

Pakan-SIP adoption as a featured ruminant-rations product of TEFA Feed Mill Polije on trends in body weight and physiological responses of local crossbred sheep

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Abstract. This research examined the impact of Pakan-SIP adoption on body weight trends and physiological characteristics of local crossbred sheep compared to conventional feeding based on native grass. Nine heads of local crossbred sheep were randomly allocated in a Completely Randomized Design (CRD) with 3 dietary treatment levels, each in triplicate. It was 100% native grass (T0), 50% native grass and 50% Pakan-SIP (T1), and 100% Pakan-SIP (T2). The sheep, aged ± 12 months old with initial body weight of ± 28.97 kg/head. They were adapted to individual pens, simultaneously offered native grass and Pakan-SIP, and provided ad libitum drinking water during several weeks. Thereafter, body weight and physiological responses were monitored over a month. Results showed an upward trend in body weight for sheep fed Pakan-SIP with average of 6.37 kg/head/month without any deleterious effects on rectal temperature, heart rate, and respiratory rate. These findings suggest that Pakan-SIP can serve a superior feed for fattening local crossbred sheep, supporting growth performance without compromising physiological stability or affecting animal welfare.

1 Introduction

The livestock sector is one of the key pillars of agricultural development in Indonesia, particularly in ensuring the supply of animal protein. Sheep represent a promising livestock commodity due to the increasing market demand for mutton and its expanding consumer base. The demand for mutton was approximately 2,250 tons in 2022 and rose to 4,200 tons in 2023 [1].

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This increase in demand is driven by both daily consumption and seasonal or religious needs, such as during religious festivals. Sheep are also an attractive small ruminant species to develop because of their high economic value, rapid reproductive rate, adaptability to diverse environments, lower absolute feed requirements per head compared to larger ruminants, lower maintenance costs, and the ability to utilize crop residues as feed. Moreover, sheep farming provides a consistent market and serves as a readily available source of cash income when needed [2].

Despite this potential, sheep fattening enterprises in Indonesia remain largely dominated by smallholder farms rather than large-scale industries. Smallholder farmers typically rely on conventional feeding practices, primarily depending on forages available from their surroundings. This feeding management limits productivity and farm development. Furthermore, constraints such as limited feed availability, fluctuating prices of feed ingredients, variable nutrient quality, and relatively low feed efficiency remain major challenges in improving sheep fattening productivity. One innovative solution to address these challenges is the adoption of Total Mixed Rations (TMR), which provides balanced nutrition [3] while also offering practicality and ease in feed preparation and feeding management. It was designed to provide a balanced supply of energy, protein, fiber, vitamins, and minerals in a single homogenous diet, thus ensuring that nutrient intake is more consistent compared to conventional feeding systems where concentrates and forages were offered separately. This is consistent with the findings of Ahmad et al., who reported that improvements in feeding technology enabled ram gains of 150–170 g/day [4,5], while the average daily gain (ADG) of local sheep raised under smallholder conditions was under 100 g/day. Other studies have also shown that TMR based on edamame waste, without the addition of exogenous enzymes, could achieve an ADG of 223–230 g/day [6,7].

The impact of TMR goes beyond ruminal fermentation and metabolic balance. It includes measurable physiological responses like rectal temperature, heart rate, and respiratory rate. These parameters serve as reliable indicators of the animal's thermal balance, metabolic status, and overall adaptability to dietary interventions. Likewise, consistent nutrient supply contributes to more efficient energy metabolism, which is reflected in heart rate regulation and respiratory dynamics. The ability of TMR is relevance not only for improving performance but also for promoting sustainable livestock production systems that prioritize animal health and welfare. One of the TMR products developed as a leading innovation of the Teaching Factory (TEFA) of Animal Feed at Politeknik Negeri Jember is Pakan-SIP. Pakan-SIP is formulated to meet the nutritional requirements of livestock, particularly for fattening sheep, and utilizes local agricultural by-products as the primary feedstuffs. It allows Pakan-SIP to be a superior feed with lower price than the market. Therefore, this research examined the impact of Pakan-SIP adoption on body weight trends and physiological responses of local crossbred sheep compared to conventional feeding based on native grass.

2 Materials and Methods

2.1 Research design and animal maintenance

This research involved minimal animal ethics issues, as the use, care, and parameters observed in the animals remained within safe and acceptable limits. No procedures were performed that harmed the animals or violated ethical and welfare standards. The research protocol was reviewed and approved by the Research Ethics Committee for Experimental Animals and Health, Politeknik Negeri Jember.

The research was conducted since August to September 2025 at the TEFA of Animal Feed, the Sheep Pen Facility, and the Feed Technology Laboratory, Politeknik Negeri Jember, Indonesia. A Completely Randomized Design (CRD) was employed, involving 9 local crossbred sheep which aged 10-12 months old with an initial body weight of approximately ± 28.97 kg/head. This number was indeed smaller due to limited resources, however all the sheep used were carefully selected to produce the most similar research units. They were randomly allocated into 3 dietary treatment levels in triplicate. The dietary treatment was consisted of different ratios of Pakan-SIP and native grass. The Pakan-SIP was formulated to contain 10–12% crude protein (CP) and 55–60% total digestible nutrients (TDN). It fulfilled the nutrient requirement for fattening local crossbred sheep according to [8]. The treatments were defined as follows:

- T0: 100% native grass
- T1: 50% native grass + 50% Pakan-SIP
- T2: 100% Pakan-SIP

Local crossbred rams observed in this study were first adapted to the pens and diets for two weeks according to their respective treatment levels. After the adaptation period, a month observation period was carried out. Sheep were housed in individual pens and were provided feed and drinking water according to their nutritional requirements on an ad libitum basis. At the beginning of the observation period, the amount of feed offered was set at 4.8% of body weight on a dry matter (DM) basis and was subsequently adjusted following the ad libitum principle. The Pakan-SIP was offered twice daily, during the morning and afternoon feeding sessions.

2.2 Parameters and data analysis

Parameters observed were animal body weight and physiological responses which starting at week 1 and 2, respectively. Each ram's body weight was measured once a week and 2 days apart did the physiological responses observation. The physiological responses were observed by measuring rectal temperature, heart rate, and respiratory rate per minute. It was assessed before morning feeding which used digital thermometer and stethoscope for rectal temperature and heart rate measurement, respectively. While, the respiratory rate was calculated by manually feeling the sheep's breath in a minute. Data were analyzed by ANOVA using PASW Statistics 18. The significant differences among treatment levels were executed by further testing using the Duncan's Multiple Range Test (DMRT).

3 Results and Discussion

3.1 Body weight of local crossbred sheep fed with or without Pakan-SIP rations

Initial and final body weight of local crossbred sheep fed with or without Pakan-SIP rations were shown in **Table 1**. It presented no statistically differences (p -value >0.05) in both initial and final body weights among treatment levels. Furthermore, the body weight trend illustrated by the **Figure 1**, that showed an increase progression for local crossbred sheep fed Pakan-SIP rations, including T1 and T2 compared to the control level (T0) across the observation period. T2 tended to exhibit the greatest rise over 4 weeks observation period. By contrast, T0 presented a plateau and slight decline towards the final weeks. It suggested a potential positive association between the rations and weight gain, which approximately gaining of T0-T2 were 0.51, 2.89, and 6.37 kg/head/month, respectively.

Table 1. Initial and final body weight of local crossbred sheep fed with or without Pakan-SIP rations

Treatment	Initial body weight (kg/head)	Final body weight (kg/head)
T0	28.48±1.23	28.99±2.96
T1	29.55±1.66	32.44±3.46
T2	28.90±4.49	35.27±4.47
Grand mean	28.97±2.52	32.23±4.19
SEM	0.951	1.228
p-value	0.900	0.194

- Notes:
- T0: 100% native grass; T1: 50% native grass + 50% Pakan-SIP; T2: 100% Pakan-SIP
 - Similar superscripts within columns indicated similar effect between treatment levels at P -value >0.05

This phenomenon validated that the Pakan-SIP used in T1 and T2 contained a balanced and better nutrient than native grass for fulfilling nutrient requirement of sheep fattening. The numerical trend in higher weight gain of T2 aligned with previous study that showed protein-energy balance significantly influencing lamb weight gain and feed efficiency [9]. More nutrient intake and good digestibility will perform muscle movements and growth. Moreover, supplementation strategies including protein-rich or balanced nutrient rations were known to enhance growth performance by supporting better feed utilization and nutrient digestibility [9,10].

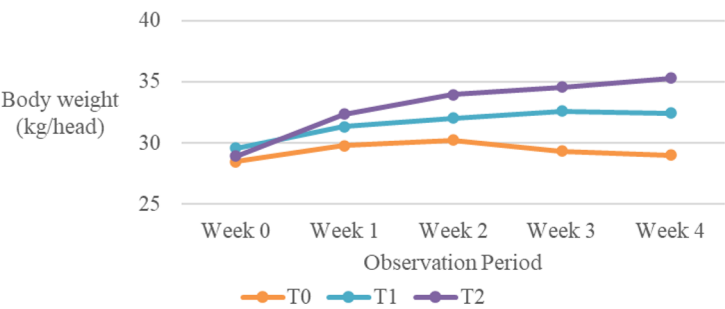


Fig. 1. Body weight trends of local crossbred sheep fed with or without Pakan-SIP rations.

3.2 Physiological responses of local crossbred sheep fed with or without Pakan-SIP rations

Physiological responses of local crossbred sheep fed with or without Pakan-SIP rations and the trend over 3 times measurement were presented in **Table 2** and **Figure 2**, respectively. There was a statistically significant increase (p-value<0.05) on rectal temperature on sheep fed T1 and T2 than control (T0). In contrast, the treatment diet did not affect (p-value>0.05) on heart rate and respiratory rate of local crossbred sheep. This pattern suggested that the Pakan-SIP rations may slight elevate or stabilize body temperature, potentially due to enhanced metabolic activity from nutrient improvement.

Previous studies have reported that nutrition improvement, especially for protein and energy supplementation may reflect enhanced metabolic activity which reflected as a slight elevation in rectal temperatures. It was aligned with the result of lambs fed high concentrate diet showed higher rectal temperature than low concentrate diet which were 39.33 °C and 38.89 °C, respectively [11]. Additionally, rectal temperature of local sheep fed commercial concentrate feed and intensively maintained was in normal ranged of 38.9-39.5 °C [12]. However, the value is still within the normal range of rectal temperature for sheep according to "Clinical Examination of Farm Animals" was 38.5–40.0 °C [13] and the rectal temperature of sheep in tropical areas was in the range of 38.2–40 °C [14].

Table 2. Physiological responses of local crossbred sheep fed with or without Pakan-SIP rations

Treatment	Rectal temperature (°C)	Heart rate (bpm)	Respiratory rate (bpm)
T0	38.11±0.33 ^a	80.67±16.15	34.22±6.04
T1	38.46±0.32 ^b	88.89±22.61	34.22±5.04
T2	38.62±0.34 ^b	94.22±18.75	37.33±6.71
Grand mean	38.33±0.46	93.00±21.21	35.26±5.93
SEM	0.065	3.724	1.149
p-value	0.011	0.343	0.455

Notes:

- T0: 100% native grass; T1: 50% native grass + 50% Pakan-SIP; T2: 100% Pakan-SIP
- Similar superscripts within columns indicated similar effect between treatment levels at P-value>0.05

Heart rates of sheep fed with or without Pakan-SIP rations ranged from 80.67±16.15 to 94.22±18.75 beats per minute and numerically tended to increase along with Pakan-SIP proportion offered but the high standard deviation indicated to considerable individual variation [15]. Generally, the normal resting heart rate for sheep was 70–90 beats per minute [13]. This also occurred in respiratory rate, respiratory rate of sheep among treatment levels was similar at around 34-37 bpm and T2 tended to be the highest number. It was above the classic normal range of 20-34 mov (the total volume of air a person breathes) per minute for sheep [16]. It indicated a tendency of increasing metabolic demands for more efficient feed utilization due to the higher nutritional value of SIP-Pakan compared to native grasses. The previous study of Seixas et al. have reported that heart rates and respiratory rates in commercial and crossbred sheep often exceed the normal number, particularly under conditions of increased metabolic demand or in tropical climates [17].

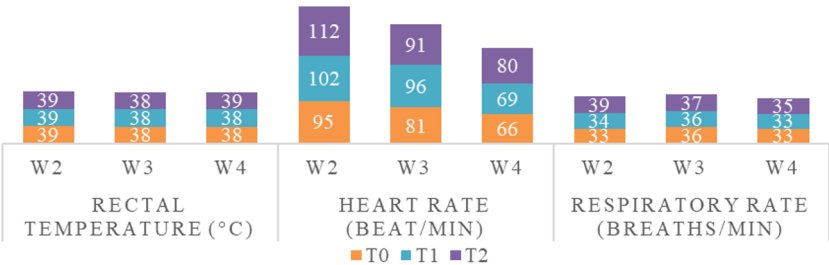


Fig. 2. Physiological responses (rectal temperature, heart rate, respiratory rate) trends of local crossbred sheep fed with or without Pakan-SIP rations.

Merely the rectal temperature of sheep that showed a noticeable change due to the different diets offered. This result supported that rectal temperature was a reliable marker of shifts in metabolism influenced by nutrition, while heart rate and respiratory rate tended to stay stable unless animals were under tropical climate or stressed. Adding a well-balanced source of protein and energy, specifically the SIP-Pakan rations, helped sheep manage their body heat efficiently without affecting animal welfare. The fact that heart rate and respiration did not change significantly also indicates that these experimental diets did not place the sheep under physiological stress.

4 Conclusion

There was an upward trend in body weight for sheep fed Pakan-SIP with average of 6.37 kg/head/month without any deleterious effects on rectal temperature, heart rate, and respiratory rate. These findings suggest that Pakan-SIP can serve a superior feed for fattening local crossbred sheep, supporting growth performance without compromising physiological stability or affecting animal welfare.

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