**Fermentation Characteristic, Nutrient Digestibility, and Nitrogen Retention, of Madura Cattle Given Complete Feed Containing Soybean Pod**

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**Keywords:** Rumen Fermentation, Nutrient digestibility, Nitrogen Retention, Madura Cattle Performance, Soybean Pod

**Running text :** Rumen Fermentation and Performance of Madura Cattle Fed Soybean Pod

**ABSTRACT**

This study was aimed to evaluate the effect of complete feed containing soybean pod on rumen microbe population, fermentation characteristic, nutrient digestibility, and nitrogen retention and of Madura cattle. Twelve Madura cattle of 1.5 years of age were used in this study, given 3 feeding treatments with 4 animals per treatment by using randomized block design. The treatments included T0 (100% native grass), T2 (concentrate: grass (60:40), T3 (complete feed containing 15% soybean pods) and T4 (complete feed containing 30% soybean pods). The treatments were based on feeding practices commonly applied by farmers in the village. Variables observed were rumen microbe population, fermentation characteristic, nutrient digestibility, and nitrogen retention. The results showed that the use of concentrate ration or complete feed containing soybean pod did not affect protozoa population, ammonia concentration and total VFA production compared to cattle fed 100% native grass. In contrast, the use of concentrate ration or complete feed containing soybean pod reduced acetate and increased butyrate proportion compared to cattle fed grass only. The use of concentrate ration resulting the highest propionate proportion. Methane estimation increased with the use of concentrate ration or complete feed containing soybean pod 15%, but decreased at the level of 30%. Soybean waste was very potential and could be used as complete feed in beef cattle ration to replace concentrate.

Keywords : Rumen Fermentation, Nutrient digestibility, Nitrogen Retention, Madura Cattle, Soybean Pod

**ABSTRAK**

Penelitian ini bertujuan untuk mengkaji pengaruh ransum komplit mengandung kulit polong kedelai pada populasi mikroba rumen, karakteristik fermentasi, kecernaan nutrien, retensi dan nitrogen. Penelitian menggunakan 12 ekor sapi Madura umur 1,5 tahun dengan bobot badan awal..... Rancangan yang diguankan adalah rancangan acak kelompok dengan 3 perlakuan pakan dan setiap perlakuan terdiri atas 4 kelompok sebagai ulangan. Perlakuan yang digunakan antara lain T0(100% rumput lapang), T2 (konsentrat:hijauan=60:40), T3 (ransum komplit mengandung kulit polong kedelai 15%) dan T4 (ransum komplit mengandung kulit polong kedelai 30%). Perlakuan yang digunakan berbasis pada pakan yang biasa digunakan oleh peternak rakyat. Peubah yang diamati adalah populasi mikroba rumen, karakteristik fermentasi, kecernaan nutrien, retensi dan nitrogen. Hasil penelitian menunjukkan bahwa ransum komplit mengandung kulit polong kedelai 15% dan 30% tidak mempengaruhi populasi protozoa, konsentrasi amonia dan produksi VFA total dibandingkan dengan ternak yang mendapat ransum 100% rumput lapang. Sebaliknya, penggunaan ransum konsentrat atau ransum komplit mengandung kulit polong kedelai mampu menurunkan proporsi asetat dan meningkatkan proporsi butirat dibandingkan ternak yang mendapat rumput lapang saja. Penggunaan ransum konsentrat menghasilkan proporsi propionat yang paling tinggi. Estimasi metan meningkat dengan penggunaan ransum konsentrat atau ransum komplit mengandung kulit polong kedelai 15%, namun menurun pada level kulit polong kedelai 30%. Dapat disimpulkan bahwa kulit polong kedelai sangat berpotensi dan dapat digunakan sebagai ransum komplit pada ternak sapi pedaging menggantikan konsentrat.

Kata kunci : Fermentasi rumen, kecernaan nutrien, retensi nitrogen, sapi madura, kulit polong kedelai

**INTRODUCTION**

Beef cattle is one of the potent livestock in Indonesia which need to be improved both in numbers and productivity to meet the meat requirement by the population for meat. The main problem behind such low productivity of beef cattle held by farmers in the villages, would be the less sufficiency of feed resources including low quality of feed nutrients available for the animal, especially the deficiency of protein/nitrogen and low feed intake. There were some strategies required to improve productivity of beef cattle, through the provision of sufficient feed stuffs as the main source of protein, among others is from soybean meals and soybean wastes. Soybean meals contained high crude protein of 44% with a balanced amino acids (McDonald, 2002).

Nowadays, the requirement of soybean meal as animal feed was fulfilled by import around 70%, while, Indonesia has very large and potential land available for producing self sufficiency in soybean production to meet the demand of the human population as well as livestock. Soybean may adapt to a variety of land types including marginal land by using applied technology for land quality improvement.

Integration between beef cattle and soybean may become one of the alternative solutions to increase beef cattle production and also to improve feed efficiency. Several studies have been carried out to evaluate the use of soybean meal as feed resources to improve beef cattle production. Kennedy (2012) reported that the use of 15% soybean meal in the sheep ration combined with corn cob increased average daily gain of sheep.

 This research was aimed to evaluate the effect of complete feed containing soybean pod on rumen microbe population, fermentation characteristic and production performance of Madura cattle.

**MATERIALS AND METHODS**

**Animal and Treatment**

Twelve Madura beef cattle of 1.5 years of age were used in this study, given 3 feeding treatments with 4animal per treatment. The treatments include T0 (100% native grass), T1 (concentrate : grass (60:40), T2 (complete feed containing 15% soybean pods) and T3 (complete feed containing 30% soybean pods). The treatments are based on feeding practices commonly applied by farmers in the village. Parameter measured were: 1) soybean waste production and nutrient quality; 2) average daily gain of beef cattle; 3) feed consumption based on dry matter; 4) feed efficiency; 5) rumen microbe; and 7) fermentation characteristics in rumen.

**Cattle Preparation**

Before starting the experiment, preparation was made on feed and drinking facilities, beef cattle and fodder. This study used 12 heads of Madura male cattle. These cattle were obtained by collaboration with small holding farmers around the IPB campus. The local cattle were weighed to obtained initial liveweight, then grouped based on initial liveweight in order to minimize animal variation between treatments.

**Animal Diet**

The rations were formulated from forage (grass) and soybean waste. Soybean waste were obtained from farmers at Grobogan, Central Java.. As positive control, there were three cattle fed by concentrate ration consisting of cassava waste, pollard, soybean meal, molasses (tetes), CACO3, urea and premix. These feedstuffs were formulated to fulfill animal nutrient requirement as suggested by Kearl (1982), which contained 14% crude protein and 68-70% total digestible nutrient (TDN). The nutrient composition of soybean pods was presented in Table 1 and ration formulation for all treatments was presented in Table 2.

**RESULTS**

**Microbe Population, Fermentation Characteristics and Methane Estimation**

 The use of concentrate ration or complete feed containing soybean pod did not affect protozoa population, bacteria population, ammonia concentration and total VFA production compare to the control treatment. In contrast, the use of concentrate ration or complete feed containing soybean pod reduced acetate and increased butyrate proportion compare to the control treatment. The use of concentrate ration resulting the highest propionate proportion. Methane estimation increased with the use of concentrate ration or complete feed containing soybean pod 15%, but decreased with the use complete feed containing soybean pod 30% (Table 3).

 **Nutrient Digestibility**

The used of soybean pod up to 30% in the complete feed significant increased (P<0.05) dry matter, crude protein, ether extract and nitrogen free-extract digestibility compared to the native grass or concentrate based ration. However, crude fiber digestibility similar among treatments (Table 4).

**Nitrogen Retention**

The use of soybean pod at level 15% significantly increased (P<0,05) N intake, N Digestible, and N retention. Furthermore, the use of soybean pod at the hihger level (30%) decreased the N intake, N digestible and N retention compared to the lower level (15%). However, the use of soybean pod still have better N retention compare to the ration with 100% grass or concentrate based ration (Table 5).

**DISCUSSION**

Protozoa population was not affected by soybean pod due to none or less antiprotozoa compound in the soybean pod such as saponin. In rumen, protozoa had roles in feed degradation. The use of complete feed containing soybean pod up to 30% did not alter the growth of rumen bacteria. This result revealed that there was no secondary compound in the soybean pod which may harm the rumen bacteria. In addition, the high lignin content in soybean pod did not influence bacteria population. As we realised that rumen microbe (protozoa and bacteria) have important role in the feed degradation and fermentation (Wang and McAllister, 2002)

Ammonia concentration tended to increase with the use of complete feed containing soybean pod, indicating that improvement of protein degradation produced ammonia. Ammonia is a precursor for microbial protein synthesis, the increasing of ammonia concentration could increase microbial protein synthesis.

Total VFA production tended to increase with the use of concentrate ration or complete feed containing soybean pod 15%, but decreased on the level of 30%. This result indicating that soybean pod at high level (30%) might decrease rumen degradation and fermentation due to lignin content. Lignin is a compound which is difficult to be digested by rumen microbe. Therefore, the use of soybean pod at high level could reduce total VFA production.Acetate proportion decreased with the use of complete feed containing soybean pod. However, propionate proportion increased with the use concentrate ration. In contrast, butirate proportion increased with the use of the complete feed containing soybean pod. This result indicating that concentrate ration contained more fermentable carbohydrate could increase propionate proportion. Conversely, complete feed containing soybean pod rich of fiber compound and resulted in less propionate proportion than concentrate ration.

 Methane estimation tended to increase with the use of concentrate ration or complete feed containing soybean pod 15%, but decreased at the level of 30%. The increasing or decreasing of methane estimation in line with the increasing or decreasing of total VFA production, since methane is normally produced during rumen fermentation.

The increase of nutrient digestibility of cattle fed soybean pod in the complete feed due to the improvement of feed degradation by rumen microbe. Despite the high content of lignin (12%), fiber degradation was not decreased, because lignin could not be digested by rumen bacteria. Lignin became a physical barrier for the microbial enzymes to reach polysaccarides of the feed (Kenneth and Jung, 2001). Mahes and Mohini (2013) sugested that the crop residue was lignocellulosic because of such high content of cellulose bounded with lignin, and rumen microbe could not break this bond efficiently. In contrast, lignin content of soybean pod did not alter the activity of rumen microbe in cellulose degradation and increased nutrient digestibility. This result indicating that rumen microbe capable to breakdown the bound between lignin and cellulose in the feed.

Nitrogen retention indicating the level of protein utilization by cattle. The use of soybean pod in the complete feed could increased N intake, N digestible and N retention up to 70% from N intake. This result showed that utilization of feed protein have improved. Kohn et al., (2005) sugested that ruminant ussualy has low N utilization efficiency of around 15-40%.

The use of complete feed containing soybean pod 15% or 30% significantly increased feed intake by cattle compared to those fed concentrate and control treatments and significantly increased feed effiency, final body weight, and average daily gain of Madura beef cattle compared to those fed grass only (Fuah et el., 2016). The increased feed intake by cattle fed complete feed containing soybean pod up to 30% revealed that soybean pod had high palatibility as beef cattle feedstuff despite the dry texture. The improved feed intake could increase feed efficiency, body weight gain and average daily gain of Madura beef cattle given complete feed containing soybean pod or given concentrate ration.This result indicate that complete feed containing soybean pod could improve the performans of Madura beef cattle as good as concentrate ration. Soybean pod is an agricultural waste which are potential as an alternative feed resources to replace concentrate for beef cattle.

**CONCLUSION**

The use of complete feed containing soybean pod 15% or 30% increased feed intake f Madura cattle compared to the concentrate and cattle fed 100% grass as control. The use of concentrate ration and complete feed containing soybean pod 15% or 30%, increased feed effiency, final body weight, and average daily gain of Madura beef cattle compare to the control treatment. The use of concentrate ration or complete feed containing soybean pod did not affect protozoa population, ammonia concentration and total VFA production, except of cattle fed control feed. In contrast, the proportion of butyrate increased and acetate reduced. Whereas, the use of concentrate ration resulted in the highest propionate proportion. Methane estimation increased with the use of concentrate ration or complete feed containing soybean pod 15%, but decreased at the level of 30%. Complete feed containing soybean pod could improve the performans of Madura beef cattle as good as concentrate ration. Soybean pod as agricultural by-products could be utilised by critical dry seasons of the year.

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Table 1. Nutrient composition of soybean pod (dry matter basis)

|  |  |
| --- | --- |
| Nutrient | (%) |
| Dry matter¹ | 93.7 |
| Ash¹ | 5.1 |
| Ether Extract¹ | 2.5 |
| Crude Protein¹ | 5.5 |
| Crude Fiber¹ | 35.4 |
| Nitrogen Free Extract¹ | 51.5 |
| Hemicellulosa² | 19.4 |
| Cellulosa² | 38.5 |
| Lignin² | 12.9 |

Note: 1 Analysed by Pusat Studi Ilmu Hayat dan Bioteknologi, Bogor Agricultural University, Indonesia; 2 Analysed by Livestock research Centre, Ciawi, Bogor, West Java, Indonesia

Table 2. Ration Formulation of all Feeding Treatments

|  |  |
| --- | --- |
| Ingredient | Treatments |
| T0 | T1 | T2 | T3 |
| % |
| Native Grass | 100 | **40** | - | - |
| Cassava waste meal | - | 21.0 | 20.0 | 14.0 |
| Pollard  | - | 18.0 | 17.0 | 18.0 |
| Soybean Meal | - | 8.5 | 5.0 | 10.0 |
| Coconut cake meal | - | 5.0 | 0.0 | 0.0 |
| Molasses | - | 5.0 | 15.0 | 15.0 |
| CaCO3 | - | 1.0 | 1.5 | 1.5 |
| Urea | - | 1.0 | 1.0 | 1.0 |
| Premix | - | 0.5 | 0.5 | 0.5 |
| Tofu Waste | - | - | **25** | **10** |
| Soybean Pod | - | - | **15** | **30** |
| Nutrient Composition | % |
| Dry Matter (DM) | 17.6 | 59.1 | 67.1 | 80.1 |
| Ash  | 12.0 | 7.8 | 5.0 | 5.5 |
| Crude Protein (CP) | 9.8 | **15.3** | **15.2** | **15.0** |
| Ether Extract (EE) | 1.1 | 3.8 | 2.9 | 3.9 |
| Crude Fiber (CF) | 31.9 | 19.2 | 17.1 | 19.4 |
| Nitrogen Free Extract (NFE) | 45.2 | 54.3 | 59.6 | 56.1 |
| *Total digestible nutrient* (TDN) | 48.4 | **68.5** | **68.3** | **68.2** |

T0 = 100% native grass), T2 = concentrate : grass (60:40), 3. T3 = complete feed containing 15% soybean pods, 4. T4 = complete feed containing 30% soybean pods.

Table 3. Concentration of NH3, Volatile Fatty Acid , Bacteria and Protozoa Numbers of Madura Cattle Fed with Complete Ration Containing Soybean Pod

|  |  |
| --- | --- |
| Variabel | Treatments |
| T0 | T1 | T2 | T3 |
| Protozoa (log 10 /ml) | 6.6 ± 0.8 | 6.1 ± 0.6 | 6.2 ± 0.3 | 6.5 ± 0.4 |
| Bacteria Population(log 10 CFU /ml) | 9.8 ± 0.0 | 9.8 ± 0.2 | 9.8 ± 0.1 | 9.9 ± 0.2 |
| NH3 | 3.500±1.47 | 3.460±0.45 | 7.503± 4.01 | 5.970± 1.93 |
| Total VFA | 61.6 ± 13.2 | 72.8 ± 15.0 | 72.6 ± 9.7 | 54.4 ± 6.5 |
| Proportional VFA (mM/100mM) |  |  |  |  |
| * Acetate
 | 72.58±0.79  | 65.27±1.96 | 67.83±3.00 | 68.62±0.57 |
| * Propionate
 | 15.95±0.32 | 17.89±3.19 | 13.95±1.81 | 13.35±1.10 |
| * Butirate
 | 9.51±0.41 | 15.37±1.09 | 15.48±1.92 | 15.41±0.84 |
| Valerate | 1.96±0.09 | 1.47±0.13 | 2.74±0.59 | 2.63±0.35 |
| Methane Estimation\* | 19.78±3.63 | 22.11±1.88 | 23.81±1.95 | 17.46±1.65 |

\*Moss et al. (2000). T0 = 100% native grass), T2 = concentrate : grass (60:40), 3. T3 = complete feed containing 15% soybean pods, 4. T4 = complete feed containing 30% soybean pods

Table 4. Nutrient Digestibility of Madura Cattle Fed Complete Ration Containing Soybean Pod

|  |  |
| --- | --- |
| Variables | Treatments |
| T0 | T1 | T2 | T3 |
| Nutrient Digestibility (%) |
| Dry matter (DM) |  64.6 ± 2.9c | 77.6 ± 0.1b | 83.0 ± 3.5a |  83.6 ± 2.8 a |
| Crude Protein (CP) |  7 4.5 ± 1.6 c | 84.7 ± 1.3b | 89.4 ± 1.1a | 87.0 ± 1.5ab |
| Ether Extract (EE) | 61.0 ± 15.5b | 88.6 ± 0.5a | 86.0 ± 5.5a |  88.8 ± 1.3 a |
| Crude Fiber (CF) |  70.9 ± 1.3 |  71.6 ± 5.5  |  70.0 ± 7.4  |  74.3 ± 6.7  |
| Nitrogen Free Extract (NFE) | 60.0 ± 5.1c | 78.4 ± 4.5b | 86.8 ± 2.5a |  88.1 ± 2.0 a |

Note: T0 = 100% native grass), T2 = concentrate : grass (60:40), 3. T3 = complete feed containing 15% soybean pods, 4. T4 = complete feed containing 30% soybean pods

; Supperscript in the same row indicating significant different (P<0.05).

Table 5. Nitrogen Retention of Madura Cattle Fed Complete Ration Containing Soybean Pod

|  |  |
| --- | --- |
| Variable | Treatments |
| T0 | T1 | T2 | T3 |
| N intake (g) | 88.0 ± 6.9b | 105.4 ± 4.0b |  207.5 ± 20.7 a | 126.7 ± 11.1 b |
| N Feces (g) | 22.0 ± 0.4  |  16.1 ± 2.1 | 22.2 ± 4.0  |  16.6 ± 3.2  |
| N Digestible (g) |  66.0 ± 6.6 |  89.3 ± 2.0 |  185.3 ± 17.1 | 110.1 ± 8.2 |
| N Urin (g) | 28.9 ± 0.8b |  54.6 ± 2.7a |  38.1 ± 4.1ab |  46.1 ± 10.4ab |
| N Retention (g) | 37.1 ± 7.4b |  34.7 ± 0.7b | 147.2 ± 21.0 a |  64.0 ± 12.3 b |
| N Retention from N intake (%) | 41.9 ± 5.1 | 32.9 ± 1.9 | 70.7 ± 3.5 | 50.5 ± 8.6 |
| N Retention from N Digestible (%) | 55.9 ± 5.7 | 38.8 ± 1.6 | 79.2 ± 4.3 | 58.0 ± 9.4 |

Note: T0 = 100% native grass), T2 = concentrate : grass (60:40), 3. T3 = complete feed containing 15% soybean pods, 4. T4 = complete feed containing 30% soybean pods

; Supperscript in the same row indicating significant different (P<0.05).

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