ± 30 minutes to reduce the air in the silo. Silage was stored in a storage room protected from direct sunlight for 21 days. The silage was opened and then tested for physical quality (color, smell and texture). Chemical quality tests carried out at the Animal Feed Analyst Unit Laboratory include pH, dry matter, crude fiber and crude protein (AOAC 2005).

The design used was a completely randomized design (CRD) with 5 treatments and 4 replications. The treatment consisted of P1 = 0% organic lactic acid, P2 = 1% organic lactic acid, P3 = 2% organic lactic acid, P4 = 3% organic lactic acid, P5 = 4% organic lactic acid. Data were analyzed using analysis of variance (ANOVA). If the data shows a significant difference, then it will be tested further using the Duncan Multiple Range Test (DMRT) (Gaspersz 1991).

RESULT AND DISCUSSION

Color

The results of the color test of the combination of sorghum and calopo silage with the addition of organic lactic acid at different levels can be seen in Figure 1. The silage color score scale showed P5 which was 2.5 and P4 which was 2.75 (dark brown), P1, P2 and P3 namely 3 (fawn). The color of the silage in the treatments (P1, P2, P3) in this study was better than the results of the research by Chalisty *et al.* (2021) namely 2.28 - 2.62 (brownish yellow to yellowish green). The yellowish brown color at P1, P2, and P3 indicates very good silage quality, while the blackish brown color at P4 and P5 indicates quite good silage quality. The good quality of silage in this study was caused by a decrease in the water content of the material and also the formation of microorganisms in the form of lactic acid bacteria. This study is in accordance with the results of research by 2.28 - 2.62 (brownish yellow to yellowish green). The yellowish brown color at P1, P2, and P3 indicates very good silage quality, while the blackish brown color at P4 and P5 indicates quite good silage quality. The good quality of silage in this study was caused by a decrease in the water content of the material and also the formation of microorganisms in the form of lactic acid bacteria. This research is in accordance with the results of research by Kaiser and Piltz (2004), which states that bright green to brownish green is the normal color for grass, grain, and corn silages, while pale green or brownish yellow is the normal color for silages with wilted grass

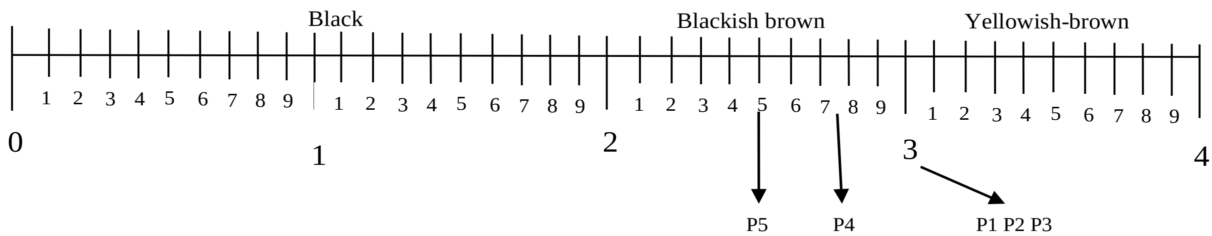

Figure 1. The organoleptic test score scale for the combination of sorghum (*Sorghum bicolor*) and calopo (*Calopogonium mucunoides*) silage color. Note: P1: 0% Organic Lactic Acid; P2: 1% Organic Lactic Acid; P3: 2% Organic Lactic Acid; P4: 3% Organic Lactic Acid; P5: 4% Organic Lactic Acid

The blackish brown color in the P4 and P5 treatments indicated a decrease in the quality of the silage. the higher the percentage of organic lactic acid used, the lower the color test score. Using high percentages of lactic acid can cause discoloration due to humidity in the silo. Reksohadiprodjo (1998) stated that the plant will experience a color changes during the ensilase process and oxygen levels are still available for the aerobic respiration process until the sugar content in the plant is not left. According to Keiser and Piltz (2004), the normal color in grass, grain and corn silage is bright green to brownish green while the normal color in withered silage is pale green or brownish yellow. Light brown or yellowish color in good silage has a sour aroma (Hidayat, 2014).

Aroma

The results of the aroma test for the combination of sorghum and calopo silage with the addition of organic lactic acid of different levels can be seen in Figure 2. The aroma score scale showed P1, which was 2.50 (rotten; slightly sour), and P2, P3, P4, P5, namely 3 (sour smell; typical of silage). The aroma score obtained in this study is in accordance with Chalisty *et al*. (2021) which stated that silage generally smells sour (2.44 – 2.72). The sour aroma that appears comes from several types of acids, especially lactic acid which is produced by lactic acid bacteria during the silage process. The aroma of silage in this study showed that the quality of the silage was quite good because lactic acid could affect the aroma of silage. The higher the use of lactic acid, the more fragrant the aroma produced by the silage. According to Wati *et al*. (2018), a slightly sour aroma in silage indicates good quality silage. The slightly sour smell of silage is due to the low pH of the silage. The level of acid produced during the ensiling process can affect the aroma produced from silage. Kurnaningtyas *et al*. (2012) states that the sour aroma in silage comes from organic acids produced by anaerobic bacteria during the ensiling process and depends on the length of the incubation process in the silage

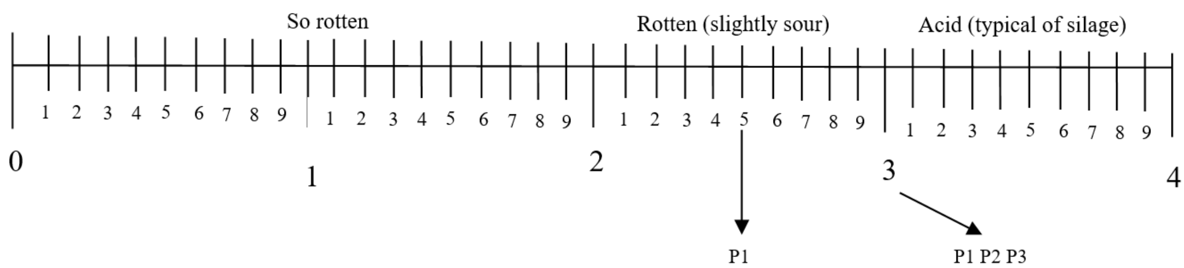

Figure 2. The scale of the organoleptic test score for the smell of silage combination of sorghum (Sorghum bicolor) and calopo (Calopogonium mucunoides). Note: P1: 0% Organic Lactic Acid; P2: 1% Organic Lactic Acid; P3: 2% Organic Lactic Acid; P4: 3% Organic Lactic Acid; P5: 4% Organic Lactic Acid.

Texture

The texture of the silage of a combination of sorghum and calopo added with different levels of lactic acid can be seen in Figure 3. The silage texture score scale showed slightly wet or a score of 2.50 and 2.75 (P1 and P4) and crumbly or a score of 3 (P2, P3 and P5). This indicates that the silage from this study was good quality, because the silage was not sticky, does not clump and was not slimy. This is in accordance with the opinion Kojo *et al*. (2015) which states that good quality silage is indicated by a soft texture, not moldy, not runny and not lumpy. According to Wati *et al*. (2018), The water content in forage will affect the texture of the silage. The poor quality of silage is shown by its soft, slimy texture and the presence of mold which is a body caused by the high water content of

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forage and increased oxygen levels in the silos (Chalisty *et al*, 2017).

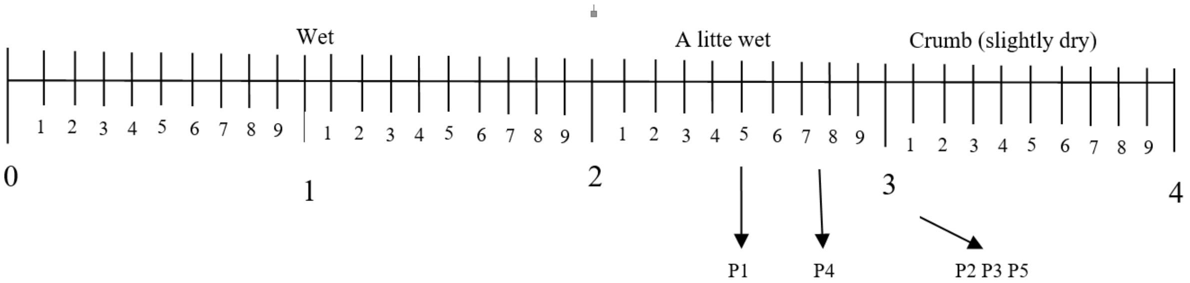

Figure 3. The scale of the organoleptic test score for the silage texture of the combination of sorghum (Sorghum bicolor) and calopo (Calopogonium mucunoides). Note: P1: 0% Organic Lactic Acid; P2: 1% Organic Lactic Acid; P3: 2% Organic Lactic Acid; P4: 3% Organic Lactic Acid; P5: 4% Organic Lactic Acid.

pH

The results showed that the addition of lactic acid at different levels had a very significant effect (P<0.01) on the pH of the silage of a combination of sorghum and calopo (Table 1). P5 was significantly different from P1 and P2, but not significantly different from P3 and P4. This is because the higher the percentage of lactic acid used, the lower the resulting pH. The decrease in silage pH can be caused by the biochemical reaction of lactic acid bacteria which produce lactic acid, so that the greater the lactic acid content, the lower the pH. The highest average pH value was shown at P1 without the addition of organic lactic acid, namely 4.93. This value indicates failure of fermentation, in accordance with the opinion Ranjit and Kung (2000) which states that if the pH of silage is more than 4.8 it means that the fermentation has failed. This showed that the resulting pH is not good, due to a lack of lactic acid so that the decomposing bacteria are unable to function properly. The pH value at the addition of 2-4% lactic acid has very good quality, while at the addition of 1% it has good quality. According to Septian *et al.* (2011), Silage quality can be classified into 4 criteria based on pH, including: very good quality (pH 3.2 - 4.2), good quality (pH 4.2 - 4.5), and poor quality (pH > 4.8). Lactic acid is very influential in accelerating the decrease in silage pH so that nutrient damage due to unwanted bacteria can be suppressed.

Table 1. Silage combination of sorghum (*Sorghum bicolor*) and calopo (*Calopogonium mucunoides*) with the addition of lactic acid at different levels

Parameter	Treatment				
	P1	P2	P3	P4	P5
pH	$4{,}93^{a} \pm 0{,}35$	$4{,}54^{a} \pm 0{,}05$	$4{,}18^{b} \pm 0{,}10$	$4{,}15^{b} \pm 0{,}14$	$4{,}00^{b} \pm 0{,}05$
Dry matter (%)	$17{,}84^{a} \pm 2{,}19$	$18{,}88^{b} \pm 0{,}33$	$19{,}53^{b} \pm 0{,}94$	$19{,}11^{b} \pm 0{,}97$	$20{,}53^{b} \pm 0{,}23$
Fleigh value	$43{,}33^{a} \pm 18{,}30$	$61{,}20^{a} \pm 1{,}63$	$76{,}75^{b} \pm 5{,}58$	$77{,}07^{b} \pm 7{,}43$	$86{,}00^{b} \pm 1{,}74$

Note: Different superscripts on the same line indicate significant differences; P1: 0% Organic Lactic Acid; P2: 1% Organic Lactic Acid; P3: 2% Organic Lactic Acid; P4: 3% Organic Lactic Acid; P5: 4% Organic Lactic Acid.

Dry Matter (DM)

The results showed that the addition of lactic acid had a significantly different effect (P<0.05) on the content of DM silage of a combination of sorghum and calopo silage (Table 1). P5 was significantly different from P1, but not significantly different from P2, P3 and P4. The highest content of DM was found in P5 which is 20.53%. The DM content was lower than Kurniawan *et al*. (2019[a]) which stated that the DM content of a combination of sorghum and gamal silage was 26.62%. This was due to differences in the percentage of DM in the silage composition using gamal (26.76%) and sorghum (20.35%), while in this study using sorghum (21.56%) and calopo (18.80%). DM values in this study ranged from 17-20%, this value was lower than Nurfauziah (2020) i.e. 20.57 - 24.63% in the combined silage of sorghum and *Indigofera zollingeriana*. P1 without the use of lactic acid has the lowest DM content (17.84%). During the aerobic phase, the greatest loss of dry matter occurs. Aerobic microbes are still actively breaking down substrates into CO_2 and H_2O and heat respiration energy. When the pH becomes acidic due to the presence of lactic acid produced by lactic acid bacteria, the decomposition process stops and the silage becomes stable (Sandi *et al*., 2012). Lactic acid can inhibit the growth of pathogenic bacteria resulting in silage that has a higher DM content than without inoculation (Zakariah *et al*, 2015).

Fleigh Value

The addition of lactic acid made a very significant difference (P<0.01) to the value of fleigh silage (Table 1). P5 was very significantly different from P1 and P2, but not significantly different from P3 and P4. The lowest fleigh value was shown at P1 without the addition of lactic acid, namely 43.33 (moderate quality) and the highest at P5, namely 86.00 (very good) with the addition of 4% lactic acid. Lestari *et al*. (2021) stated that the silage produced could be categorized as good quality if it had a fleigh value of 80. The fleigh value in this study ranged from 61.20 – 86.00. This value indicates that the silage was still in the good category. A good fleigh value can be obtained if the pH value is low (Wati *et al*., 2018). Silage using organic lactic acid with a concentration of 20% as much as 2-4% can increase the fleigh value in this study. According to Kurniawan *et al*. (2019[a]) Silage using 2% lactic acid showed the best quality, namely having the highest DM content and the lowest silage pH. The DM and pH silage values affect the fleigh value, the higher the DM value and the lower the pH value, the higher the fleigh value will be (Wati *et al*., 2018).

CONCLUSION

The use of 2-4% organic lactic acid can lower the pH value and increase the DM content and fleigh value. The best silage was shown at P5 (4% addition of lactic acid) which had a pH of 4.00, a fleigh value of 86.00 and a DM of 20.53%.

REFERENCES

Antaribaba, M., Tero, M., & Hariadi, B. (2014). Perngaruh taraf inokulum bakteri asam laktat dari ekstrak rumput terfermentasi terhadap kualitas fermentasi silase rumput raja. *JITV*. 14(4):278–283. http://peternakan.litbang.pertanian.go.id/fullteks/jitv/ jitv 144-4.pdf

Anwar, R., Laya, N.K., & Rokhayati, U. A. (2020). Fermentasi batang pisang sepatu (*Musa paradisiaca Forma Typica*) terhadap palatabilitas sapi bali (*Bos Sondaicus*). *Jambura Journal or Animal Science* 3(1): 8-15. https://ejurnal.ung.ac.id/index.php/jjas/article/ view/2384/pdf

AOAC. 2005. *Official Methods of analysis*. Association of Official Analytical Chemists, Washington DC (US).

Arianto, A. M., Malesi, L., & Kurniawan, W. (2021). Perbandingan kualitas dan karakteristik silase kombinasi rumput gajah (*Pennisetum*

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purpureum) – *Indigofera zollingeriana* dengan menggunakan asam laktat organik dan inokulan bal dari ekstrak rumput gajah terfementasi. *JIPHO* 3(2): 118-124.

Astati., Kurniawan, W., & Sandiah, N. (2022). Kualitas fisik dan kimia silase kombinasi rumput odot (*Pennisetum Purpureum* Cv. Mott) dan lamtoro (*Leucaena Leucocephala*) dengan penambahan berbagai level asam ssetat. *JIPHO* 4(3):184-189.

Efendi, R., Aqil, M., & Pabendon, M. (2013). Evaluasi genotipe sorgum manis (*Sorghum bicolor* (L.) Moench), produksi biomas dan daya ratun tinggi. *Penelit Pertan Tanam Pangan*. 32(2):116–125.

Gasperz, V. (1991). *Metode Perancangan Percobaan*. Armico, Bandung

Hidayat, N. (2014). Karakteristik dan kualitas silase rumput raja menggunakan berbagai sumber & tingkat penambahan karbohidrat fermentable. *Jurnal Agripet*. 14(1): 42–49. https://doi.org/10.17969/agripet.v14i1.1204

Chalisty, V., Utomo, R., & Bachruddin, Z. (2017). Pengaruh penambahan molasses, *Lactobacillus plantarum*, *Trichoderma viride* dan campurannya terhadap kualitas total campuran hijauan. *Buletin Peternakan*, 411(4):4311–4318.

Chalisty, V. D. (2021). Pengaruh penambahan molases, *Lactobacillus plantarum*, *Tricoderma viridae* dan campurannya terhadap komposisi kimia silase total campuran hijauan. *Jurnal sains peternakan* 1(1). https://doi.org/10.53863/jspn.v1i01.187

Kaiser, A., & Piltz, J. (2004). *Feed testing: assesing silage (assesing s)*. New South Wales: NSW Departement of Primary Industries & dairy Australia.

Kojo, R., Rustandi., Tulung, Y. R., & Malalantang, S. (2015). Pengaruh penambahan dedak padi & tepung jagung terhadap kualitas fisik silase rumput gajah. *Jurnal Zootek*, 35(1):21–29

Kurnianingtyas, I. B., P. R. Pandansari, I. Astuti, S. D. Widyawati, and W. P. S. Suprayogi. 2012. Pengaruh macam akselerator terhadap kualitas fisik, kimiawi, dan biologis silase rumput kolonjono. Tropical Animal Husbandry 1: 7-14.

Kurniawan, W., Wahyono, T., Sandiah, N., Has, H., Nafiu, L.O., & Napirah, A. (2019). Evaluasi kualitas dan karakteristik fermentasi silase kombinasi stay green sorghum (*Sorghum bicolor* L. Moench) – *Indigofera zolingeriana* dengan perberbedaan komposisi. *J Ilmu dan Teknol Peternak Trop*. 6(1):62. https://doi.org/10.33772/jitro.v6i1.5551

Kurniawan, W., Syamsuddin., Salido, W. L., & Isnaini, P.D. (2019). Evaluasi kualitas, karakteristik fermentasi dan kecernaan *in vitro* silase campuran *Sorgum Stay Green-Gliricidia sepium* dengan penambahan berbagai level asam laktat. *Agripet*. 19(2): 99-106.

Lamid, M., Koesnoto, S. ., Chusniati, S., Hidayatik, N., & Vina, E. V. F. (2012). Karakteristik silase pucuk tebu (*Saccharum officinarum*, Linn) dengan penambahan *Lactobacillus plantarum*. *J Agroveteriner*. 1(1):5–10.

Lestari, N. A., Sandiah, N., & Kurniawan, W. (2021). Kualitas organoleptik silase kombinasi jagung dan daun indigofera (*Indigofera* sp.) dengan persentase komposisi bahan yang berbeda. *JIPHO* 3(1). http://dx.doi.org/10.56625/jipho.v3i1.16904

Ndun, A. N., Hilakore, M. A., & Enawati, L. S. (2015). Kualitas silase campuran rumput kume (*Sorghum plumosum* var. Timorense) dan daun gamal (*Gliricidiasepium*) dengan rasio berbeda. *Jurnal Nukleus Peternakan* 2(1):83–87.

Nurfauzia., Sandiah, N., & Kurniawan, W. (2020). Karakteristik dan kualitas silase berbahan kombinasi sorghum stay green utuh dengan *Indigofera zolingeriana*. *JIPHO* 2(1).

Ranjit, N. K., & Kung, L. (2000). The effect of Lactobacillus buchneri, Lactobacillus plantarum, or a chemical preservative on the fermentation and aerobic stability of corn silage. *J. Dairy Sci*. 83:526-535.

Rasuli, N., Wibowo, D. N., & Taufik, M. (2022). Kajian kualitas silase rumput gajah (*Pennisetum purpureum*) dengan penambahan lamtoro (*Leucaena leococephala*), dedak, dan jagung giling. *Jurnal Agrisistem* 18(1):28-34. DOI: https://doi.org/ 10.52625/j-agr.v18i1.223

Reksohadiprodjo, S., (1998). *Pakan Ternak Gembala*. Yogyakarta

Sandi, S., Ali, A. I., & Arianto, N. (2012). Kualitas nutrisi silase pucuk tebu (*Saccarum Officinarum*) dengan penambahan inokulan effective microorganism-4 (EM-4). *Jurnal Peternakan Sriwijaya*. 1(1): 1–9.

Santoso, B., Hariadi, B. T., Manik, H., & Abubakar, H. (2009a). Pengaruh penambahan bakteri asam laktat rumput raja dan benggala. *Seminar Nasional Teknologi Peternak dan Veteriner*:718–724.

Santoso, B., Manik, H., & Abubakar, H. (2009b). Kualitas rumput unggul tropika hasil ensilase dengan bakteri asam laktat dari ekstrak rumput terfermentasi. *Media Peternakan*. 32(2):137–144.

Septian, F., Kardaya, D., & Astuti, W. D. (2011). Evaluasi kualitas silase limbah sayuran pasar yang diperkaya dengan berbagai aditif dan bakteri asam laktat. *Jurnal Pertanian* 2(2):117-124.

Wati, W. S., Mashudi & Irsyammawati, A. (2018). Kualitas silase rumput odot (*Pennisetum purureum* cv Mott) dengan penambahan *Lactobacillus plantarum* dan molasses pada waktu inkubasi yang berbeda. *Jurnal Nutrisi Ternak Tropis* 1(1):45-53.

Yahaya, M. S., Takahashi, J., Matsuoka, Y., & Kibon, A. (1999). Effect of supplementary feeding of cotton seed cake on feed intake, water consumption and work output of work bulls in Borno state, Nigeria. *Anim Feed Sci Technol*. 79(1–2):137–143. https://doi.org/10.1016/S0377-8401(99)00017-6

Zakariah, M. A., Utomo, R., & Bachruddin, Z. (2015). Pengaruh inokulum campuran *Lactobacillus plantarum* dan *Sacharomyces cereviceae* terhadap kulaitas organoleptik, fisik dan kimia silase buah kakao. *Buletin Peternakan* 39(1). https://doi.org/10.21059/buletinpeternak.v39i1.6152.