Cross Current International Journal of Agriculture and Veterinary Sciences
Abbreviated Key Title: Cross Current Int J Agri Vet Sci
ISSN: 2663-2454 (Print) & Open Access
DOI: https://doi.org/10.36344/ccijavs.2026.v08i03.002

Volume-8 | Issue-3| May-Jun, 2026 |

Original Research Article

Performance of Male Kacang Goats Fed Complete Feed Containing Different Levels of Rice Straw Silage and Concentrate

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| **Received:** 24.04.2026 | **Accepted:** 08.06.2026 | **Published:** 10.06.2026 |

Abstract: The objective of this study was to evaluate the performance of Kacang goats fed complete feed containing different ratios of rice straw silage and concentrate. Twelve male Kacang goats aged between 1 and 1.5 years, with an average initial body weight of 16.9 kg (CV 22.85%) was used in this research, arranged in a Randomized Block Design (RBD) consisting of three treatments and three replications. The treatments were: R1 = (60% rice straw silage: 40% concentrate), R2 = (50% rice straw silage : 50% concentrate), and R3 = (40% rice straw silage : 60% concentrate). The parameters measured included animal performance, feed intake, nutrient digestibility, and rumen fluid characteristics. The results showed that average daily gain (ADG), feed conversion ratio, intake and digestibility of dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), as well as rumen fluid characteristics, were not significantly affected (P>0.05) by the treatments. It was concluded that feeding complete feed with different ratios of rice straw silage and concentrate resulted in similar effects on performance, feed intake, nutrient digestibility, and rumen fluid characteristics of male Kacang goats.

Keywords: Rice Straw Silage, Concentrate, Performance, Male Kacang Goats, Ratio.

INTRODUCTION

Ruminant livestock require forage as their primary feed source, which plays an essential role in supporting animal production. However, during prolonged dry seasons, the shortage of fresh forage becomes a major constraint that must be addressed. One alternative strategy to overcome forage scarcity, particularly during the dry season, is the utilization of rice straw as an alternative feed resource. Rice cultivation on Timor Island is generally conducted only during the rainy season; therefore, for utilization throughout the long dry season (8–9 months), rice straw can be preserved and stored.

The use of rice straw as feed for ruminants should be complemented with concentrate supplementation to ensure that the nutritional requirements of the animals are adequately met. The addition of concentrate is expected to improve nutrient availability for both the animals and rumen microbial activity [1]. Rice straw has several limitations, particularly its low crude protein content and high crude fiber content [2]. Furthermore, Low content of fermentable carbohydrates and minerals, combined with high lignin and silica bonds, reduces the digestibility of rice straw by livestock [3]. These limitations constitute the main constraints in its utilization as animal feed. Therefore, to optimize the use of rice straw silage, it is necessary to balance it with concentrate supplementation. [4], stated that the inclusion of concentrate in livestock diets can improve feed palatability and body weight gain, since straw-based feed generally has low digestibility and nutritional value. Moreover, concentrate supplementation can increase the energy concentration of the ration.

The Kacang goat is an indigenous goat breed commonly raised by smallholder farmers in East Nusa Tenggara. In terms of population, the potential of goat production is relatively promising; however, improvements in productivity are still required. Goats can be provided with forage and concentrate feeds to enhance their performance. The use of complete feed is one approach that can be applied to address this issue. Therefore, the objective of this study was to evaluate the performance of Kacang goats fed complete diets

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Citation: Arnol Elyazar Manu, Nitti H. Mafefa, Edi Djoko Sulistijo, Upik Syamsiar Rosnah, Markus Miten Kleden (2026). Performance of Male Kacang Goats Fed Complete Feed Containing Different Levels of Rice Straw Silage and Concentrate. *Cross Current Int J Agri Vet Sci, 8*(3), 72-76.

containing different ratios of rice straw silage and concentrate.

METHODS

The animals used in this study were 12 male local goats aged 1–1.5 years, with an average initial body weight of 16.9 kg (CV 22.85%). The goats were housed individually in elevated battery-type cages, with each pen measuring 160 × 90 cm.

The feed ingredients used consisted of rice straw silage and concentrate composed of pollard, ground corn, fish meal, minerals, and salt, while drinking water was provided ad libitum. The composition of ration ingredients and the chemical composition of the experimental rations are presented in Tables 1 and 2.

Table 1: Chemical composition of the experimental feed ingredients

Feed ingridient	Nutrient Component (%)							
	DM	OM	CP	CF	Lipida	TDN	Ash	NFE
SJP*	90.92	84.112	7.39	32.29	4.16	56.08	15.89	40.18
Pollard	86.37	96.351	12.75	9.73	4.95	78.88	3.65	68.43
Fish meal	89.31	81.583	51.76	2.89	7.3	77.55	18.42	18.40
Corn meal	88.06	99.124	9.65	4.3	6.9	93.09	0.88	84.28

Table 2: Chemical composition of the experimental rations

Treatment	Komponen Nutrien (%)							
	DM	OM	CP	Lipida	CF	TDN[1]	NFE	Ash
R1	86.48	85.21	10.80	4.71	21.79	64.36	47.92	11.29
R2	85.93	86.25	11.41	4.91	19.13	67.28	50.80	10.00
R3	85.33	87.21	12.11	5.05	16.64	69.78	53.40	8.80

Calculated according to (5) (*), where SJP = rice straw silage.

The treatments were arranged using a Randomized Block Design (RBD) consisting of three treatments and three replications as follows:
R1 =Complete feed with a ratio of 60% rice straw silage: 40% concentrate
R2 = Complete feed with a ratio of 70% rice straw silage: 30% concentrate
R3 = Complete feed with a ratio of 80% rice straw silage: 20% concentrate

The animals were weighed at the beginning of the experiment to obtain initial body weight, and subsequently at the end of the experiment to determine average daily gain. Rumen fluid samples were collected during the 8th week of the treatment period. Fecal collection from each animal was carried out by total collection during the final week prior to the end of the experiment for 7 consecutive days to determine feed digestibility.

The variables observed in this study included dry matter intake, average daily gain, volatile fatty acids (VFA), ammonia (NH3), rumen fluid pH, and nutrient digestibility.

The data obtained were analyzed using analysis of variance (ANOVA) and further tested using Duncan's Multiple Range Test.

RESULTS AND DISCUSSION

Goat Performance

The average daily body weight gain of the experimental goats under treatments R1, R2, and R3 during the study was relatively similar (Table 3). Therefore, it can be stated that increasing the concentrate ratio from 40% to 60% did not significantly affect the average daily weight gain of the experimental goats.

The similarity in average daily weight gain may be associated with feed intake, including dry matter, organic matter, crude protein, and crude fiber intake, which also showed no significant differences among treatments. Feed type, chemical composition of the feed, and the amount of feed consumed greatly influence the rate of growth and tissue development [6].

Table 3: Average daily body weight gain, nutrient intake, and feed conversion of the experimental goats

Variabel	Perlakuan			P-value
	R_1	R_2	R_3	
ADG (g/h/d)	32.64 ± 9.13	44.92 ± 9.69	39.12 ± 13.51	0.4
DMI (g/h/d)	629.87 ± 134.08	635.23 ± 135.34	638.21 ± 209.46	0.8
OMI (g/h/d)	619.23 ± 105.05	636.12 ± 139.25	652.23 ± 199.38	0.8
CPI (g/h/d)	71.69 ± 15.08	74.87 ± 16.19	79.71 ± 23.41	0.6
CFI (g/h/d)	137.40 ± 29.06	121.39 ± 26.16	105.06 ± 32.34	0.2

The nutrient requirements for goats weighing 15 to 25 kg are 540–580 g of dry matter, 41–49 g of crude protein, and 2.8 Mcal/kg of digestible energy (DE) [7]. The dry matter intake of goats in this study met the animals' nutritional requirements. This indicates that the complete feed used in this study was palatable and that the dry matter intake fulfilled the animals' needs.

Increasing the percentage of concentrate did not increase the intake of dry matter or any of the calculated nutrients. Differences in feed intake are influenced by several factors, including animal factors (body weight and age), feed digestibility, feed quality, and palatability. Feed digestibility and the rate of digesta passage also affect ration intake. Higher digestibility and faster digesta passage rates will increase ration intake [8].

The crude protein (CP) intake observed in this study was consistent with the CP content of the diet and dry matter intake, since the factors affecting CP intake are dry matter intake and the CP content of the feed. In this study, although the CP content of the ration relatively increased with the increasing percentage of concentrate, dry matter intake remained relatively similar; therefore, CP intake did not differ among treatments. Likewise, crude fiber (CF) intake remained relatively similar because, although the CF content of the ration tended to decrease with increasing concentrate percentage, dry matter intake did not differ among treatments. However, there was a tendency for CF intake to decrease (P-value = 0.2).

There is a close relationship between nutrient digestibility and nutrient intake. The digestibility of all nutrients was also not significantly affected by the treatments. This may have occurred because the rate of feed passage through the digestive tract was relatively similar among treatments. When the digestive tract empties more rapidly and the animals consume feed again, feed intake tends to increase; however, if the feed is not sufficiently digested, feed digestibility becomes lower.

Rumen Fluid Conditions of Goats

The average values of total volatile fatty acid (VFA) concentration, ruminal ammonia, and rumen fluid pH in the experimental goats are presented in Table 4.

Table 4: Average rumen fluid metabolite values of male Kacang goats

Variabel	Treatment			P-Value
	R1	R2	R3	
VFA (mM)	131.87 ± 11.89	121.16 ± 23.01	125,32 ± 19.45	0.37
NH3 (mg/dl)	10.89 ± 1.02	10.03 ± 3.95	11,06 ± 3.01	0.31
pH	6.12 ± 0.51	6.68 ± 0.42	6.23 ± 0.26	0.08

The relatively similar VFA production among treatments indicated that the readily degradable organic matter utilized by rumen microbes as an energy source for ruminants was available in relatively equal amounts across all treatments. In this study, total VFA production was within the normal range, indicating that it was available in optimum amounts for the ruminal degradation process and reflected a balanced availability of energy and protein sources. A balance between energy and protein in the ration can improve the efficiency of microbial protein synthesis, thereby increasing the nutrients that can be digested and absorbed post-ruminally [9]. This condition indicates that microbial growth and activity in the rumen were well supported, resulting in increased VFA concentrations. Statistically, different levels of rice straw silage and concentrate had no significant effect (P>0.05) on the VFA concentration in goats. Although increasing the proportion of concentrate, which contains higher levels of protein and non-structural carbohydrates that are easily degraded and potentially able to increase VFA concentration, it was not sufficient to significantly enhance VFA concentration [10], stated that increased VFA concentration reflects an increase in readily soluble protein and carbohydrate content in the feed [11], reported that VFA production is highly dependent on the types of carbohydrates contained in the feed material. An increase in total VFA production indicates an increase in carbohydrate fermentation in the rumen. Total VFA production is influenced by the ability of microbes to degrade carbohydrates in the rumen, resulting in high fermentability and consequently higher VFA concentrations. The amount of VFA produced reflects the ability of feed to be degraded by rumen microbes. Organic matter is the portion of dry matter degraded by microbes into VFA. According to [12], higher VFA concentrations generally reflect greater degradation of organic matter because digestible nutrients are primarily organic matter. Similarly, crude fiber, which is a carbohydrate component, undergoes degradation by rumen microbes into monosaccharides followed by fermentation processes that produce VFA [13], stated that organic matter does not contain ash, and feed ingredients without ash content tend to be more easily digested in the digestive tract, thereby increasing VFA production. In this study (Table 2), organic matter content increased with increasing concentrate percentage, while crude fiber content decreased, resulting in relatively similar substrate availability across all treatments.

The statistical analysis showed that the treatments had no significant effect (P≥0.05) on rumen fluid ammonia concentration. The ability to provide sufficient ammonia in the rumen is an important indicator in evaluating dietary protein for ruminants. The

results of the study (Table 3) showed that ammonia concentrations were similar across all treatments. This indicates that all treatment rations in this study were able to provide sufficient ammonia levels to support rumen microbial growth. Ammonia production is influenced by the amount of dietary protein and its solubility [14], stated that one of the factors affecting NH3 concentration is the protein content of the feed [15], explained that the concentration of NH3 in rumen fluid is highly dependent on the protein content of the ration consumed by the animals. This means that the use of rice straw with different concentrate ratios provided protein intake that could be hydrolyzed by rumen microbes into ammonia for microbial growth and activity. Variations in ammonia concentration in rumen fluid depend on the rate of protein degradation, the amount of dietary protein, the degradation rate of protein relative to other organic matter, and the time after feeding. Based on this explanation, the similar NH3 concentrations observed across all treatments were presumably due to similar protein intake and relatively similar protein degradation rates in the rumen, resulting in relatively similar ammonia formation.

The statistical analysis showed that the treatments had no significant effect (P>0.05) on rumen fluid pH in the experimental goats. Based on these data, all treatment rations exhibited relatively similar pH values. Rumen fluid pH is influenced by the amount of acidic VFA and alkaline NH3. Data in Table 4 showed that NH3 and VFA contents among the three treatments were relatively similar, resulting in relatively similar pH values. In addition, the ration used had a high fiber content (rice straw as the sole forage source) and low moisture content, which strongly stimulated saliva secretion in the goats and helped maintain rumen pH under normal conditions. The absence of significant differences in rumen pH (P>0.05) may also be related to feed fermentation processes in the rumen that increased VFA concentration, thereby lowering rumen pH [16], stated that a decrease in rumen pH occurs due to rapid feed fermentation, which reduces saliva production. According to [17], rumen pH is influenced by the concentration of VFA produced [18], also reported that rumen pH decreases as VFA concentration increases. The rumen fluid pH values observed in each treatment were within the normal range, indicating favorable conditions for rumen microbial activity, particularly under mildly acidic conditions [19], stated that the optimum pH condition for rumen microbes to synthesize protein ranges from 6.13 to 6.35 [20], found that the type of feed given to livestock affects rumen pH. Concentrate feeds fermented in the rumen produce high levels of VFA and are acidic in nature. The rations used in this study contained relatively high concentrate levels, ranging from 40% to 60%. These findings are consistent with those reported by (17), who observed rumen pH values ranging from 5.40 to 5.96 in Kacang goats fed rations with a forage-to-concentrate ratio of 30:70. Similarly [21], reported rumen fluid pH values of 6.08–6.22 in Kacang goats fed complete feed rations containing more than 20% concentrate.

The statistical analysis showed that the treatments had no significant effect (P>0.05) on rumen fluid pH in the experimental goats. Based on these data, all treatment rations exhibited relatively similar pH values. Rumen fluid pH is influenced by the amount of acidic VFA and alkaline NH3. Data in Table 4 showed that NH3 and VFA contents among the three treatments were relatively similar, resulting in relatively similar pH values. In addition, the ration used had a high fiber content (rice straw as the sole forage source) and low moisture content, which strongly stimulated saliva secretion in the goats and helped maintain rumen pH under normal conditions.

Nutrient Digestibility

The average nutrient digestibility of goats in this study is presented in Table 5.

Table 5

Variabel	Perlakuan			P-value
	R_1	R_2	R_3	
DMD (%)	45.87 ± 1.84	46.82 ± 4.26	52.57 ± 4.39	0.08
OMD (%)	51.38 ± 4.29	51.92 ± 4.29	57.46 ± 3.67	0.1
CPD (%)	64.08 ± 3.69	67.85 ± 5.24	72.02 ± 6.57	0.2
CFD (%)	44.12 ± 3.21	41.49 ± 4.29	39.75 ± 3.47	0.2

The digestibility of all nutrients in this study was not significantly affected (P > 0.05) by the treatments. The overall nutrient digestibility was relatively good, which may be attributed to the high quality of the ration (the ration was formulated with a relatively high proportion of concentrate) and the fact that the rice straw used had undergone an ensiling process. During ensiling, the growth of microorganisms and the production of lactic acid help to loosen the bonds of fiber components that are difficult for livestock to digest, resulting in relatively similar digestibility among all dietary treatments.

The high protein digestibility leads to a greater availability of nutrients for body tissue synthesis. A positive protein balance indicates an increase in muscle tissue deposition. This utilization of protein for muscle tissue accretion is supported by the positive average daily gain (ADG) data, and because protein digestibility was similar across all treatments, the ADG was also similar among treatments.

Protein digestibility in this study ranged from 51.95% to 58.55%. A low percentage of protein in the feces indicates improved efficiency of protein digestion. This suggests that the rations in all three treatments had similar quality. The lack of differences in protein digestibility in this study resulted in no significant differences in ADG.

In this study, ruminal NH_3 and VFA production were similar among the three treatments; therefore, the amount of ammonia that was not utilized was also likely similar across treatments. All of these factors resulted in a similar protein balance among treatments, which in turn affected the availability of nutrients for muscle synthesis, leading to relatively similar ADG across all treatments.

CONCLUSION

The conclusion of this study is that feeding a complete ration with different ratios of ensiled rice straw supplemented with porang flour additive and concentrate had a relatively similar effect on the performance, feed intake, nutrient digestibility, and ruminal fluid characteristics of male Kacang goats.

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