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Original Article

Complete feed of corn silage and its effect on male Bali cattle performance, feed consumption, and beef quality

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Abstract

Objective: This study aims to observe the effect of feeding corn silage combined with elephant grass and cheap concentrate feed on male Bali cattle performance, feed consumption, and beef quality.
Methods: Animal feed testing was performed in male Bali cattle weighing 150-200 kg for 90 days, and the cattle were slaughtered in a slaughterhouse to observe the beef quality. This study employed a completely randomized design with 4 treatments and 3 replicates. Research treatment: The proportion of 30% corn silage + 60% elephant grass + 10% concentrate feed as A1; 50% corn silage + 40% elephant grass + 10% concentrate feed as A2; 70% corn silage + 20% elephant grass + 10% concentrate feed as A3; 100% corn silage as A4. The observed parameters in include average daily gain, dry matter consumption, organic matter consumption, crude protein consumption, total digestible nutrients, tenderness, beef color, water-holding capacity, cooking loss, and aroma.
Results: The results showed that the treatments significantly affect the consumption of dry matter with the highest A4 is 2.44% of body weight, organic matter with the highest A3 is 8.43 kg/head/day, crude protein with the highest A3 is 0.82 kg/head/day, and total digestible nutrients with the highest A3 is 4.88 kg/head/day. There is a significant difference in daily average weight gain (ADG) from the three treatments ($P<0.05$).
Conclusions: It can be concluded that A3 treatment, supplemented with 70% corn silage concentration, 20% elephant grass, and 10% concentrate feed is more effective in improving male Bali cattle performance, feed, consumption, and beef quality.

Keywords: Beef quality; Bali cattle; Corn silage; Performance; Feed consumption

INTRODUCTION

Ensiling is one forage preservation method massively practiced in sub-tropical countries with 4 seasons to anticipate forage availability throughout the year, especially during the winter. In contrast, in a tropical region like Indonesia, forage preservation was not popularly practiced, and therefore, an effort to anticipate forage availability during the dry season is necessary [1,2]. In Barru, South Sulawesi, Indonesia, the dry pasture area covered around 25.881,35 ha and had a good potential for corn farming and silage basic

component production. This potential becomes evident in the study by Hasan *et al*. [3]. Pariset *et al*. [4] confirmed that corn crops could be utilized as a substitution for grasses by harvesting the corn earlier to produce high-quality crops. Due to the huge range of cultivars grown in many ecological locations and good intercropping adaptation, intercropping between corn and forage may be considered as seasonal feed In addition, many beef are fed silage in the fall and winter. However, there is limited evidence on the feeding value. Barru, one of Indonesia's most popular regions for Bali cattle breeding, has developed additional feed with corn silage. Every year, the local farming activity may need extra feedstock with good quality and quantity. The practices of corn silage production surely contribute to the forage availability and eventually contribute to the increasing cattle population in Barru. Livestock productivity was predicted to be around 70% affected by environmental factors.

Interestingly, A study performed by Hasan *et al*. [3] also proved that the average production of corn crop fresh weight is 35 tons/ ha. Such a result was found after observing the level of different inorganic fertilizer applications on the BISI-18 corn variety. The study was followed by silage production and tested on male Bali cattle for fattening activity at a more affordable cost. One approach to employing a potential local food source effectively is to use complete feed [5]. Furthermore, Hasan *et al*. [6] stated that the procedure would be more effective if feeding technology innovation from local feedstuffs is implemented appropriately. To connect these claims, two experiments were conducted: the first looked at the performance of Bali cattle when fed high-quality corn, complete feed supplemented by elephant grass, and cheap concentrate in different proportions. The second found the effects of feeding on Bali cattle performance related to beef quality. Essentially, the result of this study may be a reference for approaching the implementation of effective local feedstuff in small farmers.

MATERIALS AND METHODS

Research locale and timeframe

The research was performed in Tellumpanua, Tanete Rilau, Barru Regency, South Sulawesi, Indonesia and continued at Forage Crop and Pasture Science Laboratory for beef quality assessment. This study used corn silage fermented for 21 days and involved 12 male Bali cattle weighing 150-200 kg. The materials employed in this study included silage, corn crops, elephant grass, cheap concentrate contained of bran, coconut meal, cassava bran, urea, mineral mix, and salt. Diet composition is present in Table 1. The nutrition composition of concentrate is present in Table 2. The feed was provided *ad libitum* for the

Table 1. Diet composition in each treatment

Ration types	Treatment (%)			
	A1	A2	A3	A4
Corn Silage	30	50	70	100
Elephant Grass	60	40	20	0
Concentrate	10	10	10	0

Elephant grasses were trimmed at the age of 60 days.

Table 2. Nutrition composition of the used concentrate feedstuff in this study

Feedstuff	Total (%)	Nutritional Content			
		CP	DM	CF	TDN
Rice bran	3.33	4.33	29.23	2.87	22.63
Coconut cake	2.33	6.77	29.53	3.63	26.23
Cassava bran	3	0.63	26.6	0.1	26.1
Urea	0.33	0.03	-	-	0.2
Mineral mix	0.33	0.03	-	-	0.2
Salt	0.17	-	-	-	-
Molasses	0.5	1.27	27.7	0.1	23.57

Laboratory of Feed Chemistry, Faculty of Animal Science, Hasanuddin University, 2018.

Table 3. Means of Male Bali Cattle feed consumption fed with corn silage, elephant grass, and concentrate feed.

Total consumption (%)	Parameters			
	A1	A2	A3	A4
DM consumption (%BW)	2.52[b]	2.54[c]	2.70[d]	2.44[a]
OM consumption (kg/head/day)	6.54[b]	7.55[c]	8.43[d]	6.07 [a]
Crude protein consumption (kg/head/day)	0.72[b]	0.75[c]	0.82[d]	0.45 [a]
TDN consumption (kg/head/day)	4.43[b]	4.65[c]	4.88[d]	4.07 [a]

Different superscript letters in the same row indicate a significant difference (P<0.05); Feed consumption, including dry matter (DM), organic matter (OM), crude protein (CP), and total digestible nutrient (TDN)

Table 4. The average daily gain (ADG) and feed conversion ratio (FCR) of Male Bali cattle receiving treatments

Variables	Treatments			
	A1	A2	A3	A4
ADG (kg)	0.75[b]	0.84[c]	0.86[d]	0.65[a]
FCR	11.76	9.56	9.67	10.56

Different letters in the same row indicate a significant difference (P<0.05)

experimental cattle. 12 Male Bali cattle weighing 150-200 kg were involved.

Research method

This research employed a Completely Randomized Design (CRD). The study consisted of 4 treatments and 3 replicates. The research treatments are presented as follows: The proportion of 30% corn silage + 60% elephant grass + 10% concentrate feed as A1; 50% corn silage + 40% elephant grass + 10% concentrate feed as A2; 70% corn silage + 20% elephant grass + 10% concentrate feed as A3; 100% corn silage as A4.

Observed parameters

The observed parameters included daily body weight gain, dry matter, protein, organic matter, total digestible consumption, and beef quality.

RESULTS

Feed consumption

Feed consumption, including dry matter (DM), organic matter (OM), crude protein (CP), and total digestible nutrient (TDN) consumption of corn silage, elephant grass, and concentrate feed, is presented in Table 3.

Bodyweight Gain

Bodyweight gain (BWW) of male Bali cattle supplemented with corn silage, elephant grass, and concentrate is presented in Table 4.

Beef quality

The observable beef physical qualities encompassed pH, tenderness, color, water-holding capacity, cooking loss, and smell. Means of physical beef quality are presented in Table 5.

Table 5. Means of beef quality from male Bali cattle fed with corn silage

Variables	Ration Treatment			
	A1	A2	A3	A4
Meat pH	5.40[b]	5.51[c]	5.69[d]	4.50[a]
Tenderness (kg/cm^2)	3.20[c]	3.15[b]	4.12[d]	2.40[a]
Colour	5.06[c]	5.20[d]	4.15[b]	3.15[a]
Water-Holding Capacity %	42.71[b]	44.60[c]	47.33[d]	39.15[a]
Cooking Loss %	38.4	39.31[c]	40.15[d]	22.26[a]
Smell	4.12[b]	4.18[c]	5.10[d]	2.22[a]

Different superscript letters in the same row indicate a significant difference (P<0.05); 1). Criteria of Meat Tenderness 1 = very tough, 2 = tough, 3 = slightly tender, 4 = tender; 2). Meat color score 1 = pale pink, 2 = pink, 3 = rosy, 4 = bright red, 5 = red, 6 = maroo 3. Aroma score 1= dislike extremely, 2= dislike moderately, 3= neither like nor dislike, 4 = like moderately, 5 = like extremely

DISCUSSION

The analysis of variance showed that the treatments significantly affect the consumption of dry matter, organic matter, crude protein, and total digestible nutrients. It is indicated that there was a significant difference (P<0.05) between the four treatments on every parameter. The highest DM-based body weight was observed in the A3 treatment. This is primarily due to the high protein content in the A3 feed treatment (0.82 kg/head/day). The difference in ration composition percentage resulted in different palatability and nutrients, which caused the unequal amounts of feed consumed by cattle. In a choice situation, feeding behavior is more responsive to different meal qualities, and cattle can exhibit an exclusive preference for one specific feed if infinite amounts are provided throughout the durations [7].

A significant difference between the four feed treatments was observed from the mean of organic matter consumption. This was primarily caused by the OM consumption was strongly correlated to the DM consumption (kg/head/day). Similarly, OM in the other 4 treatments did not indicate any significant effect. OM consumption is commonly correlated with DM consumption. The more DM is consumed, the more OM is consumed [8]. As for CP consumption, there was a significant difference between the four treatments (P<0.05). A4 treatment has the lowest CP consumption comparing to the other treatment. On the contrary, in the A3 treatment, the mean was higher compared to the other four treatments. TDN consumption was higher at the A3 treatment compared to A4, A1, and A2 treatments. Higher TDN consumption was identified in the A3 treatment due to the contributed TDN content from the concentrate feedstuff. Crop residues such as corn silage (agricultural byproducts) are deemed low-quality feeds if they are less than 55 % digestible, lack protein, and have low nitrogen and mineral levels [9]. Crop residues, on the other hand, are plentiful and inexpensive.

Consumption is the quantity of feed the livestock consumes for basic life needs and production. Feed consumption is one essential factor in identifying basic needs and production. The consumption rate could reflect palatability. The amount of consumed feed is the most important determining factor of food substance quantity absorbed by the livestock [10].

Based on the analysis of covariance, it can be concluded that there was a significant difference in daily average weight gain (ADG) from the three treatments (P<0.05). Daily body weight gain in the A3 treatment was higher than A4, A2, and A1 treatments. This was due to the concentration from those treatments ensuring better protein consumption compared to the other treatments.

According to the National Research Council [11], protein requirements for Bali cattle weighing 300 kg with a daily ADG target of 1 kg require 760 g of protein daily consumption. As can be seen from Table 1, crude protein consumption resulting from A1 and A2 treatments was considered to be sufficient to sustain the daily body weight gain of Male Bali cattle. According to Warren *et al.* [12], the silage-fed animals' growth rates were initially modest, at 0.3 kg/d, due to a low dry matter content. It was necessary to adjust the grass silage without considerably modifying its fatty acid composition in order to increase live weight gain.

Beef quality is the beef characteristics that may be used as the consumer's standard in selecting beef. Carcass and beef quality are highly affected by a number of factors in the post and post-mortem. Some factors affecting the beef's physical quality during slaughter include transportation, resting time, and stress level. Animal treatment, such as du-rationing lairage before slaughter, has been studied as a strategy to decrease stress-related meat quality issues [13, 14].

The result of the analysis of variance in beef pH on the 4 treatments indicated a significant difference (P<0.05) pH from four treatments, which is presented in Table 3. As can be seen from the table, the pH score was still in the normal range. Hydrogen exponent (pH) or beef acidity degree was used to identify the acidity and alkalinity level of the beef. According to Huff-Lonergan [15], fresh beef pH is between 5.3-5.8, and therefore, this study revealed that the cattle fed with corn silage, elephant grass, and concentrate feed had a normal beef pH. The difference in pH

can be identified from other factors. Hasan *et al.* [4] stated that the feed quality could be affected by the feed composition itself. Feed composition and characteristics, including pH, Protein, NDF, ADF, Cellulose, and Hemicellulose, could impact the feed quality.

The analysis result of beef's physical and chemical characteristics indicated a good quality. This was due to the final pH measurement showed a normal score for beef around 5.4-5,6 or 5,5 on average [16]. Meanwhile, in this study, the pH ranged from 5.40 to 5.69. This implies that the glycogen reserve of beef in this study was normal (approximately 1% from fresh muscle weight). This also implies that the beef cattle did not experience any physical stress (hot and cold weather) or emotional stress during the fattening. pH value had an important effect on beef quality since this could affect almost all aspects of beef, including tenderness, color, taste, juiciness, firmness, and water-holding capacity.

The hedonic test results in Table 5 indicate a significant difference ($P<0.05$). Panelists preferred the beef tenderness resulting from the A3 treatment. From the overall tenderness score, the beef falls under the category of "tender." The scale of tenderness may be categorized into very tender 0–3.30 kg/cm^2, tender >3.30–5.00 kg/cm^2, slightly tender >5.00–6.71 kg/cm^2, slightly tough >6.71–8.42 kg/cm^2, tough > 8.42-10.12 kg/cm2, and very tough (>10.12 kg cm^2). The higher the Warner-Blatzler Shear Force level, the more force is needed to cut the muscle tissue per square centimeter [17]. This implies the tougher the beef, the lower the tenderness level. Tenderness in this study was higher in cattle fed with complete treatment of corn silage, elephant grass, and concentrate feed compared to the control treatment. A study performed by Ngadiyono [18] produced a tenderness level of 2.51 kg cm$^{-2,}$ Tenderness is the most essential palatability feature of meat and, as a result, the most important determinant of meat quality [17,19,20]

The results of the beef color evaluation indicate a significant difference ($P<0.05$) in Table 3. Panelists gave a positive response to the appeared color. The color produced from each treatment depends on the pigment concentration contained in the beef. El-Din Ahmed Bekhit [21] stated that myoglobin pigment is the primary factor affecting beef color. In this context, the produced beef contained an attractive color bright red and attracted the panelists.

Handayani and Masruriyah [22] also confirmed that bright red, not pale, elastic, not sticky, and distinctive odor are some characteristics of healthy beef and may be categorized as tender. Beef pH was reduced to normal, so the produced color was not pale or dark. Higher pH could promote darker color in beef compared to beef with lower pH. Fermentation on feed also affects the feed quality. If the beef cattle are fed on fermented feed, it can change beef pigments. The produced color of the beef from each treatment was different. This occurred due to the evaporation and dehydration on the beef surface and microorganism activity. A bright red score positively indicates high red pigments in beef. The determining factor of beef color is myoglobin pigment concentration. Beef color may vary from bright red, pale red or pink, and dark red. Color change in beef may be caused by microorganisms and other contaminanting agents [23]. These factors could cause changes in the concentration of myoglobin beef pigment. Myoglobin molecule type, myoglobin chemical status, and chemical physical and other components in beef play important roles in the produced color [24].

The means of water-holding capacity from Table 5 indicated a significant difference ($P<0.05$). The result demonstrates increasing effectiveness by up to 40% compared to the previous studies. This confirmed the more effective water-holding capacity if the cattle were supplemented with the treatments in this study. This was caused by the nutrient content of the feed, especially the protein. Higher water-holding capacity was promoted by higher protein contained in the experimental feed. In this study, the water-holding capacity was significantly different because the protein content in the diet was also different. This consequently resulted in different water-holding capacities.

Another factor affecting the water-holding capacity is pH. Water-holding

capacity will be different when the pH is significantly different. A low pH value will cause protein denaturation, leading to lower water-holding capacity. In addition, low pH conditions could stimulate lactic acid to reduce the protein reactive groups, leading to lower water-holding capacity. Lower water-holding capacity causes beef inability to hold extra water. Beef becomes mushy, moist, and pale. Water-holding capacity may range from 20-60%. The denaturation depolymerization may cause reduction in water-holding capacity and increase protein solubility triggered by the pressure and boiling time, which leads to changed and damaged muscle protein, especially in actin and myosin. Damaged actin and myosin eventually because lowered water-holding capacity [25,26].

The beef produced from cattle-fed corn silage, elephant grass, and concentrate feed in this study indicated a significant difference ($P<0.05$) in the cooking loss score. The significant difference in water-holding capacity and water content caused the difference in cooking loss score. A significant difference was identified between the beef produced from the cattle receiving treatment and no treatment. This aligns with the water-holding capacity score, which is significantly different. In addition, this is also associated with the post-mortem pH decrease or low ultimate pH in beef [27].

The assessment results in Table 5 regarding aroma showed a significant difference ($P<0.05$). The sensory evaluation employed a hedonic test and a hedonic quality test. A 5-scale hedonic test assessed the panelist preference (1= dislike extremely, 2= dislike moderately, 3 neither like nor dislike 4= like moderately, and 5= like extremely). From the test, it can be observed that beef produced from A3 treatment is the most preferred sample. The cause of such preference was that the applied treatment was a mixture of good feed quality.

Means of aroma are presented in Table 5 as a part of the hedonic test in identifying the delicacy of food items. Beef aroma could be affected by the feed types during pre-mortem feeding. Panelist's score ranging from 2-5 indicates their preference for the beef aroma. The aroma may play an important role in evaluating appropriate feed items for cattle consumption [28].

CONCLUSION

The treatment supplemented with 70% corn silage concentration, 20% elephant grass, and 10% concentrate feed is more effective in improving male Bali cattle performance, feed consumption, and beef quality.

CONFLICT OF INTEREST

The authors declare no conflict of interest with any financial organization regarding the material discussed in the manuscript.

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