ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IV April 2025

Production Performance, Nutrient Digestibility of Rations, And Carcass Percentage of Kacang Goats Fed Fermented Banana Peel As A Concentrate Ingredient

Fatmawati Fatmawati[1] , Padang Hamid[2] , Moh. Basri[3]

Animal Husbandry and Fishery Faculty, Tadulako University Palu-Indonesia

DOI: https://doi.org/10.51244/IJRSI.2025.12040013

Received: 24 February 2025; Accepted: 13 March 2025; Published: 29 April 2025

ABSTRACT

Banana peels (*Musa Sp*.) hold potential for processing into livestock feed, primarily because approximately 35% of the total weight of bananas is represented by the peel. Being one of the most extensively produced crops worldwide, banana cultivation significantly contributes to the generation of agro-industrial waste. The opportunity to utilize banana peels as a source of livestock feed is limited by their polysaccharide content, particularly cellulose, hemicellulose, and lignin. However, due to their high sugar content, these polysaccharides can be broken down through fermentation methods. This study was conducted at the experimental farm owned by CV. Prima BREED in Tondo Village, Mantikulore District, Palu City, Central Sulawesi Province, from June to September 2024. The objective of this study was to determine feed digestibility and production performance of Kacang goats fed with fermented banana peels as a partial substitute for concentrate feed. A total of 15 female Kacang goats, approximately 12 months of age and weighing between 11.85 and 18.46 kg, were used in this research. The experimental design employed was a Randomized Block Design (RBD) with three treatments, each replicated five times as a group. The treatments tested were as follows: P0 = without the addition of fermented banana peels, P1 = addition of 10% fermented banana peels in the concentrate composition, and P2 = addition of 20% fermented banana peels in the concentrate composition. The results of variance analysis showed that the inclusion of fermented banana peels had a significant effect on the digestibility of dry matter, organic matter, crude fiber, crude protein, weight gain, and carcass percentage of Kacang goats. However, it did not affect the digestibility of crude fat, dry matter intake, feed utilization efficiency, carcass weight, non-carcass weight and percentage, internal non-carcass weight and percentage, external non-carcass weight and percentage, or the weight and percentage of edible non-carcass parts of female Kacang goats.

Keywords: Kacang goats, fermented banana peels, digestibility, and production performance.

INTRODUCTION

Feed is one of the critical factors determining the success of goat farming. The feed provided must meet both quantitative and qualitative standards, containing nutrients essential for basic survival, production, and reproduction needs. However, fulfilling feed requirements both quantitatively and qualitatively is not always feasible, and competition with human food needs often arises. To address these issues of inconsistent availability and competition with human needs, an effective solution is necessary. One such solution is the use of agricultural waste that still holds nutritional value, such as banana peels, which can be processed into fermented feed to meet the nutritional needs of goats. Many farmers and small-scale entrepreneurs currently dispose of banana peels or leave them to spoil after the fruit has been harvested.

The energy needs of livestock to match their requirements and improve productivity can be achieved by providing energy-rich concentrate feed. Including concentrate in livestock feed is an effort to enhance feed efficiency, add essential nutrient elements, increase feed intake, and boost microbial fermentation in the rumen, aiding in the digestion of low-quality feed.

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The processing of livestock feed aims to enhance and maintain the quality of feed ingredients, which are typically

derived from agricultural, plantation, and industrial by-products. When feed ingredients are abundant, and their usage is not immediately exhausted by livestock, it becomes essential to process these feed materials. The processed feed is intended to serve as a food reserve for livestock, ensuring that livestock farming operations continue smoothly to achieve optimal productivity and growth. Ultimately, this approach benefits the farming business economically, as it allows livestock to grow optimally in line with desired outcomes.

In Central Sulawesi Province, generally, the economic value of banana peels has not yet been fully utilized. Banana peels still hold other useful potential, particularly as raw material for livestock feed. As one of the by-products of the agro-industry, banana peels have not been maximally exploited. According to (Koni et al. 2013), banana peels contain 3.63% crude protein, 2.52% crude fat, 18.71% crude fiber, 7.18% calcium, and 2.06% phosphorus. Additionally, (Widjastuti and Hernawan, 2012) reported that banana peels contain 10.09% crude protein, 18.01% crude fiber, 5.17% fat, 0.36% calcium, 0.10% phosphorus, and a gross energy of 3,727 kcal/kg. (Koni et al., 2013) stated that the average weight of banana peels ranges from 25% to 40% of the banana's total weight, depending on its ripeness; the riper the banana, the lower the percentage of peel weight. Considering the potential and nutritional value contained within, banana peels are a promising material for use as livestock feed. However, their utilization remains very limited due to the high lignin content, which necessitates preliminary processing before use. (Larangahen et al., 2016 and Rita et. al., 2020) suggested that the reduction of lignin and the increase in protein content in banana peels can be achieved through bioconversion via fermentation. Furthermore, (Anhwange et al., 2009) stated that banana peels, if properly processed and utilized, can serve as a high-quality and cost-effective source of carbohydrates and minerals for livestock. One potential method for optimizing their use is through fermentation. Fermentation can enhance the crude protein content while reducing the crude fiber content. (Koni et al., 2013) reported that the protein content of banana peels fermented with probiotics increased by 127%. This is evident as the crude protein of banana peels before fermentation, initially at 6.56%, rose to 14.88% after fermentation.

The nutritional content of banana peels holds significant potential as a valuable carbohydrate source for all stages of livestock development. The carbohydrate content, particularly the nitrogen-free extract, is 66.20% (Fernandes et al., 2013), and it still contains cellulose and hemicellulose, which account for 40% of the total crude fiber content (Fatmawati et al., 2015), with the crude fiber content of banana peels being 13% (Gohl, 1981). Additionally, the high mineral content is highly beneficial as livestock feed. (Van Soest, 1994) noted that cellulose and hemicellulose, which are components of plant cell walls, can still be utilized by ruminant livestock.

According to (Novianti et al., 2014), an increase in feed intake for livestock aligns with improvements in feed quality and digestibility. However, feed digestibility depends on the fiber content that the livestock cannot utilize effectively. (Putra et al., 2020) stated that one of the factors that can inhibit the digestibility level is the high content of antinutrients in the feed, including tannin levels. (Thaariq, 2017) further noted that high digestibility can indicate the substantial nutritional contribution of certain feeds to livestock, whereas feeds with low digestibility suggest limited capacity to provide essential nutrients for maintenance or production purposes. Based on the untapped potential of banana peels, the author conducted a study on the use of fermented banana peels as a concentrate feed ingredient to evaluate carcass percentage and nutrient digestibility in local goats. The objective of this study is to determine the effects of using fermented banana peels as a concentrate feed on nutrient digestibility and the production performance of Kacang goats.

RESEARCH METHODS

Before this study was conducted, a feasibility test was first carried out by the Animal Ethics Team, and a letter of approval, number 2527.A/UN28.1.31/KP/2024, dated June 3, 2024, was issued, confirming that the study does not violate the Veterinary Ethics Code. (The document is attached).

This study was conducted at the Experimental Farm of CV. Prima BREED, located in Tondo Village, Mantikulore District, Palu City, Central Sulawesi Province, from June to September 2024. The study involved

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15 Kacang goats approximately 12 months old, with body weights ranging from 11.85 to 18.46 kg.

The feed provided during the study consisted of a concentrate and Panicum sarmentosum Roxb. The concentrate

used was a mixture of several ingredients, including soyKacangs, ground corn, rice bran, and fermented banana peels. The concentrate and treatment ingredients were administered at 07:30 AM at a rate of 1.0% dry matter based on body weight, while *Panicum sarmentosum* Roxb. was offered *ad-libitum* after the concentrate was fully consumed. The nutritional content of the concentrate ingredients is detailed in Table 1.

Table 1. Nutritional Content and Composition of Concentrate Ingredients Used

Feed Ingredients	Dry Matter	Crude Protein	Crude Fiber	Crude Fat	TDN***
Ground SoyKacangs*	92,13	31,35	9,73	11,65	61,00
Rice Bran*	89,92	10,67	18,39	4,64	68,41
Fermented Banana Peels**	86,99	11,86	2,75	1,20	77,56
*Panicum sarmentosum**	26,29	11,51	30,20	1,90	59,54

Note : * Results of laboratory analysis from the Feed Nutrition Department, Faculty of Animal Husbandry and Fisheries, Tadulako University, 2020.

** Results of laboratory analysis from the Feed Nutrition Department, Faculty of Animal Husbandry and Fisheries, Tadulako University, 2024.

*** Calculated based on guidelines by Hartadi et al. (1993) using Formulas 2, 4, and 5.

Preparation of Fermented Banana Peels

1. Fresh banana peels collected from fried banana vendors are chopped and then sun-dried for 5-6 days.
2. The dried banana peels are mixed with 2% molasses, 2.5% urea, 5% ground corn, 100 ml of EM4 per 10 kg of material, and 40% sterile water based on the dry weight of the banana peels.
3. The substrate, after being combined with all ingredients, is placed in a container, pressing down to reduce air gaps and volume within the container. The mouth of the container is then sealed and tied with a rubber band,
4. The container with the substrate is stored at room temperature for 14 days.
5. After the fermentation process is complete, the container is opened, and the substrate is sun-dried for 5-6 days, then ground into flour, followed by proximate analysis.
6. The fermented banana peel flour is ready to be used as a feed ingredient.

This study was designed using a Randomized Block Design (RBD) with three treatments, repeated five times as groups. The treatments tested are as follows:

P0 = No addition of fermented banana peels

P1 = Addition of 10% fermented banana peels

P2 = Addition of 20% fermented banana peels

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Variabels and Measurement Methods

The dependent variables observed in this study include nutrient digestibility, specifically dry matter digestibility and carcass percentage.

1. In vivo Nutrient Digestibility, this includes measuring the total voluntary feed intake and weighing the total feces of livestock in a metabolism cage. Digestibility is calculated by subtracting the amount of nutrients excreted in the feces from the total nutrient intake, then dividing by the total nutrient intake and multiplying by 100%.
2. Production Performance is assessed by weighing the carcass, non-carcass, internal non-carcass, external non-carcass, and edible non-carcass parts. The percentage is calculated by dividing the weight of each component (carcass, non-carcass, internal non-carcass, external non-carcass, and edible non-carcass) by the live weight after a 12-hour fasting period prior to slaughter, then multiplying by 100%.

The observation data obtained were analyzed using analysis of variance (ANOVA, F-test) according to the guidelines of (Steel and Torrie, 1991). Data that showed significant effects were further analyzed using the Least Significant Difference (LSD) test to determine the differences in the treatment means.

RESULT AND DISCUSSION

Feed Digestibility

The observations on feed digestibility in female Kacang goats receiving fermented banana peel as a concentrate ingredient during the study are presented in Table 2.

Table 2.Digestibility of feed in female Kacang goats receiving fermented banana peel as a concentrate ingredient.

Parameter	Treatment		
	P1	P2	P3
Dry Matter Digestibility (%)	61,16a	62,07a	64,51b
Organic Matter Digestibility (%)	62,17a	62,25a	64,32b
Crude Protein Digestibility (%)	56,40a	56,52a	58,65b
Crude Fiber Digestibility (%)	76,90a	77,40a	78,77b
Crude Fat Digestibility (%)	81,96a	82,00a	83,92a

Note :Different letters in a row indicate a significant difference ($P<0.05$)

Variance analysis indicates that the addition of fermented banana peel as a concentrate ingredient has a highly significant effect ($P<0.01$) on the digestibility of dry matter and crude fiber in feed and a significant effect ($P<0.05$) on the digestibility of organic matter and crude protein. However, it has no significant effect ($P>0.05$) on the crude fat digestibility in feed for female Kacang goats.

The Least Significant Difference (LSD) test results indicate that the digestibility of dry matter, organic matter, crude protein, and crude fiber in feed for goats receiving 20.0% fermented banana peel as a concentrate ingredient was significantly higher ($P<0.05$) compared to goats receiving 10.0% fermented banana peel and those without fermented banana peel. Meanwhile, the difference in digestibility of dry matter, organic matter, crude protein, and crude fiber between the 10.0% fermented banana peel group and the group without fermented banana peel was not significant ($P>0.05$) in female Kacang goats.

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The higher digestibility observed with the provision of 20.0% fermented banana peel as a concentrate ingredient, compared to other treatments, is due to the role of banana peel in enhancing feed palatability, which, in turn, increases feed digestibility.

The tannin content in banana peels can enhance digestibility within certain limits, but when tannin levels exceed these limits, it acts as an antinutrient for livestock. The high digestibility observed in the P2 treatment suggests that the banana peel, once fermented before being added as a concentrate mixture, is already broken down by microorganisms during fermentation. Additionally, the 20% inclusion level contributes a significant amount of decomposing microbes in the livestock's digestive tract, thereby increasing the digestibility of dry matter, organic matter, crude fiber, and crude protein.

Meanwhile, the addition of 10% fermented banana peel in the concentrate composition maintains tannin levels within tolerable limits, acting as a digestion-enhancing factor without exceeding the digestibility levels seen in the treatment without fermented banana peel (P1). Dietary fiber sourced from fruits possesses higher quality than other fiber sources due to its high soluble fiber content, low phytic acid levels, and low caloric value. According to (Cho, S. S., & Samuel., 2009), fiber (such as that found in bananas) provides numerous benefits, including the enhancement of digestive health.

Banana peel waste can be used as a substitute for concentrate feed in livestock. This is supported by (Yanuartono et al., 2020) who stated that banana peels, along with other banana by-products such as leaves, young plants, rejected fruits, and stems, can be utilized as a source of feed for ruminant livestock. Although the volume of banana plant waste is abundant, its utilization is limited by several factors, such as high fiber content and moisture levels. It has been stated that to overcome these challenges, further processing methods are needed to enhance its nutritional value (Fatmawati et al., 2015). Among the most simple and cost-effective methods for processing is fermentation technology. The added value of the fermentation process is its ability to preserve the surplus feed, which is seasonally abundant, for future use during feed shortages. This paper aims to briefly summarize the potential and benefits of fermenting banana plant waste as ruminant livestock feed.

Fermentation with probiotics was able to increase the crude protein content to 14.88% and reduce the crude fiber content to 11.43%, which is beneficial for livestock growth. Furthermore, it is stated that carbohydrates are an important feed ingredient as a source of energy. The primary function of carbohydrates in livestock is to meet energy and heat requirements for all bodily processes. Research conducted by Astuti (2015) revealed that the best dry matter and organic matter digestibility were found in treatments with 40% fermented banana peel and 0% field grass, yielding 74.58% and 72.62%, respectively. A ration based on fermented banana peel with MOL can be used as a substitute for pasture grass as a source of roughage for ruminant livestock.

Production Performance

The observations on the production performance of female Kacang goats receiving fermented banana peel as a concentrate ingredient during the study are presented in Table 3.

Table 3.Production Performance of Female Kacang Goats Receiving Fermented Banana Peel as a Concentrate Ingredient

Parameter	Treatment		
	P1	P2	P3
Daily Weight Gain (g/head/day)	41,57a	42,39ab	43,18b
Feed Dry Matter Intake (g/head/day)	453,88a	446,88a	439,68a
Feed Efficiency	0,095a	0,097a	0,100a
Carcass Weight (kg)	7,61a	7,72a	7,92a

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Carcass Percentage (%)	43,40a	43,60a	43,97b
Non-Carcass Weight (kg)	4,83a	4,91a	4,89a
Non-Carcass Percentage (%)	27,19a	27,43a	26,88a
External Non-Carcass Weight (kg)	2,62a	2,70a	2,65a
External Non-Carcass Percentage (%)	14,75a	15,11a	14,65a
Internal Non-Carcass Weight (kg)	2,22a	2,21a	2,23a
Internal Non-Carcass Percentage (%)	12,44a	12,32a	12,24a
Edible Non-Carcass Weight (kg)	3,66a	3,68a	3,69a
Edible Non-Carcass Percentage (%)	20,64a	20,59a	20,32a

Note : - Different letters in a row indicate a significant difference ($P<0.05$).

Variance analysis indicates that the inclusion of fermented banana peel as a concentrate ingredient has a highly significant effect ($P<0.01$) on carcass percentage and a significant effect ($P<0.05$) on daily weight gain. However, it has no significant effect ($P>0.05$) on dry matter intake, feed efficiency, carcass weight, non-carcass weight and percentage, external non-carcass weight and percentage, internal non-carcass weight and percentage, or edible non-carcass weight and percentage in Kacang goats.

The Least Significant Difference (LSD) test results show that the weight gain in goats given 20.0% fermented banana peel as a concentrate ingredient was not significantly different ($P>0.05$) from goats given 10.0% fermented banana peel. However, it was significantly higher ($P<0.05$) compared to goats without fermented banana peel. Meanwhile, there was no significant difference ($P>0.05$) in weight gain between goats given 10.0% fermented banana peel and those without fermented banana peel in female Kacang goats.

The increased weight gain in goats with higher levels of fermented banana peel in the concentrate composition is due to the improved nutritional quality of the feed. The fermented banana peel provided has enhanced quality, as it has already been broken down by microbes before being fed to the livestock, leading to better absorption in the body and, consequently, contributing to greater weight gain.

The consumption of dry matter and feed efficiency, which were not significantly affected, can be attributed to the nutritional content of the treatment feed being relatively similar and still within the threshold of livestock needs, particularly in terms of protein and energy content. According to (Kearl, 1982., Wang, et al., 2012), the protein requirement for goats ranges between 12-14% per head. (Restitrisnani, 2013) explained that if the ration provided in a feed does not meet the required energy needs, the livestock will consume more feed material. This is further supported by (Lu et al., 2005) who stated that goats require sufficient feed fiber for normal rumen activity and function. In the rumen, feed fiber is degraded by microbes to provide energy to support maintenance, growth, and reproduction.

The lack of effect on feed efficiency is likely due to the livestock's relatively similar ability to digest the nutrients in the feed, with values ranging from 0.095 to 0.1000. This indicates that to produce 95-100 grams of body weight, the livestock requires 1000 grams of feed intake. Consequently, feed efficiency was not significantly different ($P>0.05$). Feed efficiency reflects the Feed Conversion Ratio (FCR) and Feed Conversion Efficiency (FCE), which represent the biological capacity of livestock to convert feed into body mass while maintaining other essential biological functions (Edi et al., 2024).

The Least Significant Difference (LSD) test results show that the carcass percentage of goats receiving 20.0% fermented banana peel as a concentrate ingredient was significantly higher ($P<0.05$) than that of goats receiving 10.0% fermented banana peel and those without fermented banana peel. However, there was no significant

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difference (P>0.05) in carcass percentage between goats receiving 10.0% fermented banana peel and those without fermented banana peel in female Kacang goats.

The difference in carcass percentage may be attributed to the varying quality of feed provided in each treatment, while the non-significant differences are still within the tolerance limits for the livestock's growth needs. According to (18) the protein requirement for growing goats in Indonesia is 12–14% with a digestible energy (DE) of 2.8 Mcal.

A sufficient quantity and high-quality feed cannot alter livestock that are genetically small in size. However, providing a low quantity of feed will not support optimal weight gain and carcass growth according to each

animal's genetic potential, such as growth rate, high carcass percentage, and other traits (Sugeng, 2007).

The quality or nutritional value of feed can influence the amount of feed consumed by livestock. The quality of the feed consumed can affect the carcass percentage. According to (Tillman et al., 1998), protein and energy are crucial elements in the growth process; therefore, rations containing high levels of protein and energy will result in higher body weight gain.

The weight and percentage of non-carcass components, including internal non-carcass, external non-carcass, and edible non-carcass, were calculated by dividing the weight of each edible non-carcass component by the slaughter weight and multiplying by 100%. The results of this study indicate that the treatment had no effect on the weight and percentage of non-carcass components, internal non-carcass, external non-carcass, and edible non-carcass components.

This is because the growth of non-carcass components no longer occurs as the livestock has reached full physical maturity. Additionally, no fat accumulation was observed in the non-carcass sections during the study. According to Hammond (1960) *in* (Triatmodjo dan Suryanto, 1990), the growth rate of body tissues aligns with organ function, with organs essential for survival developing first, while those involved in production develop later. For instance, at birth, livestock is dominated by the head and thighs; as they grow in length and thickness, the bones develop faster than muscle and fat.

Murray et al. (1977) *in* (Triatmodjo dan Suryanto, 1990), stated that the addition of feed has no effect on the weight of internal organs except for the liver and kidneys. The relative growth of some non-carcass parts matches the relative growth rate of the livestock's body (Murray and Slezacek, 1978, *in* (Triatmodjo dan Suryanto, 1990). Furthermore, (Black, 1983) reported that the weights of the rumen, reticulum, and omasum increase rapidly in the early postnatal period, but the percentage of the digestive tract decreases upon reaching maturity. Additionally, the small intestine develops faster than the large intestine and abomasum. Generally, the weight of digestive and metabolic organs varies significantly depending on physiological status and the diet provided.

CONCLUSION

This study concludes that the provision of fermented banana peels can be implemented. The inclusion of fermented banana peels significantly affects the digestibility of dry matter, organic matter, crude fiber, and crude protein, as well as body weight gain and carcass percentage in female Kacang goats. However, it has no effect on crude fat digestibility, dry matter intake, feed efficiency, carcass weight, non-carcass weight and percentage, internal non-carcass weight and percentage, external non-carcass weight and percentage, or edible non-carcass weight and percentage in female Kacang goats.

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ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XII Issue IV April 2025

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