

Performance, Carcass Production, and Meat Quality of Sumba Ongole Bulls Fed Ration Supplemented Velvet Bean (*Mucuna pruriens*)

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ABSTRACT

This research aimed to study performance, carcass production, meat quality, and economic feasibility of male Sumba Ongole cattle fed ration supplemented with velvet bean (*M. pruriens*). The research was designed in a completely randomized block design using 16 cattle with average body weight of 488±37.08 kg. The treatments were: T0= 15% straw + 85% concentrate; T1= T0 + 12% of velvet bean flour supplement; T2= T0 + 16% of velvet bean tempeh supplement; and T3= T0 + 200 mg/head/d of ractopamine hydrochloride. Data were analyzed by using analysis of variance with orthogonal contrast. The observed variables included feed consumption, average daily body weight gain (ADG), feed efficiency (FE), income over feed cost (IOFC), hot carcass weight (HCW), carcass percentage, subcutaneous fat thickness, meat pH, tenderness, cooking loss, and water holding capacity (WHC). The result revealed that the addition of 12% velvet bean flour into the rations increased dry matter consumption (P<0.05), but did not affect ADG, FE, IOFC, carcass production, and meat quality. The addition of 12% velvet bean flour produced the lowest cooking loss (P<0.05). The addition of 16% velvet bean tempeh into the rations significantly increased (P<0.05) dry matter consumption, however reduced (P<0.05) ADG, FE, and IOFC compared to control treatment. It is concluded that velvet bean flour at the level of 12% can be used as an alternative feed supplement in the ration of Sumba Ongole cattle and can replace the use of synthetic β -agonist.

Key words: Mucuna pruriens, Sumba Ongole cattle, performance, carcass, meat quality

ABSTRAK

Penelitian ini bertujuan untuk mempelajari performa, produksi karkas, kualitas daging, dan *economic feasibility* dari sapi sumba ongole jantan yang mengkonsumsi kara benguk (*M. pruriens*). Penelitian ini dilaksanakan berdasarkan rancangan acak kelompok dengan menggunakan 16 ekor sumba ongole jantan dengan rata-rata bobot badan 488±37,08 kg dan menggunakan 4 jenis perlakuan, yaitu: T0= 15% jerami padi + 85% konsentrat, T1= T0 + 12% tepung kara benguk, T2= T0 + 16% tempe kara benguk, dan T3= T0 + 200 mg/ekor/hari ractopamine HCl. Data dianalisis menggunakan analisis ragam dan kontras ortogonal. Peubah yang diukur adalah konsumsi ransum, pertambahan bobot badan harian (PBBH), efisiensi pakan (EP), *income over feed cost* (IOFC), bobot karkas panas, persentase karkas, tebal lemak (subcutan), pH daging, keempukan, susut masak, dan daya ikat air. Hasil penelitian menunjukkan bahwa penambahan 12% tepung kara benguk meningkatkan konsumsi bahan kering (P<0.05), namun demikian tidak berpengaruh terhadap PBBH, efisiensi pakan, IOFC, produksi karkas, dan kualitas daging, serta menghasilkan susut masak terendah (P<0,05). Penambahan 16% tempe kara benguk pada ransum nyata meningkatkan konsumsi bahan kering (P<0.05), namun demikian menurunkan (P<0.05) PBBH, efisiensi pakan, dan IOFC dibandingkan kontrol. Dapat disimpulkan bahwa 12% tepung kara benguk dapat digunakan sebagai pakan tambahan alternatif dalam ransum ternak sumba ongole dan sebagai pengganti β -agonist sintetis.

Kata kunci: Mucuna pruriens, sumba ongole, performa, karkas, kualitas daging

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INTRODUCTION

The attempts to improve cattle performances have been conducted to maximize unit production per head. For instance, addition of growth inducer, including β -agonist, has been done to address this issue. Despite the effect is promising, this treatment yielded chemical residues that may harmful for the consumers. Clinical test in European countries revealed that 2 drops of 0.006% β -agonist (known as clenbuterol) promoted decreasing of bronchus resistance on asthma patient (Menard, 1994). For similar reasons, some countries had considered that addition of clenbuterol onto the feed as an illegal farming practice. Besides, the practice also promoted the use of compound without control. Recently, toxicity of meat and liver containing clenbuterol was reported in Spain (125 cases) and France (22 cases). The clenbuterol poisoning were characterized by palpitation, tachycardia, dizziness, nervousness, headaches, tremors, and muscle pains (Menard, 1994). For this reasons, the attempts to find substitution of clenbuterol is unavoidable.

Mucuna pruriens, a tropical legume native to Africa and tropical Asia and known as kara benguk in Indonesia, has been widely known as medicinal herb. This plant might, yet need to be confirmed, contain mucunan, serotonin, and L-Dopa (L-3,4-dihydroxyphenylalanine). The presence of L-dopa promotes velvet bean as a promising agent to induce the growth of beef cattle. L-Dopa is known as a precursor for dopamine, a catecholamine hormone. Naturally, L-dopamine is produced by some legumes, especially velvet bean, where it constitutes 5.38%-6.98% (Kalidass & Mohan, 2011). L-dopa, as well as L-phenylalanine and L-tyrosine, is converted to dopamine in central nervous system. L-tyrosine is the first check point for complete synthesis of catecholamine. L-tyrosine is hydroxylated to form dihydroxy-L-phenylalanine (known also as levodopa or L-dopa) by tyrosinase. In respect to dopaminergic neuron, L-dopa is metabolized to dopamine by dopa decarboxylase. Meanwhile, in noradrenergic neuron cells and adrenal medulla, dopamine is transformed to noradrenalin via dopamine β -hydroxylase. Noradrenalin can be converted to adrenaline by addition of methyl group by phenyl-ethanolamine-N-methyltransferase (Broadley, 2010).

Epinephrine and norepinephrine, physiologically, are known as β -agonist. There are three types of β -adrenergic receptor (β AR) have so far been identified, including β_1 , β_2 , and β_3 across various organisms with 40%-50% sequence similarities. Dopamine and norepinephrine are produced in hypothalamus and brain to support pituitary gland production and release of growth hormone. In human, the production of this hormone is decrease with the advance of age hence slow down the metabolism process that further yielded degenerative diseases. Study by Imbs & Schwartz (2011) in mice revealed that after an hour injection of L-dopa, the highest concentration of amino acid was detected in muscle and kept stable even after 4 h. Re-injection of L-dopa had no effect on decreasing of S-adenosyl-methionine concentration in muscle and did not cause

accumulation of dopamine concentration in the muscle. It indicated that amino acids were not metabolized but kept in muscle at high concentration. This result also indicated that injection of L-Dopa to mice significantly triggered increasing of muscle mass due to the accumulation of protein; it was not by accumulation of fat.

Chikagwa-Malunga *et al.* (2008) showed that addition of velvet bean at the level of 5-15 kg/body weight in Palibuey sheep improved dry matter consumption and body weight linearly. Velvet bean extract as an additive feed can be used up to about 4% of total ration, meanwhile fermented kara benguk (known as tempeh velvet bean) can be used up to 16% of total ration. The amount of velvet bean and tempeh velvet bean might support growth and activity of rumen microbes *in vitro* and improve concentrations of N-NH₃ and VFA and dry and organic matters digestibility (*in vitro*).

This research aimed to study performance, carcass and meat quality, and economic feasibility of male Sumba Ongole cattle treated with velvet bean (*M. pruriens*). The use of velvet bean for this purpose is part of attempts in searching of better replacer of β -agonist in improving cattle performance in related to beef cattle fattening.

MATERIALS AND METHODS

Seed flour and tempeh velvet bean were manufactured at Laboratory of Dairy Cattle Nutrition, Faculty of Animal Science, Bogor Agricultural University. *In vivo* testing on cattle was performed in PT Karya Anugerah Rumpin.

The cattle used in this study were male Sumba Ongole cattle at finisher phase. Sixteen cattle were used with average body weights of 488±37 kg. Ration used in this study consisted of forage and concentrate with ratio of 15% : 85%. The concentrate used consisted of molasses, palm kernel, rice bran, *gaplek* (dried root cassava), copra, *onggok* (tapioca wastes), corn gluten feed, fish meal, soybean meal, and corn (Table 1). There were four treatments in this study, including control, natural growth promoter in form of kara benguk flour or tempeh and ractopamine HCl as a positive control. Water and feed were available *ad libitum*, in which feed was given twice at 9 am and 2 pm.

Randomized complete design was used in this study consisting of 4 treatments and 4 cattle as replication, in which each replication used one cattle. The grouping was based on body weight yielding groups of small (424-445 kg), medium (460-473kg), large (484-491kg), and extra-large (523-551kg). Meanwhile, ration treatments were:

T0= 15% straw + 85% concentrate

T1=T0 +12% of velvet bean flour supplement*

T2=T0 +16% of velvet bean tempeh supplement

T3=T0 + 200 mg/head/d of ractopamine hydrochloride.

*Adjustment of velvet bean extract dosage to the seed flour: A: 350g; B: 325g; C: 320g

This study was conducted for 35 d before the slaughtering process. The variables measured were feed consumption, average daily weight gain (ADG), feed

Table 1. Composition and nutrient content of the experimental ration

Item	Treatments			
	T0	T1	T2	T3
Ingredients, % DM				
Molasses	12.00	10.71	10.34	12.00
Palm kernel meal	4.00	3.57	3.45	4.00
Rice bran	5.00	4.46	4.31	5.00
Dried cassava	7.70	6.88	6.64	7.70
Copra meal	8.00	7.14	6.90	8.00
Tapioca waste	38.80	34.61	33.41	38.80
Corn gluten feed	5.00	4.46	4.31	5.00
Fish meal	4.00	3.57	3.45	4.00
Soybean meal	3.00	2.68	2.59	3.00
Corn	6.00	5.36	5.17	6.00
Potato flour	3.30	2.59	2.84	3.30
Sodium bicarbonate	0.50	0.445	0.43	0.50
Monensin	0.007	0.006	0.006	0.007
Salt	0.20	0.18	0.17	0.20
Limestone	1.00	0.89	0.86	1.00
Premix ¹	0.13	0.12	0.11	0.13
Urea	1.40	1.25	1.20	1.40
Velvet bean flour	-	10.71	-	-
Velvet bean tempeh	-	-	13.79	-
Ractopamine HCL	-	-	-	0.02
Nutrient level, % DM²				
Dry matter	87.84	88.35	87.81	87.84
Crude protein	15.39	15.82	16.15	15.39
Ether extract	4.01	3.87	4.53	4.01
Crude fiber	14.21	12.78	14.16	14.21
TDN	70.22	70.51	70.60	70.22

¹ on 1 kg Premix consisted of vitamin A, 2000000 IU; Vitamin D3, 400000 IU; Vitamin E, 1200 mg; Ca, 180000 mg; Mg, 5000 mg; P, 10000 mg; Co, 10 mg; Cu, 1000 mg; I, 15 mg; Fe, 5000 mg; Mn, 6000 mg; Se, 20 mg; Zn, 5000 mg; Antioxidant, q.s mg; Carrier, q.s mg.

²Laboratory Analysis, Pusat Penelitian Sumber Daya Hayati dan Bioteknologi (2013).

T0= 15% straw + 85% concentrate (control); T1= T0 + 12% of velvet bean flour supplement; T2= T0 + 16% of velvet bean tempeh supplement; and T3= T0 + 200 mg/head/d of ractopamine hydrochloride.

efficiency, and income over feed cost (IOFC), hot carcass weight (HCW), carcass percentage, subcutaneous fat thickness, meat pH, tenderness, cooking loss, and water holding capacity (WHC). Feed consumption was calculated by differences between given and remaining feeds. Daily weight gain was calculated based on the differences between the body weight at the beginning and end of the days divided by number of days (referring to the length of study). Feed efficiency was obtained by dividing ADG (kg) with amount of consumed feed (in dry matter). Meanwhile, IOFC was calculated using the following formula (Bailey *et al.*, 2009).

$$\text{IOFC} = (\text{PLW} \times \text{ADG}) - \text{DFC}$$

IOFC = income over feed cost (IDR/bull/d)
 PLW = farm-gate price of live weight bull (IDR/kg)
 ADG = average daily gain (kg)
 DFC = daily feed cost (IDR/bull)

Carcass are the body parts of cattle that had been cut in order to obtain meat and bone without skin, head, feet, tail, and viscera. HCW was obtained from the weighing of carcasses. Carcass percentage was measured by HCW from cattle live weight. Subcutaneous fat thickness was measured with digital caliper in the longissimus dorsi. Meat pH was measured with pH meter, tenderness was measured with Warner Blatzer shear, cooking loss was measured by calculating the difference in meat weight before and after cooked, and WHC was measured according to Muchenje *et al.* (2009) method.

Data Analysis

The data were analyzed by using Analysis of Variance (ANOVA) followed by orthogonal contrast test to find the differences among the treatments.

RESULTS AND DISCUSSION

Feed Consumption

Treatments on the concentrate used in this study significantly affected feed consumption ($P < 0.05$). Supplementation of velvet bean flour yielded improvement on dry matter consumption up to 11.22 kg/head/d (Table 2). Meanwhile, when tempeh velvet bean flour was used, the increase of dry matter intake was 11.74 kg/head/d. These values correspond to the increase in dry matter consumption by 9.57% and 14.65%, respectively, as compared to control cattle. In addition, dry and organic matters digestibilities were high enough ranging from 66.56%-71.86% and 67.45%-71.34%, respectively, based on *in vitro* study. This high digestibility is probably due to the presence of active compounds in velvet bean that further affected the feed consumption. Nevertheless, dry matter consumption in control and treated cattle were relatively low. The values varied as following: 1.92% (control), 2.04% (velvet bean flour), 2.25 (tempeh flour), and 1.90% (ractopamine). According to Kears (1992), dry matter consumption is generally found to be about 2.8% in the fattening cattle.

Addition of tempeh kara bengkok flour yielded the highest dry matter consumption. The high dry matter consumption is probably due to the improved palatability of the ration supplemented with tempeh flour which has fragrant flavor. This flavor might increase the palatability of the ration hence improve dry matter consumption. Walker *et al.* (2010) reported that ractopamine treatment to heifer significantly reduced dry matter consumption. This report is in good agreement with our result which revealed that ractopamine did not improve dry matter consumption.

Body Weight Gain

Treatment effects on the average of daily body weight gain (ADG) were found not to be significant, yet orthogonal contrast test revealed some differences among the treatments. Addition of velvet bean flour did not significantly affect ADG, even though numerically higher by 8.28% ($P < 0.17$) as compared to control

Table 2. Performance and income over feed cost (IOFC) of Ongole cattle under various treatments

Variables	Treatments			
	T0	T1	T2	T3
Initial body weight (kg)	482.75 ± 40.19	497.50 ± 40.67	481.50 ± 41.46	491.50 ± 40.75
Final body weight (kg)	534.25 ± 34.86	553.00 ± 55.22	523.25 ± 40.84	531.00 ± 40.95
Weight gain (kg)	51.50 ± 11.03	55.50 ± 16.82	42.00 ± 3.46	39.50 ± 2.52
Average daily weight gain (kg/head/d)	1.45 ± 0.26 ^a	1.57 ± 0.43 ^a	1.18 ± 0.09 ^b	1.11 ± 0.07 ^b
Dry matter intake (kg/head/d)	10.24 ± 0.41	11.22 ± 0.13	11.74 ± 0.09	10.07 ± 0.28
Dry matter intake (%)	1.92 ± 0.12 ^a	2.04 ± 0.21 ^c	2.25 ± 0.19 ^c	1.90 ± 0.12 ^b
Feed efficiency ratio	0.141 ± 0.023 ^a	0.139 ± 0.037 ^a	0.100 ± 0.007 ^b	0.111 ± 0.008 ^b
Price of live weight (IDR ×10 ⁵)	19.90 ± 4.31	22.20 ± 6.72	16.30 ± 1.23	15.70 ± 1.05
Average dry matter intake (kg)	10,237.00 ± 409.41	11,221.00 ± 127.11	11,740.00 ± 106.96	10,065.00 ± 276.28
Daily feed cost (IDR ×10 ⁵)	7.47 ± 0.29	8.18 ± 0.09	8.56 ± 0.06	7.34 ± 0.20
Income over feed cost (IOFC) (IDR ×10 ⁴)	3.57 ± 1.18 ^a	3.70 ± 1.94 ^a	1.88 ± 0.33 ^b	2.02 ± 0.33 ^b

Note: Means in the same column with different superscripts differ significantly ($P < 0.05$). T0= 15% straw + 85% concentrate (control); T1= T0 + 12% of velvet bean flour supplement; T2= T0 + 16% of velvet bean tempeh supplement; and T3= T0 + 200 mg/head/d of ractopamine hydrochloride.

(Table 2). Feed supplemented with 4% of velvet bean extract significantly increased volatile fatty acid (VFA) concentration (*in vitro* study). High level of VFA implied the increased available energy. The increased of energy productivity in the feed indicated the increased of available energy for cattle metabolism. The high ADG value in the cattle treated with velvet bean flour is might be due to availability of NH_3 . This assumption is evidenced by the concentration of N-NH_3 at feed with velvet bean extract, which was the highest among the treatments (*in vitro* study).

The cattle treated with tempeh velvet bean and ractopamine had 18.62% and 23.45% lower ADG, respectively, as compared to control. In respect to addition of tempeh velvet bean, low level of ADG is might be due to the production of tyrosinase by *Rhizopus oryzae* in the digestive tract that changes L-tyrosine and L-dopa to dopaquinone that is further converted back to melanin (Chávez-Béjar *et al.*, 2012). This result indicated the diversion of feed metabolism pathway, in which the feed was metabolized to be coloring compounds, instead of energy. This pathway diversion did not cause any effect on ADG; meat from the cattle treated with the tempeh has darker color compared to others.

Low ADG value in the cattle treated with ractopamine is probable due to low dry matter consumption. As explained by Gruber *et al.* (2007), ractopamine treatment on steer had no effect on dry matter consumption yet with significant effect on ADG and feed efficiency, with combination of TBA/E₂ (*trenbolone acetate/estradiol benzoate*) implant. However, TBA/E₂ implant was not used in our present experiment. TBA/E₂ implant on cattle, as reported by Walker *et al.* (2011), yielded 10-50 times higher response on the growth as compared to testosterone, hence this implant was widely used as a testosterone replacer. Walker *et al.* (2011) explained there were significant differences between cattle with or without the implant, in which cattle with implant displayed a better growth performance. Avendano-Reyes *et al.* (2006) stated that addition of ractopamine in the fattening cattle was less effective as compared to the use of β -agonist 2.

Feed Efficiency (FE)

In this study, it was found that there was no differences in FE among treatments (Table 2). However, orthogonal contrast test yielded differences among the treatments. In this study, FE was in the range of 0.10-0.14, which was considered to be good values for Sumba Ongole cattle. Orthogonal contrast test revealed that the addition of tempeh kara benguk and ractopamine decreased FE by 28.57% and 21.43%, respectively, as compared to control. The low level of dry matter consumption in the cattle treated with ractopamine might account for the insignificant changes of FE. Yet, addition of velvet bean flour improved FE that was 20.14% higher than ractopamine treatment (positive control group). Higher FE value suggests a better efficiency of the cattle in metabolizing the feed. According to Vadivel *et al.* (2011), low protein digestibility is probably due to L-Dopa oxidation which is conjugated to cysteine and form a bond so called 5-s-cysteinyl-dopa that promotes protein polymerization.

Income Over Feed Cost (IOFC)

The result revealed that velvet bean flour, tempeh velvet bean, and ractopamine HCl did not affect IOFC value (Table 2). However, orthogonal contrast test revealed that there were significant differences between control and velvet bean flour with tempeh velvet bean and ractopamine HCl. Weller (1994) reported that body weight gain was highly correlated to FE under the issue of cattle productivity and ADG directly related to IOFC value.

In respect to the addition of velvet bean, IOFC value was Rp1,325.58/head/d that was higher than that of control. Meanwhile, addition of tempeh velvet bean and ractopamine HCl decreased IOFC by Rp16,911.75/head/d and Rp15,525.11/head/d, respectively, as compared to control. High value of IOFC in the addition of velvet bean flour was due to a high ADG value in the cattle treated with this flour. ADG highly affects the income. This result was also supported by the improve-

ment of body shape (esthetic value) which is better as compared to control hence increasing its selling price. In the treatment of velvet bean flour and ractopamine HCl, esthetic value of the cattle was judged to be 10, which is much higher as compared to that of control cattle (8) with bigger belly.

IOFC value in the cattle treated with tempeh velvet bean was the lowest, which was due to the low ADG (1.18 kg/head/d) and high daily feed costing amounting up to Rp27,697.97 head/d. Low IOFC value in tempeh velvet bean treatment was supported by low FE value (0.100) which explained that high feed consumption did not necessarily in line with feed digestibility. Combination of these factors is believed to promote low IOFC value in the cattle treated with tempeh velvet bean.

Cattle treated with ractopamine HCl (positive control) had lower IOFC value than the control. The most possible factor causing this evidence was low ADG value (1.11 kg/head/d) and high daily feed costing amounting up to Rp24,760.52 head/d. Low ADG value caused low added value obtained from the cattle. As comparison, study by Prasetyono *et al.* (2007) showed that beef cattle treated with straw and addition of rice bran and cassava-urea complex, ad libitum, yielded IOFC value only Rp7,500.00/head/d with ADG 0.85 kg/head/d. Mayulu *et al.* (2009) also reported that Simmental crossed beef cattle fed with ammoniated straw based complete ration yielded highest IOFC value of Rp18,391.00 /head/d.

Carcass Production

The statistical analysis proved that all treatment did not affect hot carcass weight, carcass percentage, and subcutaneous fat thickness (Table 3). It is proved that supplementation with either flour, tempeh, and ractopamine HCl had no significant effect on the development of the hot carcass weight. The use of ractopamine HCl against hot carcass weight was not significant compared with the control (Sachtleben *et al.*, 2006).

All treatments did not affect carcass percentage ($P>0.05$). Supplementation of flour, tempeh, and ractopamine HCl produce final weight and hot carcass weight almost equal, so carcass percentage is no different. Generally, carcass percentage has a higher value than research Maggioni (2010) that is equal to 52.69%. Quinn *et al.* (2008) and Winterholler *et al.* (2007) reported that the addition ractopamine HCl not significant on carcass percentage.

Table 3. Carcass performance of Ongole cattle under various treatments

Variables	Treatments			
	T0	T1	T2	T3
Final body weight (kg)	534.25 ± 34.88	553.00 ± 55.21	523.25 ± 40.84	531.00 ± 40.94
Hot carcass weight (kg)	294.75 ± 24.19	288.25 ± 27.63	284.25 ± 25.66	300.75 ± 11.53
Carcass percentage (%)	55.24 ± 4.35	52.24 ± 3.73	54.29 ± 1.08	56.79 ± 2.90
Subcutaneous fat thickness (mm)	8.56 ± 1.05	7.57 ± 0.56	9.04 ± 1.48	9.24 ± 0.09

Note: Means in the same column with different superscripts differ significantly ($P<0.05$). T0= 15% straw + 85% concentrate (control); T1= T0 + 12% of velvet bean flour supplement; T2= T0 + 16% of velvet bean tempeh supplement; and T3= T0 + 200 mg/head/d of ractopamine hydrochloride.

Statistical analysis showed that treatment outcomes were not significantly different ($P>0.05$). In this study, subcutaneous fat thickness ranged 7.5 to 9.2 mm. Fat thickness are affected by triglycerides activity in cattle, and will be stored in adipose tissue under the skin (subcutan) and abdominal cavity (abdomen) if it excess. Feed consumed affect the activity of triglycerides in cattle (Soeparo, 2005).

Meat Quality

Soeparo (2005) stated that there are two factors that affect the pH of the meat that are extrinsic (temperature, humidity, stress, and drugs) and intrinsic factors (species, race, sex, muscle, muscle glycogen and activity of enzymes that affect glycolysis). Statistical analysis showed that the treatment was not significantly different to the pH of meat ($P>0.05$) (Table 4). This proved that the addition of velvet bean flour, velvet bean tempeh, and ractopamine HCl did not affect the meat pH. This result was supported by Avendano-reyes *et al.* (2006) stated that pH of beef treated by ractopamine HCl was not significant to controls.

Statistical analysis showed that the treatment was not significantly different ($P>0.05$) to the tenderness of meat. Giving beta agonis resulted the decrease of protein degradation as much as 27% that was caused by the reduce of proteolytic activity, and the increase of protein synthesis. Protein synthesis boosting changed the diameter of muscle fibers (hypertrophy) that could affect the tenderness of meat (Carr *et al.*, 2005). The provision of tempeh flour and ractopamine HCl did not leave a negative effect on tenderness of meat. This result was in line with Quinn *et al.* (2008) stated that the administra-

Table 4. Meat quality of Ongole cattle under various treatments

Variables	Treatments			
	T0	T1	T2	T3
pH	6.25±0.09	6.10±0.14	6.21±0.20	6.17±0.17
Tenderness (kg/cm ²)	4.80±0.36	5.10±0.92	4.10±1.05	4.60±0.80
Cooking loss (%)	43.38±1.94 ^a	34.53±6.64 ^b	39.37±3.19 ^a	39.21±3.99 ^a
Water holding capacity (%)	29.37±1.40	29.62±2.78	27.15±1.71	31.35±3.59

Note: Means in the same column with different superscripts differ significantly ($P<0.05$). T0= 15% straw + 85% concentrate (control); T1= T0 + 12% of velvet bean flour supplement; T2= T0 + 16% of velvet bean tempeh supplement; and T3= T0 + 200 mg/head/d of ractopamine hydrochloride.

tion of ractophamine HCl 200 g/head/d in heifers had no effect on tenderness.

Cooking loss is nutritional value indicator of meat related to the water content of the meat, which is the amount of water that is bound in and between the muscles. Factors affecting the cooking loss including pH, temperature, cooking time, and the type of muscle. Meat having pH values above 6 has a high cooking loss (Lawrie, 2003). The high value of cooking loss is an indicator of a weakening of protein bonds, so the ability to bind meat fluid weakened. The treatment of velvet bean flour significantly affected cooking loss ($P < 0.05$). Velvet bean flour supplementation resulted in lower cooking loss compared to control and other treatments. It might be caused by catecholamine contained in velvet bean flour was not fully overhauled after processing. Catecholamine can bind a specific β -adrenergic receptor in fat tissue and muscle cells so it could decrease gluconeogenesis (Walker & Drouillard, 2010).

Velvet bean tempeh and ractophamine HCl to the water holding capacity showed that the results were not significantly different ($P > 0.05$) (Table 4). The pH value has a relationship with water holding capacity (WHC), the higher pH value will result in the higher WHC, also vice versa (Soeparno, 2005). This has been described above that the pH in this study were not significantly different. Quinn *et al.* (2008) also stated that ractophamine HCl usage was not significant to the water binding power.

CONCLUSION

Velvet bean flour at the level of 12% increased dry matter consumption, but did not affect ADG, FE, IOFC, carcass production, and meat quality. It could be concluded that 12% velvet bean flour could be used as an alternative feed supplement in the ration of Sumba Ongole cattle and could replace the use of synthetic β -agonist.

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