The Weight Gain and Growth of Crossbred Bulls Fed Locally Inspired Supplements Compared with Current Feeding Systems in Village Smallholdings in Malang, East Java

D Setiadi¹, Kusmartono², Kasmiyati³, Mashudi², A Z Zakariya³, K J Harper⁴ and D P Poppi⁴

¹Graduate student at Faculty of Animal Science, University of Brawijaya, Jl. Veteran, Malang 65145, Indonesia
²Faculty of Animal Science, University of Brawijaya, Jl. Veteran, Malang 65145, Indonesia
³Assessment Institute for Agricultural Technology (BPTP) East Java, Jl. Raya Karangploso Km. 4, Malang 65152, Indonesia
⁴School of Agriculture and Food Sciences, University of Queensland, Gatton, Queensland, Australia

Abstract. Growth rates of cattle in village smallholder farms are often low (0.2-0.5 kg/d) due to the ration formulation not meeting the nutrient requirements for cattle to achieve their potential live weight gain. This experiment aims to determine the growth of crossbred bulls fed a range of supplemented diets using local products comparing them to current traditional feeding system. This village was conducted in Kucur village, Dau sub-district, Malang. Fifty cross bred aged between 1.5-2 years were allocated into five treatments; cassava-based diet by recent ACIAR-UB experiment (T1), commercial concentrate (T2), YaYa diet (T3), Santos diet (T4) and current feeding system (CFS) by smallholder farmers (T0) as the control. Cassava-based diet (T1) consisted of 50% cassava, 25% copra meal (CM) and 25% palm kernel cake (PKC). Local concentrate (T2) was bought from local cooperative in Malang. Yaya diet (T2) consisted of 30% cassava, 20% corn cob, 20% copra meal, 20% palm kernel cake and 10% rice bran. Santos diet (T4) consisted of 40% corn cob, 20% palm kernel cake 20% rice bran, and 20% wheat pollard. Control treatment (T0) was 1 kg wheat pollard a day which was the general current feeding system by local smallholders. The experiment found that cassava-based diet (T1) supplementation showed the highest body growth compared to the other diets.

1. Introduction

The Indonesian government has placed a high priority on self-sufficiency in beef production where domestic beef supply is currently unable to meet consumer demand. More than 90% of beef cattle production is derived from village smallholder farmers, and East Java is the area with the biggest contributor [1]. The smallholder cattle management is still traditional and characterized by only 2-4 cattle per farmer and limited source of feed [2]. Growth rates of these village cattle are often lower than expected due to feeding system not meeting the nutrient requirement for cattle to achieve their
potential liveweight gain. Traditional diets usually cut and carry tropical grass and some crop by products. These diets are based to the cheapest valuable feed with no consideration of the quantity of feed [3]. This is mainly because there is a lack of understanding of the benefits of improved diets (i.e. increased growth rates and decreased cost weight gain), there is an aversion to risk and these are no tools for formulating a simple diet based on nutritional principles. The lower growth rates affected bull’s prices and farmers income. Supplementing a high-quality concentrate could improve smallholder farmers in two ways: 1) a single bull will have a heavier sale weight in the given fattening period (4-6 months), and 2) the bull will reach a specified weight faster, and could fatten more bulls each year [4].

A cassava-based supplement could be implemented in the community of smallholder farmers because the availability of cassava is easy, inexpensive and abundant [5]. The addition of easily obtained protein sources, such as copra meal (CM) and palm kernel cake (PKC) could also increase the nutritive value, especially since they are more affordable than the other protein sources (i.e. soybean meal). Concentrate with 50% proportion of cassava, could enhance the Ongole crossbred bull’s average daily gain (ADG) into 1.09 kg/head/day [6]. On-site research conducted by Universitas Brawijaya (UB) and Australian Centre of International Agricultural Research (ACIAR) in 2018, showed that cassava-based diets (mixture of cassava, CM, and PKC) could enhance ADG of Limousine-Ongole crossbred to more than 1 kg/head/day.

Kucur village, community of smallholder farmers, is an area with lot of cattle and the potential to improve their income through cattle. There is a large range of high energy food processing wastes that could be incorporated into cattle diets but there are limited data on the benefits of using the ingredients in cattle diets. This experiment intends to examine the weight gain of village crossbred bulls fed combinations of formulated cassava-based supplements, other supplement locally accessible and compare it to traditional feeding systems.

2. Materials and methods

2.1. Location and time

The field experiment was conducted in individual smallholder farms in Kucur Village, Dau sub-district, Malang district, East Java. The village experiment consisted of 3 weeks (21 days) adaption and 12 weeks (85 days) experimental period. The experiment was conducted from January until May 2019.

2.2. Animals

The total of 50 growing crossbred bulls were used in the experiment. The young bulls on arrival were approximately 18-24 month of age and ranged 250-300 Kg in live weight. The cattle were owned by smallholder farmers in the Kucur village.

2.3. Treatments

The site was randomly allocated into five treatment groups. Each group consists of 10 bulls as replicates. Each treatment was allocated randomly. If a farmer had two or more bulls, only one bull per farmer was allocated to the same treatment to avoid a mix up in the feeding. Bulls were separated from other animals on each farm. The dietary treatments was:

1. $T_0$: currently feeding system (CFS) + 1 kg of wheat pollard (A) as control
2. $T_1$: CFS + 2% W/d of cassava-based diet by UB-ACIAR (B)
3. $T_2$: CFS + 2% W/d of commercial concentrate (C)
4. $T_3$: CFS + 2% W/d of Yaya Best diet (D)
5. $T_4$: CFS + 2% W/d Santos diet (E)

The current feeding system (CFS) is the common feed provided by farmers in the area. The feeds consist of native grass, rice straw, corn stover, and other green materials available around the village (Table 1). The CFS was offered ad libitum. UB best diet is cassava-based diet based on-site research
between UB-ACIAR in 2018 that had been proved to enhance the ADG by over 1 kg/head/day of Limousin-Ongole crossbred bull. The commercial concentrate is from the local cooperative in Malang (JabFeed Sapot), and is available for farmers in Malang. Yaya best diet is a diet formulated by Pak Yaya from BPTP Balitbangtan East Java for cattle. Santos diet is a diet originating from a neighbouring village feedlot. The feedstuffs compositions and feed nutrients are showed in Table 2 and 3. Feed ingredients were provided periodically every 2 weeks. The feed mixing and packaging process were carried out together with farmers every week. After packed, each packaged was labelled differently according to the concentrate formulation. Feeding frequencies was dependent on each farmer individually, but the daily amount offered appropriate for the bull’s body mass and fed ad libitum. Bulls were weighed every 3 weeks and feed offered was adjusted accordingly. Fresh water was offered ad libitum in a 15 L bucket.

**Table 1.** Forages type and frequency during experiment by farmers in Kucur Village

| Ingredients                        | Amount | Frequency |
|------------------------------------|--------|-----------|
| Kolonjono grass (*Panicum munitum*) | 263    | 42.9      |
| Field/teki grass (*Cyperus rotundus*) | 178    | 29.03     |
| Wedusan/babadan (*Ageratum conyzoides*) | 128    | 20.88     |
| Corn straw (*Zea mays*)           | 22     | 3.59      |
| Rice straw (*T sodiva*)            | 13     | 2.12      |
| Sugarcane leaves (*Saccharum officinarum*) | 6      | 0.98      |
| Mungbean peels (*Phaseolus radiatus*)  | 3      | 0.5       |
| Total                              | 613    | 100       |

**Table 2.** Composition of experimental diets (on DM basis)

| Ingredients                        | A      | B      | C      | D      | E      |
|------------------------------------|--------|--------|--------|--------|--------|
| Wheat Pollard                      | 100.00 | 0.00   | 0.00   | 0.00   | 0.00   |
| Cassava meal                       | 0.00   | 50.00  | 0.00   | 30.00  | 0.00   |
| Copra meal (CM)                    | 0.00   | 25.00  | 0.00   | 20.00  | 20.00  |
| Palm Kernel Cake (PKC)             | 0.00   | 25.00  | 0.00   | 20.00  | 20.00  |
| Local concentrate                  | 0.00   | 0.00   | 100.00 | 0.00   | 0.00   |
| Corn cob                           | 0.00   | 0.00   | 0.00   | 20.00  | 40.00  |
| Rice bran                          | 0.00   | 0.00   | 0.00   | 10.00  | 20.00  |
| Mineral mix                        | 0.00   | 0.00   | 0.00   | 0.00   | 2.00   |
| Salt                               | 0.00   | 0.00   | 0.00   | 2.00   | 0.00   |

**Table 3.** Feed nutrients content based on proximate analysis

| Parameters | Forages | Diets |
|------------|---------|-------|
|            | KG      | TG    | WS    | CS    | RS    | SL    | MP    | A     | B     | C     | D     | E     |
| DM (%)     | 26.08   | 26.48 | 27.81 | 26.04 | 49.39 | 24.53 | 36.54 | 89.45 | 88.15 | 90.78 | 89.35 | 89.97 |
| OM (%)*    | 21.7    | 23.34 | 22.42 | 24.99 | 36.85 | 20.38 | 34.92 | 84.62 | 78.63 | 81.51 | 80.28 | 81.24 |
| Ash (%)*   | 4.37    | 3.14  | 5.39  | 1.05  | 12.54 | 4.15  | 1.62  | 4.83  | 9.53  | 9.54  | 7.84  | 9.70  |
| CP (%)*    | 2.44    | 2.11  | 3.37  | 1.19  | 2.79  | 2.19  | 4.71  | 14.36 | 10.33 | 10.54 | 9.11  | 7.42  |
| CF (%)*    | 9.58    | 9.28  | 9.24  | 9.65  | 15.24 | 8.03  | 14.14 | 8.33  | 17.92 | 20.6  | 24.46 | 23.86 |
| EE (%)*    | 0.28    | 0.30  | 0.3   | 0.1   | 0.36  | 0.3   | 0.06  | 3.47  | 0.65  | 2.88  | 0.86  | 1.04  |

*) Base on DM basis
2.4. Measurements and analysis data

2.4.1. Feed nutrient intake
The feed intake was measured on last 7 days during experiment. Food intake was calculated by weighing the feed ingredients provided and the feeds residue of the morning the next day. Nutrient intake results were obtained by multiplying feed consumption by the nutrient contents (DM, OM, and CP) of each of the feed ingredients.

2.4.2. Live weight gain and average daily gain
Liveweight gain was measured by weighing the bull every three weeks. The weight was recorded based on empty weight condition whereby bulls did not have access to water or feed from 22:00 h the night before up until the completion of weighing. Scales were calibrated at each weighing. Average daily gain was measured by dividing total live weight gain over the experimental period of 85 days.

2.4.3. Body dimension
The body dimension parameters include the height at withers, chest girth, and hip height. These parameters were measured at the commencement and at the completion of the experiment.

2.4.4. Feed conversion ratio
Feed conversion ratio is the amount of feed required to produce one kilogram of weight gain [7]. Feed conversion ratio is measured by dividing the amount of daily consumption by daily body weight gain.

2.4.5. Data analysis
The data was analysed statistically by one way analysis of variances (ANOVA) using Microsoft Excel.

3. Result and discussions

3.1. Feed Nutrient Intake
Feed nutrient intake results of the study are shown in Table 4. Dry matter intake as a function of body weight percentage showed insignificant difference (p>0.05) between treatments. Likewise, nutrient consumption of organic matter and crude protein as a function of body weight showed no significant difference (p>0,05) between treatments.

The daily nutrient consumption between treatments were not significantly different (p> 0.05) on all parameters (DM, OM and CP). These results establish that the nutrients consumed (DM, OM, and CP) in each treatment group were relatively even, however, the nutrient intake in T3 was lower. The relatively high variation between animals in each treatment may have accounted for this lack of statistical significance between treatments with regard to intake. A high intake variation is expected in village trials for there is farmer to farmer feeding differences (frequency of feeding) and the different motivations of each farmer during the course of the experiment. In these trials, farmers tend to compete with other farmers in the other groups to reach the highest live weight gain. In these cases, farmers may offer more or different feed which may influence intake. Other factors also influence the consumption of ruminant animal feed such as external factors (environment), internal factors (condition of livestock) [8].
**Table 4.** Feed nutrient intake of treatments

| Parameters          | Treatments |
|---------------------|------------|
| kg/head/day         |            |
| DM                  | T0: 9.08±6.26  | T1: 8.15±2.23  | T2: 8.95±4.70  | T3: 6.42±1.03  | T4: 8.78±3.87  |
| OM                  | T0: 7.73±4.80  | T1: 7.49±1.97  | T2: 7.86±3.36  | T3: 6.06±0.95  | T4: 7.77±2.92  |
| CP                  | T0: 0.82±0.39  | T1: 0.88±0.19  | T2: 0.85±0.27  | T3: 0.68±0.09  | T4: 0.79±0.26  |
| gr/kg/BW$^{0.75}$/day |            |
| DM                  | T0: 111.50±73.03 | T1: 93.42±27.74 | T2: 116.31±76.34 | T3: 75.99±9.70 | T4: 107.36±43.51 |
| OM                  | T0: 95.16±56.80 | T1: 85.82±24.37 | T2: 101.59±56.10 | T3: 71.65±8.08 | T4: 95.13±32.87 |
| CP                  | T0: 10.02±4.59  | T1: 10.06±2.45  | T2: 10.88±4.59  | T3: 8.05±1.15  | T4: 9.69±2.98  |

Data were presented in average ± SD.

3.2. **Body growth**

![Figure 1](https://example.com/image1.png)

*Figure 1. Average live weight gain per week during experiment*

The live weight gain and average daily gain showed insignificant differences (p> 0.05). Although not significantly different, the T1 treatment group (a cassava based diet) showed a better average live weight gain and average daily gain compared to the other treatment groups as shown in Figure 1. The average body weight gain and daily body weight gain of the T1 treatment group was 91.42 ± 21.37 kg and 1.08 ± 0.25 kg / day (Table 5), respectively. The results of this daily body weight gain are comparable to the research of [6] that using concentrates contained 50% cassava, and a body weight gain of 1,090 kg / head / day.

**Table 5.** Body growth and feed conversion ratio of smallholder cattle

| Parameters       | Treatments |
|------------------|------------|
| Liveweight gain (kg) | T0: 70.20±29   | T1: 91.42±21.37 | T2: 73.70±18.15 | T3: 72.35±22.77 | T4: 66.10±13.56 |
| Average daily gain | 0.84±0.34    | 1.08±0.25      | 0.87±0.21       | 0.85±0.27       | 0.78±0.16       |
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3.3. Body dimension
The change of body dimensions (withers, girth, and hip height) showed insignificant differences (p>0.05) between treatments. Although statistically insignificant, the T1 treatment group increased their body dimensions to a greater extent than other treatment groups (Table 4). The growth of height wither, girth and hip height in the T1 treatment were 6.70 ± 4.06, 20.30 ± 4.85, and 7.60 ± 2.32, respectively.

3.4. Feed conversion ratio
Feed conversion ratio (FCR) shows insignificant differences (p>0.05). The T0 treatment group had the highest average feed conversion ratio, which was 13.35 ± 11, while the lowest average feed conversion ratio was shown in the T3 treatment group, which was 8.01 ± 2.01 (Table 4). Although the average FCR value in the T3 treatment group had the lowest result, this value did not show a better results of liveweight gain, average daily gain and body growth. At the same time, the T1 treatment group with an average FCR value (8.33 ± 4.43) comparable to the FCR value of T3 treatment group, showed a better result in liveweight gain, average daily gain and body growth (Table 4). The lower value of the T1 group shows better feed conversion and efficiency to increase body weight [8, 9].

4. Conclusion
The cattle belonging to the T1 treatment group had the best body growth, weight gain and FCR value. which showed more efficient results compared to other treatment groups. Rather than having traditional diets based on the cheapest ingredients available, a combination of cost-effective and feed efficient diets should be considered. Smallholder farmers generally have a lack of understanding of the benefits of improved diets (i.e. increased growth rates and decreased cost/weight gain), ThOuris research shows that there are substantial benefits to using cassava based supplements. There is therefore a need to customise diets for different regions in Indonesia as each region has a different range of feed resources – both on farm and purchased feeds.

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References
[1] Priyanti A, Hanifah V W, Mahendri I G A P, Cahyadi F and Cramb R A 2012 Small-scale beef cattle production in East Java Indonesia Proceeding of Australia Agricultural Research Economy and Social pp 1-22
[2] Agus A and Widi T S M 2018 Asian-Australas J. Anim. Sci. 31 24023
[3] Handayanta E, Ifar S, Hartutik H, and Kusmartono K 2014 J. Bio. Agr. Healthcare 4 11214
[4] Ratnawati D, Cowley F, Mayberry D, Pamunkas D and Poppi D P 2015 JITV 20 1115
[5] Antari R and Umiyashi 2009 WARTAZOA 19 924
[6] Rianto E M, Wulandari and Adwinarti R 2007 The utilization of protein to PO and FH bulls that offered elephant grass (Pennisetum purpureum), tofu waste, and cassava Proceeding of Livestock and Veterinar Technology Seminar pp 64-70
[7] Boatiey A, Goddard E, Mohapatra S and Crowley J 2017 J. Sus. Agr 6 65223
[8] Lunn D 2006 Improving Feed Efficiency in Feedlot Cattle (Canada: Shur-Gain, Nutreco Canada Inc.) pp 1-8
[9] Shike D W 2013 Beef cattle feed efficiency *Proceedings of the Driftless Region Beef Conference* pp 3-4