Research Article

Influence of Fermentation Duration on Rice Bran Fermented with Local Microorganisms Derived from Kacang Goat Rumen Fluid and Palmyra Sap

Theresia Nur Indah Koni[1]*, Oswilda Henyati[1], Stormy Vertigo[1], Tri Anggarini Yuniwati Foenay[2]

[1]Feed Technology Study Program, Department of Animal Husbandry, Politeknik Pertanian Negeri Kupang, Kupang, Indonesia; [2]Animal Production Study Program, Department of Animal Husbandry, Politeknik Pertanian Negeri Kupang, Kupang, Indonesia, Jl. Prof. Dr. Herman Yohanes Kel. Lasiana Kupang 85011. East Nusa Tenggara 85011.

Abstract | This study evaluated the effect of fermentation duration on fermentation characteristics and nutrient composition of rice bran fermented with 10% local microorganisms derived from Kacang goat rumen fluid and palmyra sap (LM-KGRFPS) to improve its feeding value for livestock. A completely randomized design was applied with four fermentation durations (0, 6, 12, and 18 days) and five replications. Fermentation characteristics, including pH, lactic acid concentration, and ammonia nitrogen ($N–NH_3$), as well as nutrient composition (dry matter, ash, crude protein, crude fat, and crude fiber), were analyzed. Fermentation duration significantly affected ($P<0.05$) final pH, lactic acid concentration, and $N–NH_3$ content, but did not affect ($P>0.05$) the initial pH before fermentation. Unfermented rice bran exhibited a higher pH (4.68) than fermented treatments. The highest lactic acid concentration was observed at 18 days of fermentation (123.2 mg/100 g), whereas the lowest $N–NH_3$ content occurred at 6 days (7.92 mg/100 g). Fermentation duration significantly influenced ($P<0.05$) dry matter, ash, and crude fiber contents, but had no significant effect ($P>0.05$) on crude protein and crude fat contents. Dry matter content decreased with increasing fermentation duration, reaching the lowest value at 12 days (56.7%), while ash content increased progressively. Crude fiber content decreased up to 6 days of fermentation (16.7%) and increased thereafter. Based on favorable fermentation characteristics, particularly low $N–NH_3$ and crude fiber contents, a 6-day fermentation using LM-KGRFPS was considered optimal for improving the quality of fermented rice bran as a feed ingredient.

Keywords | Fermentation duration, Goat rumen fluid, Nutrient composition, Palmyra sap, Rice bran

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***Correspondence** | Theresia Nur Indah Koni, Feed Technology Study Program, Department of Animal Husbandry, Politeknik Pertanian Negeri Kupang, Kupang, Indonesia; **Email:** Indahkoni@gmail.com

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INTRODUCTION

Rice bran is a by-product of rice milling commonly used as a feed ingredient for poultry and livestock (Debi *et al.*, 2022). It can be included up to 10% in poultry diets (Kim *et al.*, 2017). However, its utilization is limited by high crude fiber content 24 g/100 g (Koni *et al.*, 2022) and phytic acid concentration 7.30 mg/100 g (Koni *et al.*, 2025), which reduce nutrient digestibility and mineral bioavailability. Fermentation is an effective biological process to decrease crude fiber and phytic acid content, thereby improving feed quality (Munira *et al.*, 2016; Ibrahim and Usman, 2019).

Microbial inoculants used in fermentation can be derived from local resources such as rumen fluid and natural plant saps. Goat rumen fluid contains cellulolytic and phytase-producing microorganisms (Islam *et al.*, 2022). Goat rumen harbors diverse microbial phyla, including Bacteroidetes, Firmicutes, and Proteobacteria, which are dominated by genera such as *Prevotella, Ruminococcus, Butyrivibrio,* and *Succinivibrio*. These microorganisms contribute to the degradation of crude fiber, protein, and lipids in feed materials (Liu *et al.*, 2017). Ruminococcus is composed of two strong fiber digesting bacterial species, *Ruminococcus albus* and *Ruminococcus flavefaciens*, which can produce a large amount of cellulases and hemicellulases (Odeyemi *et al.*, 2020). Goat rumen fluid inclusion in rice bran fermentation has been shown to reduce crude fiber (Ermalia *et al.*, 2016). Similarly, palmyra sap (*Borassus flabellifer*) is rich in fermentable sugars and contains *Saccharomyces cerevisiae* and lactic acid bacteria (Chayaningsih, 2006; Irmayuni *et al.*, 2018), both of which enhance fermentation. palmyra sap supplementation at 10% was previously found to improve the nutritional profile of rice bran (Koni *et al.*, 2023).

This study utilized a mixture of Kacang goat rumen fluid and palmyra sap to produce local microorganisms (LM-KGRFPS) based on the modified method of Sio *et al.* (2022). The duration of fermentation influences microbial activity and enzyme production (Mantut *et al.*, 2019), which are key determinants of nutrient modification. Therefore, this study aimed to evaluate the effects of fermentation duration using LM-KGRFPS on the fermentation characteristics and nutrient composition of rice bran.

MATERIALS AND METHODS

Materials

Rice bran was obtained from a local rice mill in Kaniti, Kupang Regency, East Nusa Tenggara, Indonesia. Palmyra sap was collected from palm tappers in Lasiana, Kupang City, and Kacang goat rumen fluid was obtained from a local slaughterhouse in Pasir Panjang, Kota Lama Kupang City.

Preparation of rice bran

Rice bran was cleaned to remove impurities such as husks and stones. The cleaned material was analyzed for initial nutrient composition at the Nutrition and Animal Feed Laboratory, Politeknik Pertanian Negeri Kupang. The proximate and mineral composition of the unfermented rice bran is presented in Table 1.

Production of local microorganisms (LM-KGRFPS)

Goat rumen fluid from Kacang goats was mixed with palmyra sap and a sugar solution following a modified procedure of Foenay *et al.* (2025). The mixture contained 1000 mL Kacang goat rumen fluid, 100 mL palmyra sap, and 500 mL sugar solution (prepared by dissolving 250 g sugar in 500 mL water). The mixture was incubated in airtight containers at room temperature for eight days to allow fermentation.

Table 1: Nutrient composition of rice bran before fermentation.

Nutrient component	Unit	Value
Dry matter*	%	92.7
Crude fat*	%	1.76
Crude fibre*	%	25.8
Crude protein*	%	7.65
Ash*	%	11.2
Calcium (Ca)**	mg/kg	2715
Phosphorus (P)**	mg/kg	5069

*Analyzed at the Nutrition and Animal Feed Laboratory, Politeknik Pertanian Negeri Kupang (2025). ** Laboratory of Nutritional Biochemistry, Faculty of Animal Science, Universitas Gadjah Mada (2025).

Rice bran fermentation

Fermentation was conducted following Koni *et al.* (2023). The rice bran was adjusted to 65% dry matter and 35% moisture, mixed with 10% LM-KGRFPS (v/w), and placed in 2-kg plastic jars. The jars were sealed anaerobically and incubated for 0, 6, 12, and 18 days.

Measurement of fermentation characteristics and nutrient composition

The pH was measured using a pH meter following the procedures of Bernardes *et al.* (2019). Ammonia nitrogen ($N\text{-}NH_3$) and lactic acid were determined according to Matias *et al.* (2020) and Ergin and Gumus (2020) respectively. Nutrient composition (crude protein, crude fiber, crude fat, ash, calcium, and phosphorus) was analyzed using Association of Official Analytical Chemists (AOAC, 2005) procedures.

Statistical analysis

The experiment followed a completely randomized design with four treatments (0, 6, 12, and 18 days) and five replications. Data were analyzed using Analysis of variance and significant differences among means were determined by Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Fermentation characteristics of rice bran

The pH, lactic acid, and $N\text{-}NH_3$ concentrations of rice bran fermented with LM-KGRFPS for different durations

are presented in Table 2. The pH of rice bran decreased significantly ($P < 0.05$) after fermentation, indicating active microbial metabolism and acid production. Lactic acid bacteria (LAB) present in LM-KGRFPS produced organic acids, mainly lactic acid, leading to a drop in pH. Anaerobic fermentation conditions favoured LAB growth and inhibited the development of spoilage microorganisms. A low pH is desirable because it improves preservation quality and prevents the growth of undesirable bacteria such as *Clostridium* spp. (Queiroz *et al*., 2018). The final pH values (3.91–4.80) obtained in this study were within the range reported for good-quality silage (Despal *et al*., 2011; Bernardes *et al*., 2019).

Lactic acid concentration increased ($P < 0.05$) with fermentation duration, confirming efficient conversion of soluble carbohydrates into organic acids by LAB. The lactic acid content (49.20–123.17 mg/100 g) was within the range reported by Cherney and Cherney (2015), who indicated that levels above 3% (30 g/kg) are characteristic of well-preserved silage.

Table 2: Changes in pH, lactic acid, and Ammonia nitrogen ($N\text{-}NH_3$) contents of rice bran fermented with LM-KGRFPS at different fermentation durations.

Treatment	Initial pH	Final pH	Lactic acid (mg/100 g)	$N\text{–}NH_3$ (mg/100 g)
T0	4.68 ± 0.27	4.68 ±0.27^{a}	49.2 ± 4.37^{a}	10.70 ± 0.39^{c}
T1	4.87 ± 0.05	4.01 ± 0.03^{b}	104.3 ± 6.39^{b}	7.92 ± 1.45^{a}
T2	4.88 ± 0.07	3.91 ± 0.12^{b}	110.8 ± 8.59^{c}	9.71 ± 0.39^{ab}
T3	4.87 ± 0.02	4.02 ± 0.02^{b}	123.2 ± 2.55^{d}	10.10 ± 0.63^{b}
P-value	0.269	0.000	0.000	0.000

Values are means ± standard deviation. Mean in the same column and followed by the same superscript letter means no difference (P>0.05) T0 = unfermented; T1 = 6 days; T2 = 12 days; T3 = 18 days.

The lowest nitrogen ammonia ($N\text{–}NH_3$) concentration was observed in the 6-day treatment (T1), suggesting limited proteolysis at this stage. Lower $N\text{–}NH_3$ values indicate reduced protein degradation and better preservation of nitrogen compounds (Samadi *et al*., 2015). According to Despal *et al*. (2011), ammonia values below 50 g/kg total N reflect high-quality silage. Therefore, fermentation for six days appeared optimal for maintaining nitrogen integrity in rice bran.

Nutrient composition of fermented rice bran

Table 3 presents the nutrient composition of rice bran fermented with LM-KGRFPS for different durations. Fermentation duration had a significant effect ($P < 0.05$) on the dry matter content of rice bran. Prolonged fermentation for 12 and 18 days resulted in a marked decrease ($P < 0.05$) in dry matter content compared with shorter fermentation periods. This reduction is attributed to the metabolic activity of microorganisms during fermentation, which produces water as one of its by-products. The accumulation of water over time consequently decreases the dry matter proportion in the substrate. This finding is consistent with the statement of Irawati *et al*. (2019), who reported that as the fermentation period increases, microorganisms reach their optimal growth phase, utilizing more nutrients from the substrate and generating a higher amount of water through metabolic processes. Therefore, extended fermentation tends to lower dry matter content due to the increased metabolic activity and moisture accumulation within the fermenting material.

Ash content increased ($P < 0.05$) in samples fermented for 12 and 18 days. The increase could be related to the reduction of organic matter as microorganisms utilized available nutrients, thereby concentrating the mineral fraction. Comparable trends were observed by Superianto *et al*. (2018), while Sabuna *et al*. (2024) found that palmyra sap concentration did not significantly affect ash levels in fermented Putak meal (Putak is the inner pith of the *Corypha gebanga* palm). Crude protein content did not differ significantly ($P > 0.05$) among treatments, suggesting that microbial protein synthesis did not increase with longer fermentation periods. These results differ from Koni *et al*. (2025), who reported an increase in crude protein in Putak (*Corypha gebanga*) fermented with 10–30% palmyra sap, and from Irawati *et al*. (2019), who found gradual protein enrichment in fermented water hyacinth up to 14 days.

Table 3: Nutrient composition of rice bran fermented with LM-KGRFPS at different fermentation durations.

Parameter	T0	T1	T2	T3	P value
Dry matter (%)	60.5 ±0.59^{bc}	61.8 ± 1.75^{c}	56.7 ± 1.92^{a}	57.9 ±0.87^{ab}	0.007
Ash (%)	10.9 ± 0.11^{a}	11.1 ± 0.46^{a}	12.3 ± 0.18^{b}	12.1 ± 0.20^{b}	0.000
Crude protein (%)	7.67 ± 0.27	7.84 ± 0.19	7.26 ± 0.21	7.49 ± 0.23	0.065
Crude fat (%)	1.37 ± 0.25	1.94 ± 1.38	3.10 ± 0.05	2.30 ± 0.19	0.087
Crude fiber (%)	17.9 ± 1.44^{a}	16.7 ± 0.64^{ab}	21.8 ± 0.27^{c}	19.6 ± 1.25^{bc}	0.003

Values are means ± standard deviation. Means in the same row and followed by the same superscript letter means no difference (P>0.05). Means in a row with different superscripts differ significantly ($P < 0.05$). T0 = unfermented; T1 = 6 days; T2 = 12 days; T3 = 18 days.

Fermentation duration had no significant effect on crude fat content (P > 0.05). The lack of difference indicates that microorganisms used other carbon sources rather than lipids as energy substrates. In contrast, Sao *et al.* (2021) observed an increase in crude fat in banana peel fermented with goat rumen fluid.

Crude fiber decreased significantly (P < 0.05) after six days of fermentation (T1). The reduction was attributed to cellulolytic microbial activity in LM-KGRFPS, which degraded cellulose and hemicellulose fractions through enzymatic hydrolysis. Similar reductions were reported by Helda and Sabuna (2012) in goat manure fermented with palmyra sap, and by Koni *et al.* (2021, 2023) in banana peel and rice bran, respectively.

Overall, fermentation for six days using LM-KGRFPS produced the most favorable results, characterized by lower pH and ammonia levels, increased lactic acid concentration, and reduced crude fiber content while maintaining crude protein stability. These findings indicate that a six-day fermentation period is optimal for improving the nutritional and fermentation quality of rice bran.

CONCLUSION

Fermentation of rice bran with local microorganisms derived from goat rumen fluid and palmyra sap significantly improved its fermentation quality. The six-day fermentation period produced the lowest crude fiber and ammonia contents while maintaining stable crude protein levels and high lactic acid concentration. This duration is recommended as the optimal fermentation time for enhancing the nutritional value and feed quality of rice bran.

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NOVELTY STATEMENT

This study presents a novel fermentation strategy using a consortium of local microorganisms derived from Kacang goat rumen fluid and palmyra sap to improve the nutritional quality of rice bran. The integration of rumen cellulolytic microbes with fermentative microorganisms from palmyra sap enhances substrate degradation, with a six-day fermentation period identified as optimal for reducing crude fiber and ammonia contents.

AUTHOR'S CONTRIBUTION

TNIK contributed to the development of the research concept, actively participated in data collection, conducted the experimental procedures, performed data analysis, and was the main author of the manuscript. OH contributed to the experimental implementation, particularly in the preparation of LM-KGRFPS and the proximate analysis. SV and TAYF contributed to data analysis and critically reviewed and revised the manuscript for intellectual content.

Generative AI and AI-assisted technology statement

Artificial intelligence tools were used only to assist with grammar correction and sentence editing. The authors affirm that all scientific content, data analysis, interpretation, and conclusions are entirely their own original work.

Conflict of interest

There was no conflict of interest in this research with other parties, both individuals and organizations.

REFERENCES

Association of Official Analytical Chemists (AOAC) (2005). Official methods of analysis. 16th ed. Wansington USA.

Bernardes TF, Gervásio JRS, De Morais G, Casagrande DR (2019). Technical note: A comparison of methods to determine pH in silages. J. Dairy Sci., 102(10): 9039–9042. https://doi.org/10.7202/1059182ar

Chayaningsih H (2006). Identification of lactic acid bacteria from palmyra sap and its application in reducing *Salmonella typhimurium* and *Aspergillus flavus* in cocoa beans. Bogor: Sekolah Pasca Sarjana IPB.

Cherney JH, Cherney DJR (2015). Assessing silage quality. Silage Sci Technol., (42): 141–198. https://doi.org/10.2134/agronmonogr42.c4

Debi MR, Wichert BA, Liesegang A (2022). Anaerobic fermentation of rice bran with rumen liquor for reducing their fiber components to use as chicken feed. Heliyon, 8(4): e09275. https://doi.org/10.1016/j.heliyon.2022.e09275

Despal, Permana IG, Safarina SN, Tatra AJ (2011). Addition of water soluble carbohydrate sources prior to ensilage for ramie leaves silage qualities improvement. Media Peternak., 34(1): 69–76. https://doi.org/10.5398/medpet.2011.34.1.69

Ergin S, Gumus H (2020). Silage quality, fermentation dynamics and chemical composition of alfalfa silage prepared with salt and lactic acid bacteria inoculants. Anim. Nutr. Feed Technol., 20: 367–380. https://doi.org/10.5958/0974-181X.2020.00033.5

Ermalia AAU, Sjofjan O, Djunaidi IH (2016). Evaluation nutritients of rice bran second quality fermented using rumen fluid. Bull. Anim. Sci., 40(2): 113–123. https://doi.org/10.21059/buletinpeternak.v40i2.8700

Foenay TAY, Koni TNI, Paga A, Oswilda H, Da-lopez YF (2025). Effect of local microorganisms from Bali cattle rumen fluid

and palmyra sap on fiber fractions and nutrient composition of fermented rice bran. Adv. Anim. Vet. Sci., 13(4): 860–865. https://doi.org/10.17582/journal.aavs/2025/13.4.860.865

Helda, Sabuna C. (2012). Fermentation of goat and poultry manure with palmyra sap (*Borassus flabellifer*) as a feed ingredient for chickens. Partner. 19(1): 112–120.

Ibrahim, Usman (2019). Efficiency of rations with the use of fermented rice bran in growth phase native chickens. Tolis Ilmiah J. Penelit., 1(2): 124–129. https://doi.org/https://doi.org/10.56630/jti.v1i1

Irawati E, Purnamasari E, Arsyad F (2019). Physical and nutritional qualities of Water Hyacinth silage (*Eichornia crassipes*) with different fermentation lengths. J. Petern., 16(1): 18. https://doi.org/10.24014/jupet.v16i1.3679

Irmayuni E, Nurmila, Sukainah A (2018). Effectiveness of palmyra sap (*Borassus flabellifer*) as an ingredient for the development of apem cake doungh. J. Pendidik Teknol. Pertan., 4: 170–183. https://doi.org/10.26858/jptp.v4i0.7122

Islam KMS, Elsabagh M, Lv R, Dang HL, Sugino T, Obitsu T (2022). Anaerobic fermentation of rice bran using rumen liquor for desirable chemical changes as animal feed. J. Adv. Vet. Anim. Res., 9(4): 728–735. https://doi.org/10.5455/javar.2022.i642

Kim CH, Park SB, Jeon JJ, Kim H, Kim SH, Hong EC, Kang HK (2017). Effects of dietary supplementation of fermented rice bran (FRB) or fermented broken rice (FBR) on laying performance, egg quality, blood parameter, and cholesterol in egg yolk of Hy-Line Brown laying hens. Korean J. Poult. Sci., 44(4): 235–243. https://doi.org/10.5536/KJPS.2017.44.4.235

Koni TNI, Foenay TAY, Jehemat A (2022). Fermentation characteristics and chemical composition of fermented rice bran with different levels of palmyra sap (*Borassus flabellifer*). Livest. Res. Rural Dev., 34(10): 88.

Koni TNI, Foenay TAY, Sabuna C, Rohyati E (2021). The nutritional value of fermented banana peels using different levels of palmyra sap. J. Ilm. Petern. Terpadu., 9(1): 62–71. https://doi.org/10.23960/jipt.v9i1.p62-71

Koni TNI, Foenay TAY, Vertigo S (2023). The use of urea and palmyra sap (*Borassus flabellifer*) on the characteristics and nutrient composition of fermented rice bran. Adv. Anim. Vet. Sci., 11(4): 624–629. https://doi.org/10.17582/journal.aavs/2023/11.4.624.629

Koni TNI, Paga A, Jehemat A, Asrul, Batafor GG, Foenay TAY (2025). Growth performance of Java super chickens fed fermented rice bran during the starter phase. J. Anim. Health Prod., 13(1): 149–153. https://doi.org/10.17582/journal.jahp/2025/13.1.149.153

Liu K, Xu Q, Wang L, Wang J, Guo W, Zhou M (2017). The impact of diet on the composition and relative abundance of rumen microbes in goat. Asian-Australas. J. Anim. Sci., 30: 531–537. https://doi.org/10.5713/ajas.16.0353

Mantut HP, Mauboy R, Boro T (2019). Study of the fermentation time of palmyra sap (*Borassus flabeliffer* L.) on the abundance and morphological characteristics of microbes. In: Semin Nas Sains dan Tek FST Undana. Kupang; pp. 79–86.

Matias AGS, Araujo GGL, Campos FS, Emerenciano JV (2020). Fermentation profile and nutritional quality of silages composed of cactus pear and manicoba for goat feeding. J. Agric. Sci., 1: 1–9. https://doi.org/ 10.1017/S0021859620000581

Munira S, Nafiu LO, Tasse AM (2016). Performance of cross bred native chickens fed feed substituted with fermented rice bran with different fermentors. J. Ilmu dan Teknol. Petern. Trop., 3(2): 21–29. https://doi.org/10.33772/jitro.v3i2.1683

Odeyemi AT, Oluwole OA, Oso MO (2020). Characterization of bacteria isolated from rumen substrates of goat (*Capra aegagrus hircus*). Afr. J. Biol. Sci. (South Africa). 2(2): 100–111. https://doi.org/10.33472/AFJBS.2.2.2020.100-111

Queiroz OCM, Ogunade IM, Weinberg Z, Adesogan AT (2018). Silage review: Foodborne pathogens in silage and their mitigation by silage additives. J. Dairy Sci. [Internet]. 101(5): 4132–4142. https://doi.org/10.3168/jds.2017-13901

Sabuna C, Ndolu DAJ, Asrul, Koni TNI (2024). pH, lactic acid, and ammonia changes anaerobic fermentation putak with different levels of palmyra sap. J. Ilmu Petern. dan Vet. Trop., 14(2): 63–69. https://doi.org/10.46549/jipvet.v14i2.412

Samadi, Wajizah S, Usman Y (2015). *In vitro* study of fermented complete feed by using sago residues as main source diet. Anim. Prod., 17(3): 129. https://doi.org/10.20884/1.anprod.2015.17.3.542

Sao T, Foenay T, Koni TNI (2021). Nutritive content of banana peel flour (*Musa paradisiaca*) fermented by goat rumen fluid. J. Ilmu Petern. Terap., 4(2): 78–83. https://doi.org/10.25047/jipt.v4i2.2467

Sio S, Bira GF, Batu MS, Pardosi L, Mau RJ, Klau MO, 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(1): 36–41.

Superianto S, Harahap AE, Ali A (2018). Nutrition value of cabbage vegetable waste silage with rice bran addition and different duration of fermentation. J. Sain Petern. Indones., 13(2): 172–181.