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Effect of Corn Hull Supplementation on Cattle Productivity of Simmental and Limousin

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ABSTRACT

Corn hull, a local feed ingredient derived from corn waste, has the potential to serve as an alternative to increase beef cattle productivity in order to meet the demand for meat in Indonesia. This study aimed to evaluate the effects of corn hull on productivity of Limousin and Simmental cattle. The study was conducted on July 2-31, 2024 at a commercial cattle farm, involving 5 Simmental and 5 Limousin aged 1.5 years of age. This study was exploratory research. Total feed per cattle was 3.2% of body weight with 30% corn hull in the ration consisting of concentrate (65%) and forage (35%). Cattle were kept individually in pens, and data collected included final body weight, average daily gain (ADG), feed conversion ratio (FCR), and feed cost per gain (FCG). Data were analyzed using independent sample t test with SPSS version 25.0 at a significance level of $P < 0.05$. The results showed no significant differences between Simmental and Limousin groups for all tested parameters (ADG, final body weight, FCR, and FCG) ($P > 0.05$). Descriptively, Simmental cattle were superior in ADG and final body weight, while Limousin cattle were superior in FCR and FCG. In conclusion, both cattle breeds demonstrated similar performance, suggesting their potential to support meat consumption. Further research is needed to examine the effects of corn stover supplementation on various other ruminants to improve feed efficiency and growth performance.

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ABSTRAK

Tumpi jagung, bahan pakan lokal dari limbah jagung, berpotensi sebagai pakan alternatif untuk meningkatkan produktivitas sapi potong dalam rangka memenuhi konsumsi daging di Indonesia. Penelitian ini bertujuan mengevaluasi efek suplementasi tumpi jagung terhadap produktivitas sapi Limousin dan Simmental. Penelitian dilakukan pada 2-31 Juli 2024 di peternakan sapi komersial, menggunakan 5 sapi Simmental dan 5 sapi Limousin berusia 1,5 tahun. Penelitian ini bersifat eksploratif. Total pakan sapi per ekor yaitu 3,2% dari bobot badan dengan pemberian tumpi jagung 30% dalam ransum yang terdiri atas konsentrat (65%) dan hijauan (35%). Sapi dipelihara secara individual dalam kandang individu. Variabel yang diamati adalah bobot badan akhir (final body weight), pertambahan bobot badan harian (PBBH), feed conversion ratio (FCR), dan feed cost per gain (FCG). Data dianalisis dengan Independent sample t test menggunakan SPSS versi 25.0 dengan tingkat signifikansi P < 0,05. Hasil penelitian menunjukkan bahwa tidak ada perbedaan signifikan antara kelompok Simmental dan Limousin untuk semua parameter uji (PBBH, bobot akhir, FCR, dan FCG). Secara deskriptif, sapi Simmental unggul dalam PBBH dan bobot akhir, sedangkan sapi Limousin unggul dalam FCR dan FCG. Kesimpulannya, kedua jenis sapi memiliki performa yang tidak jauh berbeda sehingga berpotensi untuk mendukung pemenuhan konsumsi daging masyarakat. Penelitian lanjutan diperlukan untuk mengkaji efek suplementasi tumpi jagung pada berbagai jenis ruminansia lainnya guna meningkatkan efisiensi pakan dan performa pertumbuhan.

INTRODUCTION

Beef is one of the significant sources of animal protein in Indonesia, with consumption continuing to rise annually (Puradireja *et al*., 2021). According to the Chafid (2023) in the Beef Livestock Commodity Outlook, per capita beef consumption in Indonesia has increased over the past five years (2018-2022), with an average annual growth of 0.28%. Concurrently, the beef cattle population in Indonesia has experienced positive growth, with an annual increase of 3.81% from 2013 to 2022. However, the domestic cattle population remain insufficient to meet the national demand, leading to continued reliance on cattle and beef imports. Central Bureau of Statistics (2023) reported that in 2022, beef ranked among the highest imported commodities, with an average import volume of 19,065.90 tonnes per month.

The quality of imported beef is generally considered superior to that of local beef. Pertiwi & Soenarno (2020) noted that the physical quality of imported frozen beef exceeds that of locally produced beef, suggesting that the processing, distribution and rearing methods of imported cattle are better than local cattle. Some types of cattle that have been raised in Indonesia are Limousin and Simmental cattle. Various studies reported the superiority of these two breeds of cattle. Limousin cattle are known with excellent beef production quality (Hristov *et al*., 2023), while Setiawan (2023) reported that the carcass characteristics and meat bone ratio of Simmental cattle were greater than those of Peranakan Ongole (PO) cattle, which is a kind of local or domestic cattle. In addition, Rahayu & Suhendra (2024) confirmed, Limousin and Simmental cattle breeds tend to have a higher average daily gain (ADG) and more efficient feed conversion compared to local cattle breeds such as Bali and PO cattle.

Various studies have reported ADG and Feed Conversion Ratio (FCR) of different cattle breeds. Simmental cattle exhibit an ADG ranging from 1.84 to 1.87 kg/day (Koch *et al*., 2023) and 0.77 to 1.14 kg/day (Syahniar *et al*., 2023), while Limousin cattle show an ADG between 1.04 kg/day (Callegaro *et al*., 2024)

and 1.14 to1.15 kg/day (Nannucci *et al*., 2021). Local cattle exhibit lower ADG of 600 g/day for PO and 574 g/day for Madura cattle (Meles *et al*., 2021). In term of FCR, both imported and local cattle have relatively similar values. Studies reported that the FCR of Simmental cattle ranged from 12.1 to 13.6 (Syahniar *et al*., 2023) while Limousin cattle ranged from 11.4 to 11.5 (Nannucci *et al*., 2021). As for local cattle, the FCR ranges from 9.78 to 10.06 for PO (Mariyono *et al*., 2022) and 12.1 for Bali cattle (Mastur *et al*., 2022). These findings validates that Simmental and Limousin cattle exhibit superior ADG and FCR efficiency compared to local cattle, making these breeds more favorable for meat production due to their higher productivity.

Livestock productivity is influenced by two main factors: environmental and genetic factors. Among environmental factors, feeding management is the most influencial, contributing approximately 60% to livestock productivity (Supriyantono *et al*., 2020). This underscores the importance of proper feeding, as even with high genetic potential, suboptimal feeding in terms of the quantity and quality will prevent achievement of optimal production. Mayulu (2021) noted that in an intensive beef cattle fattening system, the provision of concentrates in larger quantities aimed at increasing ADG. The supplementation of concentrates over forage is intended to increase crude protein intake and, which subsequently promote increased production and body weight gain (Ali & Mardhotillah, 2023). On the other hand, the high cost of concentrates presents significant challenge for farmers. Therefore, alternative feeds are needed to replace concentrate ingredients, reduce production costs, and maintain high nutrititional value.

Corn stover, better referred to as corn hull, is a promising alternative feed ingredient with high potential to enhance livestock productivity. According to the Central Bureau of Statistics (2024), the total production of dry corn kernels in Indonesia in 2024 reached 15.21 million tons on a land area of 2.58 million hectares. This high level of production also generates a significant amount of agricultural waste including corn hulls. As reported by Yuzaria *et al*. (2020), the availability of corn hull in West Pasaman Regency alone reached 1,854.9 tons per year. This indicates that corn hull have strong potential alternative feed ingredient with high potential to support livestock productivity.

Nutritionally, corn hull contains 91.2% dry matter (DM), 8.7-12% crude protein (CP), 1.8-4% crude fat, 2-6.2% ash, 50% heteroxylan, 20% cellulose, 4-5% starch, and 4-5% phenolic acids (ferulic and diferulic acids) (Hao *et al*., 2021; Hussain *et al*., 2021). Ferulic acid, either directly added or produced by microorganisms in diet, has been shown to improve digestibility, antioxidant activity of diet, and support the growth and development of goats (Andrada *et al*., 2022). Valadez-García *et al*. (2021) reported that the inclusion of ferulic acid in lamb feed at levels up to 250 mg/kg is not detrimental to livestock health and may confer beneficial physiological effects. In other small ruminant, Toghdory *et al*. (2020) reported that supplementation up to 21% corn hull in sheep rations did not result in adverse effects.

Additionally, Hao *et al.* (2021) demonstrated that incorporating corn hull up to 17% in the ration of fattening sheep led to a 12.6% increase in final weight compared to the control gorup, along with a 35% improvement in ADG (263.9 g/day).

Although the effect of corn hull has been extensively studied in small ruminants, such as goats and sheep, similar studies in large ruminants, especially Limousin and Simmental cattle, are limited. Therefore, this aim of this study is to address this gap by evaluating the effect of corn hull supplementation on the productivity of Limousin and Simmental cattle. The findings are expected to provide valuable insights into the potential of corn hull as an efficient and nutritious balanced alternative feed ingredient in beef cattle fattening systems.

METHOD

This study was conducted from 2 to 31 July 2024 at the commercial cattle farm in Wonogiri Regency, Central Java, Indonesia (7°54′22″ South latitude and 110°58′33″ East longitude) at an altitude of 300 m above sea level (MASL). The temperature in this area ranges from 26.4 to 32°C, while the humidity ranges from 50-60%.

All protocols for the use of livestock were approved by the farm to conduct exploratory research. A total of 10 cattles were employed in this study, specifically employing five Simmental and five Limousin cattle, each. The age of the Simmental and Limousin cattle used in this study had an average age of 1.5 years old, and the experimental period lasted for one month.

All the cattles were housed in individual cage units, measuring 12.4 m long, 3 m wide and 4 m high. The dimensions of the feeding and drinking are were 12.4 m x 0.76 m x 0.9 m with a head-to-head cage design, where the cattles face each other. The roofing structure was of the gable type, characterized by two sloping meeting a a peak, forming a triangle shape. The floor of the cage was constructed from cast concrete and is covered with a 2-m by 1-m mat to reduce the risk of cows slipping on the potentially slippery surface. The floor was designed with a 3% slope to facilitate waste removal and ensure proper drainage, preventing water accumulation during sanitation or urine management**.**

The feed given were concentrates and forage with a ratio of 65% : 35%. Forage was fed two hours before concentrate, with concentrate given twice daily at 09:00 and 14:00, and forage provided at 11:00 and 16:00. Drinking water was available *ad libitum*. Total cattle feed allocation per head was 3.2% of body weight, with 30% corn hull included in the diet for all cattle to optimise growth and reduce production costs. In detail, the concentrate mixture consisted of 26.3% commercial concentrate, 8.7% pollard, and the remaining portion made up of corn hull, while forage component was provided in the form of hay.

The diet nutrient composition was formulated based on the average body weight of the study objects to meet their basic nutritional requirements, as outlined in the Nutrient Requirements of Ruminants in Developing Countries (Kearl, 1982). The diet consisted of 85.15% DM, 10.86% CP, 55.59% Total

Digestible Nutrient (TDN), 19.37% crude fibre, 0.62% calcium (Ca), and 0.31% phosphorus (P).

Daily feed intake was recorded by measuring the amount of feed given and the residual feed using a weighing scale (Talun *et al*., 2024). The remaining feed was weighed the following day. The weight of each cow was recorded individually. The ADG was calculated by substracting the initial weight from the final weight and dividing the difference by the number of days in the study (Aji *et al*., 2021). Feed intake and weight gain were then used to predict feed conversion ratio, while feed cost per gain (FCG) was determined by dividing the daily feed cost by the ADG (Laili *et al*., 2022).

Cattle productivity data including final body weight, FCR, FCG and ADG were presented as mean ± standard mean error. Data were analysed using IBM® SPSS Statistics 25.0 for Windows. Independent sample t test was employed to compare the effect of corn hull supplementation on Simmental and Limousin cattle with a significance level of $P < 0.05$. If the P value was close to 0.01, the data indicates highly significant.

RESULT AND DISCUSSION

Table 1 shows the impact of corn hull supplementation on the performance of Simmental and Limousin cattle. The results indicate that there were no significant differences between the two breeds across the parameters measured, including Average Daily Gain (ADG), Final Weight, Feed Conversion Ratio (FCR), and Feed Cost per Gain (FCG). These findings suggest that corn hull supplementation does not significantly affect livestock performance in this study.

Table 1. The Effect of Corn Hull Supplementation on Livestock Performance on Simmental and Limousin

Parameter	Jenis	Mean±SEM	*P-value*	Information
ADG (kg/ekor/hari)	Simmental	1.27±0.18	0.929	ns
	Limousin	1.25±0.11	0.930	ns
Final Weight (kg)	Simmental	756.00±34.85	0.667	ns
	Limousin	734.80±32.13	0.667	ns
FCR	Simmental	13.78±1.86	0.823	ns
	Limousin	13.28±1.08	0.825	ns
FCG (Rp/kg)	Simmental	31,526.80±4,258.14	0.823	ns
	Limousin	30,384.60±5,569.57	0.824	ns

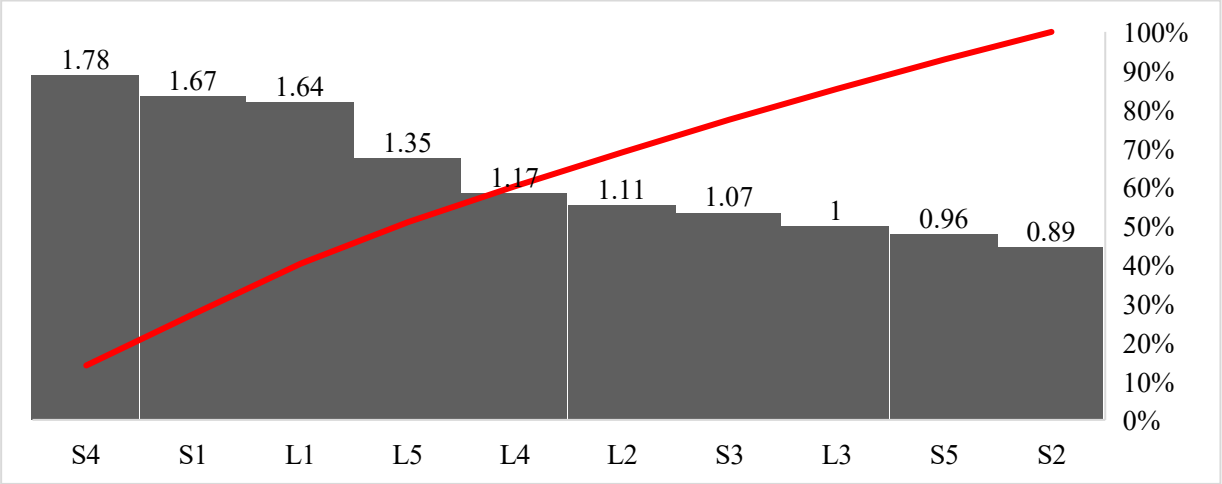
*ns = Non Significant

Avarage Daily Gain (ADG)

Animal body weight gain is the result of the absorption of nutrients obtained through feed intake, both from concentrates and forages, which are then used for meat formation. ADG can be used as an indicator to assess the quality of animal feed ingredients, which is expressed in kg/head/day (Yanto, 2024). The results showed that corn hull supplementation did not give significant differences in ADG of Limousin and Simmental cattle (Table 1). In other words, this indicates that both cows have relatively similar ADG, with the average of 1.2 kg/day. Descriptively, Simmental cattle had a

slightly higher ADG (20 g/day) than Limousin cattle. In more detail, Simmental cattle 4 and 1 have the highest potential in producing ADG (Figure 1). Unfortunately, to our best knowledge, there is no similar previous research report regarding corn hull supplementation on ADG of Simmental and Limousin cattle. However, Wulandari *et al*. (2018) reported that fermented corn hull at a 60% inclusion level can significantly increase ADG of the male fat-tailed sheep. This suggests that the corn hull inclusion level in this study may not high enough to produce a significant increase of ADG.

Additionally, corn hull feeding produced better ADG in Limousin and Simmental cattle compared to elephant grass as reported by Sholeh *et al*. (2023). This is thought to be because the fibre content of corn hull is easier to digest than elephant grass. According to Yahya *et al*. (2023), the corn hull contains 8% protein and 25.38% fibre, while Muhiddin *et al.* (2022) reported that the protein and fibre content of elephant grass were 9.66% and 30.86%, respectively. In addition, Zullaikah *et al.* (2022) noted that high crude fibre content affects livestock growth because most of the crude fibre components are difficult to digest and only act as fillers, resulting in decreased feed intake and an adverse effect on ADG.



Note: S= Simmental; L= Limousin

Figure 1. The distribution of cattle's potential to achieve optimum ADG (kg/head/day)

Furthermore, the findings of this study reflect that Simmental and Limousin cattle have equal potential to utilise the nutrients contained in the ration to support their growth. Descriptively, the ADG of Simmental cattle was 1.6% higher than Limousin cattle. These findings are inversely proportional to the findings of Sholeh *et al.* (2023) who reported that the ADG of Limousin cattle was 1.03 kg/head/day and Simmental cattle was 0.85 kg/head/day. The body weight gain occurs when livestock can absorb nutrients and convert them into fat or meat. ADG is influenced by various internal and external factors. Internal factors are influenced by genetics, while external factors are the environment including

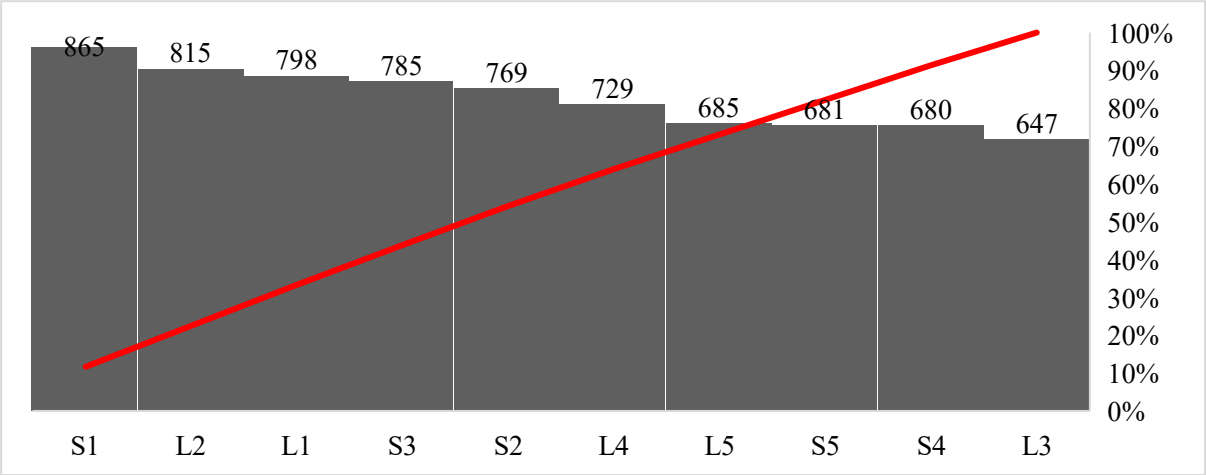
feeding management that affects ADG. According to Azzahra *et al.* (2022), the higher the nutrient intake received by livestock, the greater the nutrients that can be absorbed. Oktavia *et al.* (2021) also noted that maximum nutrient absorption will produce optimal body weight.

Final Body Weight

Final body weight gain is an indicator of growth rate during livestock rearing (Ananda *et al*., 2021). The results showed that corn hull supplementation did not give a significant difference in the final weight of Limousin and Simmental cattle (Table 1). Descriptively, Simmental cattle exhibited a 2.89% higher weight percentage (21.20 kg) compared to Limousin cattle. In particular, a sample of Simmental 1 demonstrated greater final weights (Figure 2). It was reported that Simmental cattle can reach a body weight up to 1400 kg for adult males and 600-800 kg for adult females (Setiawan & Arifin, 2024), while Limousin body weight can achieve up to 800-1200 kg (Dakhlan *et al*., 2021).

In this study, the final weight of both cattle tended to be similar at around 700 kg. In line with Izzudin (2024) that Simmental exhibit superior performance compared to Limousin. Furthermore, these findings are probably due to the provision of the similar feed ingredients and levels to all cattle including the similar corn hull nutritional content such as protein. Although protein is essential for muscle growth and development in animals (Idowu *et al*., 2024), similar protein levels in the feed may explain the comparable final body weights observed. This further suggests that all cattle exhibit a similar capacity for protein absorption.

Additionally, the findings are likely attributable to the fact that the feed used did not contain any additional feed additives. Daka *et al.* (2023) noted that 1.5-year-old Limousin cattle produced insignificant final weights in the control group, while the treatment group with feed additives in the form of probiotics in diet produced significant final body weights. Furthermore, Nguyen *et al.* (2021) stated that final weight is influenced by high nutritional feed including feed and protein intake. However, for ruminants, the need for high-grade protein in diet is relatively low because protein processing naturally occurs in the rumen and intestine with the help of microorganisms (Ramaiyulis *et al*., 2022).



Note: S= Simmental; L= Limousin
Figure 2. The distribution of potential cattle in achieving final weight (kg)

Protein in ruminant feed is categorized into two types: Rumen Undegradable Protein (RUDP) and Rumen Degradable Protein (RDP). RUDP is not degraded in the rumen and is directly absorbed in the small intestine, while RDP is degraded in the rumen by proteolytic bacteria, producing amino acids which are then absorbed by the body (Maharani, 2023).

However, the effect of corn hull protein on the final weight of livestock can be maximized by the fermentation method, where during the 4-day incubation period it will reduce the levels of NDF and ADF, which affect the fiber content in corn hull so that it can increase the digestibility of corn hull (Nurazizah, 2021). Unfortunately, this study utilized the unfermented corn hull, which limited the optimization of rumen fermentation.

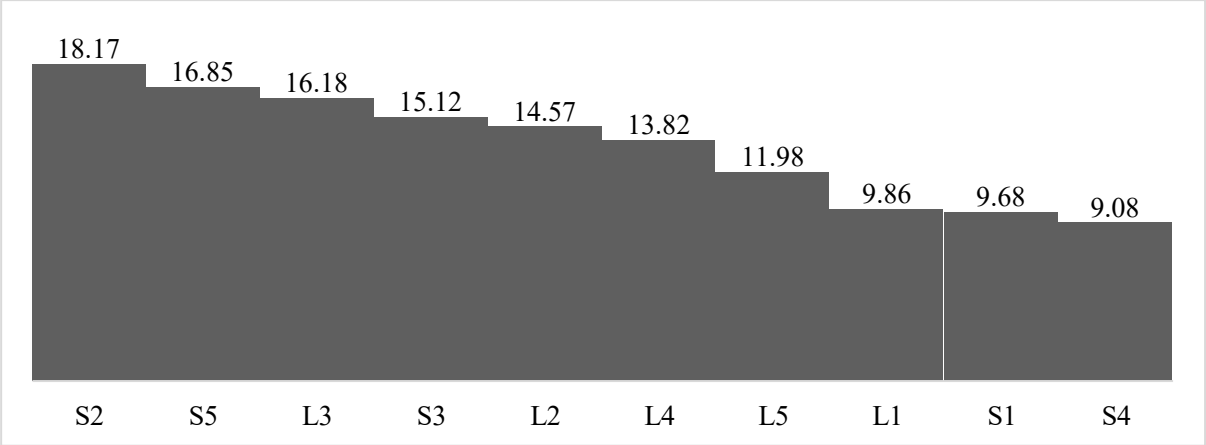
Additionally, rumen microbes also produce proteins that account for 50-80% of the total protein that can be absorbed in the small intestine (Achmadi & Surono, 2021). These microbial proteins are degraded with the help of digestive enzymes such as protease, peptidase, and deaminase, into peptides, amino acids, and NH_3 (Putri *et al*., 2021). The absorbed amino acids enter the bloodstream, distributed to various body tissues, including muscles. Within muscle tissue, amino acids are utilised in the process of muscle protein synthesis, ultimately forming muscle fibres and contributing to increased body weight.

Feed Conversion Ratio (FCR)

Feed Conversion Ratio (FCR) is a value that reflects the efficiency of the amount of feed consumed by livestock to support growth, especially the increase in body weight within a certain period of time (Laili *et al*., 2022). According to Hasyim (2022), FCR defined as the amount of feed digested by livestock that can be converted into one kilogram of live body weight. Sholeh *et al*. (2023) reported the standard FCR of Limousin cattle was 11.13, while Simmental cattle was 12.90. A high FCR value indicates low efficiency, which further suggests that poor absorption of nutrients in the intestine, thereby making inefficient feed the conversion into beef (Mahardika *et al*., 2020). Gompi *et al.* (2023) added that the lower the FCR value, the higher the level of feed

efficiency, which in turn increases profit potential.

The results (Table 1) showed that corn hull supplementation did not give a significant difference on the FCR of Limousin and Simmental cattle (P>0.05). Descriptively, Limousin cattle had 3.75% higher efficiency than Simmental cattle. Specifically, samples of Simmental 1 and 4 exhibit the best potential to produce the most significant FCR (Figure 3). To our best knowledge, no study has specifically examined the effect of corn hull on FCR in ruminants especially Limousin and Simmental cattle. Regardless with Nannucci *et al.* (2021) reported that Limousin cattle fed soy bean meal (SBM) had an FCR of 11.4, while Limousin cattle fed cardoon meal had an FCR of 11.55. Syahniar *et al*. (2023) reported that the FCR of Simmental cattle using elephant grass was 13.52. Therefore, feeding Limousin cattle using corn hull had a higher FCR than using SBM and cardoon meal, while corn hull and elephant grass exhibited relatively similar FCR. These findings suggest that feed type affects FCR. In detail, Gaillard *et al.* (2020) observed that FCR is influenced by feed intake, feed digestibility, and feed digestion efficiency. In this study, the feed intake of both Simmental and Limousin cattle was similar. Thus, cattle with a lower FCR are probably due to poor feed digestion process associated with the condition of the cattle's rumen.



Note: S= Simmental; L= Limousin
Figure 3. The distribution of potential cows to produce an efficient FCR

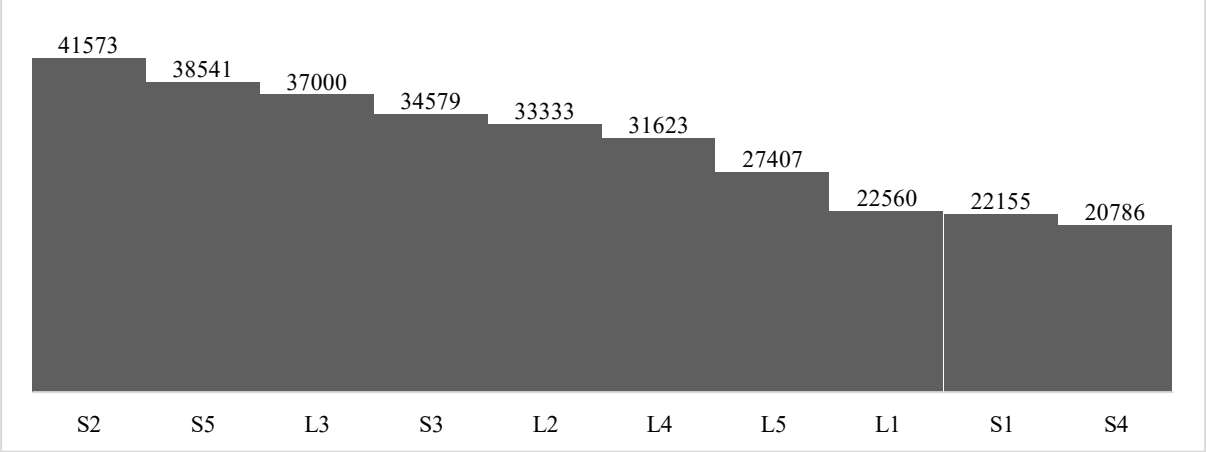
The condition of the rumen is influenced by several factors, such as the number of microbes in the rumen, the diversity and balance of these microbes, and the optimal rumen pH. These conditions allow more efficient feed fermentation, thereby enhancing nutrients absorption. Yasin *et al.* (2021) emphasized that microbial diversity in the rumen is crucial to optimise the digestive process in ruminants. These microbes consist of bacteria, protozoa, and fungi, each of which has a specific role in degrading feed components.

Feed Cost per Gain (FCG)

Feed Cost per Gain (FCG) is a metric used to assess cost required to produce 1 kg of body weight in livestock. FCG is influenced by both the price and type of feed provided. A low FCG value reflects more efficient feed

utilization and reduced production costs. FCG is considered favorable when the feed cost to produce 1 kg of body weight is minimized (Akbar, 2024). FCG calculation is performed by dividing the total daily feed cost by the ADG to determine the feed cost per kilogram of body weight (Rivaldi, 2023).

The results (Table 1) of this study showed that corn hull supplementation did not give a significant difference in the FCG value of Limousin and Simmental cattle. Descriptively, Simmental cattle exhibit a 3.75% greater FCG value than Limousin cattle, with a price difference of Rp 1,142.00/kg. Thus, feeding Limousin is more cost-effective than Simmental cattle. However, samples of Simmental cattle 1 and 4 demonstrated the most efficient FCG values (Figure 4). Lower FCG values indicate better feed efficiency (Nur, 2024). In contrast, Ramadhan (2024) reported that the FCG value of Limousin cattle was Rp 23,809.00/kg, while Simmental was Rp 24,000.00/kg using fermented pineapple peel. These findings suggest that feeding pineapple peel yields more efficient FCG than feeding corn hull. The variation in FCG value can be influenced by various factors such as the price of feed ingredients and ADG achieved (Nur, 2024). Presumably, the difference in FCG value can be caused by the higher price of corn hull compared to pineapple peel. It was reported that the price of pineapple peels as animal feed was IDR 400.00/kg (Ramadhan, 2024), while the price of corn hull for animal feed was IDR 900.00/kg (Priyadi *et al.*, 2023). Additionally, a significantly higher FCG value was reported by Emaryanawan (2024) for concentrate feed, priced at IDR 65,979/kg. This indicates that the FCG from feeding corn hull is more affordable than the concentrate fed in Emaryanawan's (2024) study.



Note: S= Simmental; L= Limousin
Figure 4. The distribution of potential cattle in producing FCG (Rp/kg)

CONCLUSION AND RECOMMENDATIONS

Supplementation of corn hull up to 30% had no negative impact on beef cattle performance. Simmental and Limousin cattle exhibit relatively equal performance in beef production in terms of ADG, Final Body Weight, FCR, and FCG. Although both cattle

breeds have similar ADG and final body weight, Simmental cattle are slightly superior in terms of feed efficiency. However, the lack of significant impact may be due to the relatively low energy and protein content of corn hull. The high fiber content, although digestible, may not have provided sufficient nutrients for improved growth or feed efficiency. Further research is needed to examine the effect of corn hull supplementation on various other ruminants to compare feed efficiency and growth performance.

CONTRIBUTIONS STATEMENTS

The authors' contributions to the research and manuscript preparation are outlined as follows. The study was conceived by AAY and MAN, while MRNF and JGA handled data curation. MSNA and MRM were responsible for formal analysis, and the methodology was developed through the joint efforts of FRF, AAY, and MRNF. AAY took charge of software implementation. Validation was carried out by both MAN and MRNF, with AAY and MRM overseeing the investigation. The original manuscript draft was written by MRNF, JGA, and MRM, while AAY contributed to the review and editing stages. All authors have read and approved the final manuscript version.

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