e-ISSN 2581-0405
Asian Journal of Applied Research for Community Development and Empowerment
Journal home page: http://ajarcde-safe-network.org ISSN 2581-0405

Characteristics of Carcass and Marbling Score of Male Bali Cattle Using Herbal Supplement of Molasses Block Based on Fermented Pineapple Peel

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ARTICLE INFO

Article History:
Received: 03April 2025
Final Revision: 07 May 2025
Accepted: 16 May 2025
Online Publication: 18 May 2025

KEYWORDS

Bali cattle, herbal molasses block, carcass characteristics, marbling score

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A B S T R A C T

Bali cattle are well-adapted to tropical climates and produce stable, standard-compliant carcasses. This study evaluated carcass traits and marbling scores in nine male Bali cattle (206–245 kg) fed with herbal molasses block (HMB) supplements containing fermented pineapple peel. The cattle were randomly assigned to three dietary treatments (3 replicates each) in a Completely Randomized Design:The research material consisted of: Nine male Bali cattle weighing 206-245 kg, concentrate composed of local ingredients, including: pineapple peel fermented with lactic acid bacteria, ground corn, rice bran, molasses and HMB. Nine Bali cattle were placed in individual pens Randomly Based on a Completely Randomized design with 3 treatments and 3 replications. Feeding treatment: P0 = 39% Ground corn + 61% rice bran + 0% fermented pineapple peel + field grass (adlibitum); P1 = 15% ground corn + 65% rice bran + 20% fermented pineapple peel LAB + field grass (ad libitum) and P2 = 12% ground corn + 73% rice bran + 15% pineapple peel without lactic acid bacteria fermentation + field grass + HMB (adlibitum). The research variables consisting of carcass characteristics and marbling scores were analyzed using analysis of variance using the SPSS version 25 program. The results of the study showed that the addition of pineapple peel without lactic acid bacteria fermentation of 15% in the ration and herbal molasses block (P2) produced carcasses of 52.34% significantly (P>0.05) higher than carcasses in P0 (50.55%) and P1 (49.70%). Carcass length ranges from 144.50±0.50-155.50±4.50 cm. The meat index ranges from 0.89 to 0.98. The area of the rib eye ranged from 28.50-33.00 cm2 and was not significantly different (P>0.05) between treatments. The marbling score of male Bali beef based on treatment was 1.81. The use of fermented pineapple peel in the form of HMB can improve the quality characteristics of Bali male cattle carcasses with a carcass percentage reaching 52.34%; carcass length 155.50 cm, meat index 0.89 and rib eye area 28.50 cm2. The resulting meat has a relatively low marbling score, bright meat color with white meat fat.

Contribution to Sustainable Development Goals (SDGs):
SDG 2: Zero Hunger
SDG 8: Decent Work and Economic Growth
SDG 12: Responsible Consumption and Production

1. INTRODUCTION

1.1. Research Background

The type of cattle in Indonesia that is resistant to tropical conditions is the Bali cattle [1]. Bali cattle have good performance when fed with agricultural waste such as pineapple peel fermented with 30% lactic acid bacteria, namely they can achieve a daily weight gain of 0.66 kg/head/day, carcass percentage of 55.17%, carcass length of 129.25 cm, rib eye area of 55.97% and meat index of 1.00 with a marbling score of 4 [2].

Herbal Molasses Block (HMB) as a supplement to meet protein and energy deficiencies that occur in Bali cattle and to improve performance [3]. It goes on to say that herbal ingredients that have been tried to be mixed into feed include turmeric and ginger. These herbal ingredients are used with the aim of fulfilling

mineral needs while increasing immunity, so that indirectly they can improve the quality of beef and goat meat.

The development of HBM is intended as a replacement for urea mineral block (UMB). The main ingredients for making HMB are pineapple peel fermented by lactic acid bacteria and molasses. The formula used in making HMB: Molasses 33%, pineapple peel fermented by lactic acid bacteria 30%, starch 14%, premium minerals 13%, turmeric powder 5% and salt 5% [3]. This solid feed contains ingredients as a source of protein, carbohydrates and minerals coated with molasses. This solid feed can be formulated according to needs, for example in cases of iodine, Fe, Mg, Zn deficiency or by mixing herbs to increase body resistance [3].

It is hoped that Bali male cattle given HMB will grow optimally so that they can provide carcass characteristics and meat marbling scores that can meet the minimum standards set by the Indonesian National Standard (SNI) [4]. The quality levels of Bali cattle carcasses according to SNI are grouped into 3 groups, namely quality I has a fat thickness of <13 mm; quality II has a fat thickness of 13-<22 mm and quality III has a fat thickness of >22 mm [4]. Male Bali cattle that were intensively raised with additional fermented cocoa skin feed had a carcass percentage of 53.77%, a meat to bone ratio (3.28:1); with a meat index of 0.91[5].

One of the indicators for determining meat quality is by looking at the marbling score. The marbling score depends on the location of the muscles and the breed [6]. The marbling score also depends on the condition of fat distribution on the surface of the longissimus thoracis muscle between the 5th and 13th ribs [7]. The meat on the 5th rib has a marbling score of 2.6 while the meat on the 10th rib has a marbling score of 2.4. Beef marbling can be formed by providing feed in the form of grains containing high protein [8]. Factors that influence the degree of marbling: genetics, food, and stress [9]. Stressed cows cause blood pressure to be disturbed and result in the taste of the meat becoming tough, and marbling will not appear. There is a correlation between marbling and overall meat palatability, If the marbling content is < 3% the palatability decreases and the meat is not accepted by consumers, On the other hand, if the marbling content is high (<7.3%) it gives a negative perception regarding increased fat consumption and its relationship with coronary heart disease, obesity and cancer [10].

1.2. Literature Review

Pineapple peel is agricultural waste that contains high water content so it is easily damaged if not fermented immediately [11]. Pineapple peel is an organic material with a crude fiber and crude protein content of 33.25% and 4.93% [12]; 27.09% and 8.78% [13]; 16.7% and 6.4% [14]. In an effort to improve the palatability of feed and to be more efficient in its use as a feed supplement, pineapple peel needs to be processed into solid feed such as HMB [15]. Apart from being in the form of HMB, pineapple peel waste can be processed into silage. Silage is the result of fermenting feed ingredients with the addition of additives to increase protein and reduce crude fiber using either liquid media (yogurt, kefir, vinegar, wine) or solid media [14].

The productivity of Bali cattle is greatly influenced by several factors, namely genetic factors and environmental factors, as well as the maintenance system. These factors influence the live weight so that it ultimately influences the weight of the carcass produced [16]. One of the genetic factors that influences live weight and carcass weight is gender. Sex affects body composition such as weight distribution and carcass chemical composition [1]. The carcass percentage of male Balinese cattle is higher than that of female Balinese cattle, which is caused by the presence of the testosterone hormone in male Balinese cattle [17]. Live weight and carcass weight are indicators of Bali cattle productivity, so both are very important. Live weight and carcass weight are interconnected and cannot be separated, as live weight increases, the productivity of carcass weight will also increase [18].

In assessing meat quality, several indicators are used, including marbling content, nutritional value content, physical characteristics, cholesterol content, saturated and unsaturated fatty acid content, total microorganisms, sensory properties including color, odor, taste ([1];[19]; [20]. The high and low marbling scores and meat tenderness are very dependent on feed quality [21]. Bali cattle fed concentrate have a higher marbling score than Balinese cattle fed various types of grass [22].

Bali cattle fed fermented cocoa skins have a marbling score of 2.65 [5], while Bali cattle whose rations were supplemented with commercial concentrate had a marbling score of 3.91[21]. Improving feed management by paying attention to quality and continuity of availability is one strategy to obtain Bali beef that has a balanced marbling, cholesterol and meat physicochemical content (tenderness). Non-competitive local material sources that have the potential to be used as ingredients in Bali cattle rations are pineapple peel waste, cocoa skin waste, banana skin and other agricultural waste [2].

1.3. Research Objective

This study was conducted with the aim of determining the carcass characteristics and marbling score of male Bali beef by administering HMB supplements based on fermented pineapple peel.

2. MATERIALS AND METHODS

2.1. Materials

Research material: Nine male Bali cattle with a weight range of 206-245 kg, and concentrate composed of local ingredients including: fermented pineapple peel with lactic acid bacteria, ground corn, rice bran, molasses and HMB. The cattle are placed in individual cages measuring 1.5 x 2 M2 which are equipped with a place for feeding and drinking water.

2.2. Research Methods

2.2.1. Making HMB:

a. Prepare 1,050 g of fermented pineapple peel
b. Fermented pineapple peel is mixed together with 175 g turmeric powder, 490 g tapioca flour, 455 g premix and 175 g fine salt
c. The homogeneous mixture is moistened with molasses solution (molasses + water) in a 1:1 ratio little by little until the dough forms a lump
d. The dough that has formed a lump is put into the HMB printing machine and pressed for 10-15 minutes
e. The printed results are dried in the sun for 2-3 days
f. The dried HMB print results can be given directly to cattle. The form of HMB is presented in Figure 1.

https://doi.org/10.29165/ajarcde.v9i2.655

Fig. 1. Cattle feed in the form of HMB

2.2.2. Male Bali cattle fattening

Nine male Bali cattle were placed in individual pens randomly based on a Completely Randomized Design with a one-way pattern with 3 treatments and 3 replications. Feeding treatment is as follows:

P0: 39% ground corn + 61% rice bran + 0% fermented pineapple peel + field grass (ad libitum)

P1: 15% ground corn + 65% rice bran + 20% pineapple peel fermented with lactic acid bacteria and field grass (ad libitum)

P2: 12% ground corn + 73% rice bran + 15% pineapple peel without lactic acid bacteria fermentation + field grass + HMB (ad libitum)

The formula and nutritional content of the ration for each treatment are presented in Table 1.

Table 1. Formula and Nutritional Content of Rations

Ingredients composition	Treatment		
	P0	P1	P2
Ground corn (%)	39	15	12
Rice bran (%)	61	65	73
Pineapple peel fermented with lactic acid bacteria (%)	0	20	0
Pineapple peel without lactic acid bacteria fermentation	0	0	15
Total	100	100	100
Nutritional Content of the Ration			
Crude protein (%)	12.01	12.08	11.98
Crude fiber (%)	4.52	7.18	7.74
Crude fat (%)	9.12	9.10	9.61
Nitrogen Free Extract (NFE)(%)	66.87	62.87	61.96
Total Digestible Nutrient (%)	83.05	85.11	85.05
Calcium (Ca) (%)	0.04	0.04	0.04
Phosphor (%)	0.99	1.07	1.16

2.3. Research Variables

2.3.1. Carcase characteristics

Carcass Weight: Carcass weight is the weight of the meat, bones and fat after separating the four legs, head, skin and all the contents of the abdominal cavity except the kidneys.

Carcass Percentage: Carcass percentage is the ratio of carcass weight to slaughter weight multiplied by 100%.

Carcass length: Carcass length was obtained by measuring the length of the carcass from the first rib to the front end of the base of the tailbone using a measuring tape [23].

Meat index: The Meat index is the ratio between carcass weight and carcass length [17].

Rib area: Rib area measurements can be made by drawing the cross-sectional area of the longissimus dorsi muscle between the 10th and 11th ribs, then calculating using millimeter blocks [17].

2.3.2. Marbling score

Measurement of marbling scores is carried out using a comparative method based on international scores ([2]);[24]).

2.3.3. Meat color and fat color

Assessment of meat and fat color using color standards [4].

2.4. Data Analysis

The research results were analyzed using Analysis of Variance based on a Complete Randomized Design (one-way pattern) and continued with Duncan's Multiple Range Test at a 5% confidence level using SPSS software version 25 [25].

3. RESULT AND DISCUSSION

3.1. Carcass Characteristics

The results of the study on the characteristics of male Bali cattle carcasses fed with fermented pineapple peel in the form of HMB are presented in Table 2. The results of the One-Way ANOVA analysis showed that the addition of fermented pineapple peel in Bali cattle rations had a significant effect ($P<0.05$) on carcass percentage, very significant ($P<0.01$) on carcass length and meat index, while on slaughter weight, carcass weight and rib eye area there was no significant difference ($P>0.05$). The results of the Duncan test showed that the addition of pineapple peel without lactic acid bacteria fermentation of 15% in the ration and herbal molasses block (P2) resulted in a carcass percentage of Bali cattle of 52.34% which was significantly ($P>0.05$) higher compared to the carcass percentage in P0 (50.55%) and P1 (49.70%).

https://doi.org/10.29165/ajarcde.v9i2.655

Table 2. Characteristics of Bali Male Cattle Carcasses Given Fermented Pineapple Peel Feed

Variables	Percentage of fermented pineapple peel BAL			Sig.
	P0	P1	P2	
Slaughter weight (kg)	280.00±10.00	285.00±15.00	277.00±2,50	0.689
Carcass weight (kg)	139.00±1.00	141.50±3.50	138.70±3.30	0.549
Carcass Percentage (%)	50.55±0.56^{b}	49.70±1.39^{b}	52.34±0.26^{a}	0.026
Carcass Length (cm)	145.50±0.50^{b}	144.50±0.50^{b}	155.50±4.50^{a}	0.004
Meat index	0.96±0.00^{a}	0.98±0.02^{a}	0.89±0.00^{b}	0.001
Rib Eye Area (cm^{2})	32.50±3.50	33.00±3.00	28.50±0.50	0.158

Description: Different superscripts in the same line indicate highly significant differences (P<0.01) and significant (P<0.05); Sig= Significance. BAL= Lactic acid bacteria.

The percentage of Bali cattle carcasses given a ration containing 15% pineapple peel without lactic acid bacteria fermentation plus an herbal molasses block in this study was smaller (52.34%) compared to the percentage of male Balinese cattle carcasses given fermented cocoa skin feed, which was 54.76 [5]. also, smaller when compared to the percentage of carcasses of male Bali cattle that are extensively raised in the East-West region of East Nusa Tenggara (53.38%)[26]. Male Bali cattle slaughtered at the Manado Slaughterhouse, North Sulawesi, had a carcass percentage of 50.168% lower compared to the carcass percentage of male Bali cattle fed fermented pineapple peel with yeast or lactic acid bacteria [27].

The carcass length obtained in this study ranged from 144.50±0.50-155.50±4.50 cm, higher than the carcass length of male Bali cattle with a slaughter weight of 300-400 kg which had a carcass length of 125 cm [28]. The length of the carcass is determined more by the length of the permanent bones, while the width of the carcass is determined by the growth of the tendons in the area around the chest. Male Bali cattle aged between 3 and 3.5 years and fat in body condition have a carcass length of 148.20 cm [29].

The results of the Duncan test showed that the meat index of male Bali cattle in the control treatment (P1) was 0.98±0.02 higher and was very significantly different (P<0.01) from the meat index in the P2 treatment (0.89±0.00) and the meat index of Bali cattle in the P0 treatment (0.96±0.00).This is because the ration treatment containing 20% lactic acid bacteria fermented pineapple peel (P1) had a higher carcass weight compared to other treatments. The size of the meat index is very dependent on the carcass weight, the higher the carcass weight per unit length, the higher the meat index [29]. The meat index obtained in this study ranged from 0.89 to 0.98, lower than the meat index of male Bali cattle of 1.23 [29]. This is because the age of the male Bali cattle used as research material is still relatively young, namely 1.5-2 years, so that it has not provided maximum growth in carcass components.

The rib eye area of male Bali cattle obtained in this study ranged from 28.50 to 33.00 cm2 and was not significantly different (P>0.05) between treatments. The results of this study were lower than the area of the ribs of male Bali cattle fed fermented cocoa skin, which was 61.79 cm2 [5]. This is because the age of the Bali cattle used in this study was still young, namely 1.5 - 2 years old. On average, the P1 treatment had a rib eye area of 33.00±3.00 cm2 higher than the rib eye area in treatments P0 and P2. This is because the P1 treatment had a higher carcass weight (141.50±3.50 kg) compared to the carcass weight of treatments P0 and P2. The results of this study indicate that there is a positive correlation between the area of the rib eye and carcass weight. It is said that the factors that influence the area of the rib eye are live weight and carcass weight [5].

3.2. Marbling Score, Meat Color and Fat Color

Determination of marbling score, fat color and meat color of male Bali beef with the provision of fermented pineapple peel with lactic acid bacteria in the form of HMB was carried out by organoleptic test involving 16 panelists, each panelist conducted the test 27 times. In determining the marbling score, fat color and meat color, the following standards are used: Marbling score using the meat marbling score standard according to AUS MEAT=Meat Australia and MSA=Meat Standard Australia [6]. The white color between the muscle fibers is called meat marbling, while the white color on each side of the muscle is called perimysium tissue. The numbers 0–9 indicate the marbling score. The marbling score standards are presented in Figure 2.

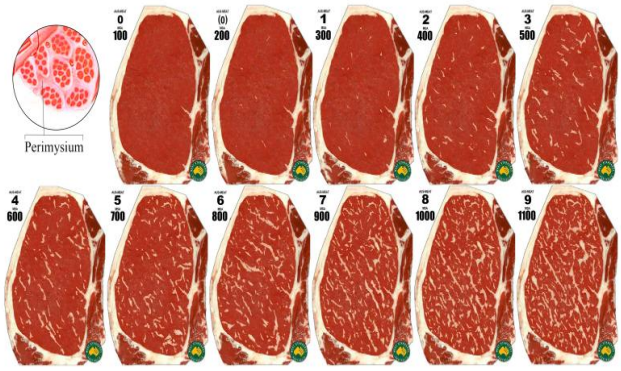

Fig. 2. Meat marbling score standards according to AUS_MEAT and MSA [6].

The meat color score uses the standard, namely Score 1–5: bright red meat color; score 6–7: flesh color dark red; and a score of 8–9: dark red flesh color [4]. Meat color standards are presented in Figure 3.

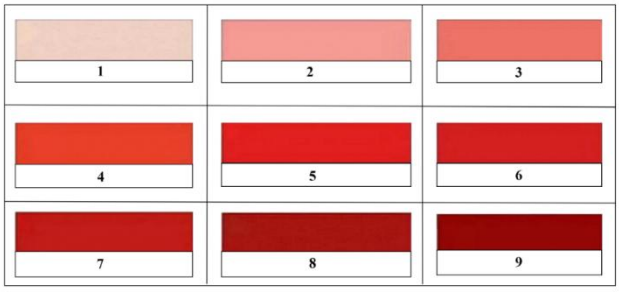

Fig. 3. Meat color standards [4].

https://doi.org/10.29165/ajarcde.v9i2.655

The standard fat color score used is: score 1–3: white fat; score 4–6: yellowish white fat; and score 7–9: yellow fat [4]. The standard color of meat fat is presented in Figure 4. The results of research on marbling scores, meat color and fat color of male Bali beef using the standard scores above are presented in Table 3.

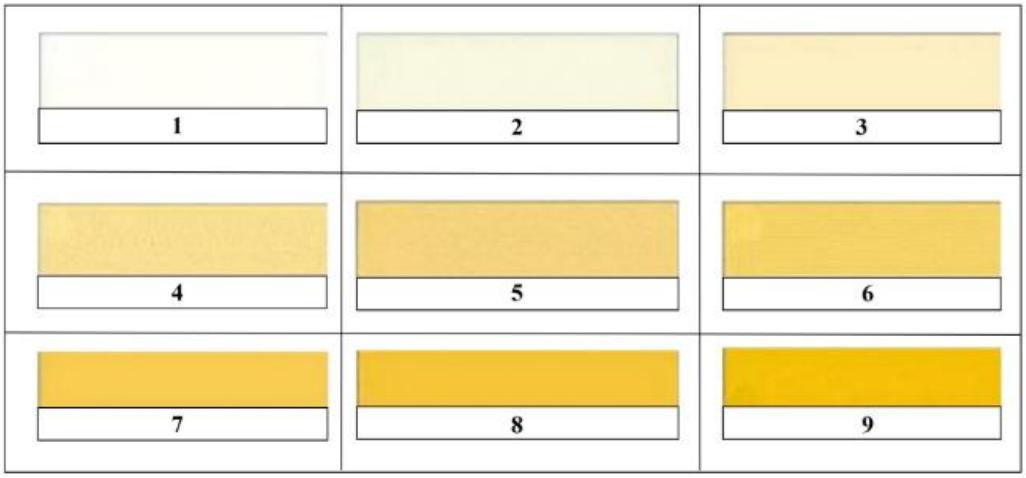

Fig. 4. Standard color of fat for male Bali beef [4]

Table 3. Marbling Score, Fat Color and Meat Color of Male Bali Cattle

Variable	Percentage of fermented pineapple peel BAL			Sig.
	P0	P1	P2	
Marbling	1.71 ± 0.56	1.81 ± 0.50	1.81 ± 0.34	0.769
Meat color	3.9 ± 1.97^{b}	2.56 ± 1.03^{b}	4.31 ± 1.20^{a}	0.005
Fat color	4.31 ± 1.25^{a}	4.56 ± 1.09^{a}	2.44 ± 1.26^{b}	0.000

Description: Different superscripts in the same line indicate highly significant differences (P<0.01); Sig.= Significance. BAL= Lactic acid bacteria

The results of the one-way ANOVA analysis showed that the addition of fermented pineapple peel in Bali cattle rations had a very significant effect (P<0.01) on meat color and meat fat color, while it had no significant effect on the marbling score (P>0.05). The results of the Duncan test showed that the marbling score of male Bali beef fed with fermented pineapple peel with lactic acid bacteria at 20% (P1) and 15% unfermented pineapple peel with added herbal molasses block (P2) was the same, namely 1.81 rounded up to 2 or can be equated to 2% according to the United States Department of Agriculture (USDA) beef grades [30]. The marbling score of male Bali beef fed with fermented pineapple peel with lactic acid bacteria in the form of herbal molasses block is presented in Figure 5.

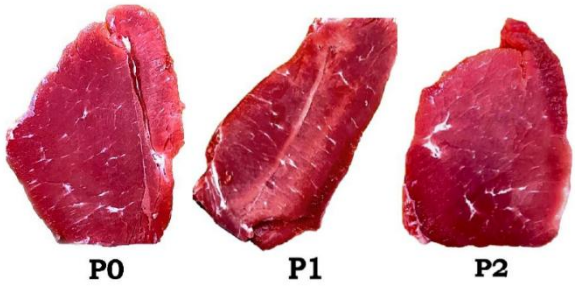

Fig. 5. Marbling score: P0=1.71; P1=1.81 and P2=1.81

Figure 5 shows that the marbling score of male Bali beef fed with fermented pineapple peel lactic acid bacteria with the addition of herbal molasses block in the control (P0), P1 and P2 were respectively 1.71; 1.81 and 1.81, which are classified as low (small) according to meat marbling standards [30]. The percentage of intramuscular fat (marbling) usually tends to increase as the percentage of body tissue fat increases, including the thickness of back fat. The marbling content is also influenced by the nutritional status of the feed given while the livestock is still alive. Cows fed grain feed will produce higher marbling compared to cows fed more grass or other forage [21].

The marbling score of Bali beef obtained in this study was around 1.71-1.81% lower when compared to the marbling score of Sumba Ongole cattle fed concentrate feed based on rice bran and soybean meal with a marbling score of 3.00 [17]. Local Pasundan cattle, which are the result of crossbreeding the 10th generation of Bali cattle with Madura cattle and/or Sumba Ongole cattle with a body condition value of 3.5-4.0, have a meat marbling score of 5 [31].

Beef is mostly red in color typical of beef like dark red color. The standard for meat color that is commonly used is the beef color standard using a score of 1–9, ranging from pink to dark red, namely bright red (score 1–5), dark/slightly dark red (score 6–7) and dark red (score 8–9)[4]. The color of male Bali beef obtained in this study was bright red, which had an average score of 2.56-4.31. The results of this study provide an illustration that the color of the meat produced is different from the color of the meat of male Bali cattle fed green fodder on community farms

https://doi.org/10.29165/ajarcde.v9i2.655

with a meat color score of 9, which means dark red [22]. The light color of the meat indicates that the oxygen content of the meat is still available, the energy reserves are still high, the slaughtering is handled according to procedures and the pH of the meat is still normal (5.6-5.9). Beef cattle fed concentrate feed containing medium to high energy produce bright red meat [22]. Meat with a pH range of 6.0-7.0 will cause the meat color to become dark red [64]. Beef cattle raised on pasture will produce meat with varying ultimate pH values caused by the glycolysis of muscle glucose into lactic acid decreasing so that the color of the meat produced becomes darker [32].

The research results show that the color of fat in male Bali beef based on treatment ranges from 2.44-4.56, which is classified as white [4]. The color of the fat of the male Bali cattle obtained in this study was different from the color of the fat of the male Bali cattle fed green fodder with a fat color score of 5.33, which was classified as yellowish white. One of the factors causing the yellowish-white color of beef fat is the carotenoid content in field grass, especially β-carotene content [22]. Carotenoids are a group of pigments that are yellow, orange or red-orange in color, which are generally found in plants, groups of bacteria, fungi, algae and green plants[33]. The formation of the color of Bali beef fat which leads to quality I meat fat color (score 1-3) can be done by changing the feeding pattern of livestock, namely giving less forage compared to giving concentrate for 4-10 weeks in order to reduce the content of β-carotene in blood serum which influences the yellowish color of meat fat [34].

4. CONCLUSION

The utilization of fermented pineapple peel in the form of HMB can improve the quality of carcass characteristics of male Bali cattle with a carcass percentage reaching 52.34%; carcass length 155.50 cm, meat index 0.89 and rib eye area 28.50 cm2. The resulting meat has a relatively small mabling score, bright meat color with white meat fat.

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