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by Muhamad Bata

Nutrient digestibility, intake rate, and performance of Indonesian native cattle breeds fed rice straw ammoniation and concentrate

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Abstract. Native beef cattle breeds in Indonesia such as Bali Timor (BT), Bali Flores (BF), Madura (M), and Sumba Ongole (SO) come from different regions with different types of feed because of the different environmental ecosystems. This situation results in native cattle breeds having different microbial compositions and functions. The purpose of this study was to find native cattle breeds fed ammoniated rice straw and concentrate having the highest productivity and feed efficiency. The material used was four native beef cattle breeds with a weight of 210-250 kg and age of 3.5-3.7 years. There were ten for each native cattle and they were fed concentrate and ammoniated rice straw. The amount of concentrate fed was [illegible] of body weight, while ammoniated rice straw was prepared ad libitum. Randomized Block Design with an initial body weight of cattle as a group was used in this research. Covariance analysis showed that the breed of native cattle had a significant effect (P < 0.05) on average daily gain (ADG), feed conversion ratio (FCR), feed efficiency (FE), digestibility of dry matter (DMD), organic matter (OMD), neutral detergent fiber (DNDF), acid detergent fiber (DADF) and gross energy (DGE). BF cattle were higher (P <0.05) in nutrient digestibility compared to the other three local cattle breeds and among the three breeds had relatively similar (P > 0.05). In contrast to nutrient digestibility, ADG of SO and M cattle were higher (P < 0.05) followed by BF and BT cattle, respectively. The FC of BT and BF cattle were similar (P > 0.05), but it was high (P < 0.05) compared to M and SO cattle. The conclusion is SO and M cattle have good ability when fattened using ammoniated rice straw and concentrate.

1. Introduction

Nowadays there are many livestock businesses which fatten various nations of beef cattle, both imported and local cattle. In general, beef cattle fattening companies use imported feeder cattle more than local feeder cattle. This is due to the difficulty of providing adequate local feeders and the average daily body weight gain is still low. However, local cattle have the advantage of high adaptability to the tropical environment and disease resistance.

Various native cattle breeds such as Bali Flores (BF), Bali Timor (BT), Madura (M), and Sumba Ongole (SO) cattle have been developed in various regions with varying climatic and feed conditions. Flores Island is a fertile area so that the BF cattle reared on this island are fed from different kinds of fresh forage. While BT cattle kept on the island of Timor, which is a dry plains area, are herded on natural pastures, accustomed to being fed dry grass and they also used Leucaena

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leococephala leaves as a protein supplement. Sumba Ongole (SO) cattle reared and lived in the savanna grasslands of Sumba Island, so that is the main feed various types of grass in the natural field. Madura cattle are raised by smallholder farmers with a semi-intensive system by providing feed in the form of rice straw and concentrate. Multiple factors, including geographic location, breed, sex, and diet were identified to drive the variation of rumen microbiota among animals [1],[2]. Paz et al.[3]reported that there are differences in the composition of rumen microbiota were detected between Holstein and Jersey dairy cows fed the same diet. Through omics-based approaches, recent studies have found that various in rumen microbiota are related to cattle production and health traits, such as feed efficiency [4],[5] and methane (CH4) yield [6].

Rice straw is the main source of fibrous feed for fattening cattle on the island of Java. However, rice straw has a low nutritive value indicated highly lignified material. The high level of lignification and silicification, the slow and limited ruminal degradation of the carbohydrates, and the low content of nitrogen are the main deficiencies of rice straw, affecting its value as feed for ruminants [7]. For improving quality, rice straws are treated with urea or calcium hydroxide or by supplementing rice straw with protein result increasing intake and degradability, compared to feeding untreated rice straw alone [8]. The use of ammoniated rice straw using urea ensiled with fermentable carbohydrate sources such as cassava pulp and supplemented with concentrates can optimize the function of the rumen as indicated by increased rumen fermentation products [9],[10], digestibility and nutrient balance, and increased growth of local cattle of Ongole Crossbred Cattle from Java Island [11]. However, there is no information or limited data for native cattle in other islands as described before such as BF, BT, M and SO cattle for fattening using rice straw ammoniation and concentrate. The objective of this study was to find the native cattle that have a good ability to adapt to the diets containing rice straw ammoniation and concentrate for fattening indicated the highest of performance such as average daily gain and feed efficiency.

2. Materials and methods

2.1. Animal, diets, and experimental design

Four native cattle breeds such as BF, BT, M and SO with an average weight of 210 -250 kg (3,5 – 3,7 years old) were used in this research. They were purchased from Flores Island, Timor Island, Madura Island, and Sumba Island for BF, BT, M dan SO, respectively. The animals were transported to the Animal House of Sapi Amanah Farm, Purwokerto, Central Java Province, Java Island, where they were housed in individual pens. They were grouped to become 10 groups according to initial body weight and were given worm drugs. The experimental design was the Randomized Block Design with native cattle breeds as treatments. The animals were allocated to receive the same diets consisting of ammoniated rice straw and concentrate. The nutrient content of concentrate and ammoniated rice straw were listed in Table 1. Composition of Concentrate were 47.60% cassava pulp, 24.00% pollard bran, 10,00% rice bran, 5.70% coconut meal, 7.00% soybean meal, 10,50% palm kernel meal, 0.60% Urea, 1.6% dolomite, 0.30% mineral mix, 1.0% salt and 4.00% molasses. Rice straw ammoniation used urea ensiled cassava pulp according to the procedure developed by [11]. In brief, the ammoniation procedure was as follows. Doses of urea and cassava pulp respectively 4 and 8 percent of the total dry rice straw. Urea was dissolved in water at a concentration of 10% and added cassava pulp. The mixture was stirred evenly and sprayed to rice straw stacked as thick as 40 cm. The process was repeated until the stack height was 2 m and closed for 21 days. Concentrates were offered to the animals two times a day at 07.00 and 14.00, while ammoniated rice straw was prepared adlibitum to the animals.

The experiment consisted of 7 d for house adaptation, 14 d dietary adaptation, 7 d sample collection, and 90 d for feeding trial. At the house adaptation, the animals were weighed before the morning feed (06:00 h) to determine the amount of diets were fed for dietary adaptation and data collection. After data collection, all of the animals were weighed to have initial body weight for the feeding trial. Animals were weighed for each month during the feeding trial.

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Table 1. Nutrient Composition of concentrate and ammoniated rice straw.

Feed	DM (%)	% DM						GE (MJ)
		CP	CF	Ash	NFE	ADF	NDF	
Concentrate	83.39	15.13	26.63	72.60	56.01	26.31	55.69	3.3054
Ammoniated Rice straw	40.72	6.17	37.94	15.73	66.65	51.00	59.51	3.5964

DM, dry matter; CP, crude protein; EE, ether extract; CF, crude fiber; NFE, nitrogen free extract; ADF, acids detergent fiber; NDF, nitrogen detergent fiber; GE, gross energy

2.2. Whole tract in vivo digestibility measurements
The whole tract in vivo digestibility was determined by collecting all the faeces, feed, and refused from days 15-21 of the sample collection period. Faecal, feed, and refused feed samples were dried for three days in an oven at a temperature of 650 C prior to analysis for DM, ash, N, GE, ADF, and NDF content. All samples collected were composited according to days of collection.

2.3. Analytical method
The DM, ash, and N content of the feed, refused feed and faecal samples were determined according to AOAC [12]. The OM was calculated by subtracting the ash from the DM content. NDF and ADF were analysed according to Van Soest et al. [13]. Gross energy (GE) was determined by using an Auto Bomb Calorimeter LECO model AC-350 (Corporation, USA)

2.4. Digestibility measurements of nutrients
According to MAFF (1983), the digestibility coefficients of nutrients can be calculated as :

$$\text{Digestibility coefficient of the DM} = \frac{\text{Intake DM (g/d)} - \text{Faecal DM (g/d)}}{\text{Intake DM (g/d)}} \times 100\%$$

Using the same procedure (by replacing DM with OM, ADF, NDF, and N), the digestibility coefficients of OM, NDF, and N were calculated

2.5. Statistical analysis
The means of ADG, FC, and FE parameter measured in this study were analysed by Analysis of Covariance (ANCOVA), while digestion coefficient of DM, OM, ADF, NDF, and GE were analysed by Analysis of Variance (ANOVA) using the procedures of the Statistical Analysis System Institute [14]. The differences between means were compared by a least significant difference method (LSD)

3. Result and discussion

3.1. Whole Tract in vivo Digestibility
Covariance analysis showed that digestibility of DM, OM, ADF, NDF, and GE were affected ($P<0.05$) by the breeds of native cattle. As shown in Table 2, the apparent whole tract digestibility of DM and OM was higher ($p<0.05$) in BF than in those M, BT and SO. However, there were no differences in DM and OM digestibility between M, BT and SO. NDF, ADF, and GE digestibility of BF were similar ($P>0.05$) to M, but it was higher ($p<0.05$) than BT and SO. This showed that even though the same feed caused different digestive responses depending on the breeds and origin of ruminants such as BF cattle and BT cattle. The difference in the level of digestibility of nutrients is caused by differences in the type of rumen microbes and their functions and one of the factors that influence them is the ruminant breed. Li et al. [2] reported that multiple factors were identified to

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drive different kinds of microbiota rumen among animals such as breed, sex, and diet. Paz et al. [3] found that there are differences in rumen microbiota between Holstein and Jersey dairy cow fed the same diets. Studies have also indicated that microbiota could be influenced by the host breeds [1].

Table 2. Average Digestion Coefficient of Dry Matter (DM), Organic Matter (OM), Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF), and Gross Energy (GE) Feed Conversion (FC) and Feed Efficiency (FE) in different of Native Cattle Breeds.

Cattle Breeds	Digestion Coefficient (%)				
	BK	BO	NDF	ADF	GE
Sumba Ongole (SO)	69.02 ± 5.57^{a}	73.13 ± 4.94^{a}	68.01 ± 0.28^{b}	50.08 ± 1.73^{c}	72.47 ± 2.59^{b}
Madura (M)	72.92 ± 2.20^{a}	75.19 ± 2.11^{a}	75.51 ± 0.34^{ab}	68.65 ± 3.8^{ab}	75.99 ± 2.31^{ab}
Bali Timor (BT)	71.85 ± 3.79^{a}	75.10 ± 3.80^{a}	69.01 ± 0.47^{b}	65.38 ± 2.13^{b}	74.34 ± 2.44^{ab}
Bali Flores (BF)	81.25 ± 5.67^{b}	82.61 ± 5.40^{b}	78.05 ± 0.32^{a}	78.85 ± 4.17^{a}	80.16 ± 2.89^{a}

^{abc} Means in the same not having at least one common superscript differ significantly (p<0,05)

Although BT and BF come from the same breeds, because the two cattle have long been developed maintained in different geographical conditions, their rearing systems and types of feed caused different rumen microbiota differences. This was what causes differences in the level of digestibility of DM, OM, ADF, NDF, and GE. Many factors have been identified to affect rumen microbial diversity, density, and functions and two of them were geographic location and feeding [15,16]

Nutrient digestibility of SO cattle was lower than other cattle (Bali Flores, Bali Timor, and Madura). This was due to the higher speed of eating concentrate (P <0.05) of SO compared to other cattle. Generally, when more feed is consumed by the animal, the rate of passage of the digest in the alimentary canal is faster and the digestibility declines due to lesser retention time and it makes limited contact with enzyme and microbes. This effect has been significantly observed in ruminants. This is in agreement with previous research showing that apparent digestibility of OM, N, NDF, and ADF decreased (P<0.05) when the in-take level of the diet increased [17]. In addition, it may also be caused by the amount of concentrate consumed is very high in a short time so that the rumen pH becomes down. Thus many rumen microbes are inactive to digest or ferment feed. Based on the actual DM intake of ammoniated rice straw and concentrate, we found that the higher DM ammoniated rice straw intake compared to ammoniated concentrate was SO (45.86 : 54.14) followed by M (39.75 : 60.25), BT (36.33 : 63.67) and BF (31.64 : 68.36).

3.2. Performance and eating rate

Average daily gain-ADG, FC, FE, and eating rate of concentrate and ammoniated rice straw was listed in Table 3. Analysis of covariance showed that native cattle breeds influenced (P <0.05) on ADG, FC and FE. The results are consistent with those reported by Xie et al. [18] and Aditia et al. [19]. ADG and FE of M cattle were higher (AP <0.05) than BF and BT cattle, but it was not different (P> 0.05) with SO cattle. A high FE in M and SO cattle was also followed by a low FC (<0.05) compared to BT and BF cattle. Among BF and BT cattle, there were no differences (P> 0.05) of ADG, FC, and FE. These results were the same as reported by Aditia et al. [19] that native cattle breeds of Bali and Ongole cattle fed the same diet produce different of ADG and FC.

The difference in feed efficiency of M and SO cattle with BT and BF cattle might be caused by the variation of the rumen microbiome. Different feed efficiency was also found in Charolais and Angus cattle due to differences in microbial diversity as reported by [20,21]. Maternal factors can influence the rumen microbiome beyond weaning and may have implications for divergence in feed efficiency [21]. Hernandez-Sanabria et al. [15] analysed the rumen microbiome in beef cattle with different residual feed intake (RFI) as one indicator of the efficiency of diets for growing and finishing. They found that the abundance of Succinivibrio sp. was associated with host dry matter

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intake and average daily gain in low RFI (efficient) animals, Robinsoniella sp. abundance was associated with high RFI (inefficient) animals, whereas the abundance of Eubacterium sp. differed between RFI groups when animals were fed with feedlot finishing diets.

Table 3. Average daily gain (ADG), Feed Conversion (FC) and Feed Efficiency (FE) and Intake rate of concentrate and Ammoniated rice straw (ARS) at different of Native Cattle Breeds

Cattle Breeds	Performance			Intake Rate (kg DM/hour)	
	ADG(kg)	FC	FE (%)	Concentrate	ARS
Sumba Ongole	1.29 ± 0.44^{ab}	7.03 ± 4.64^{ab}	17.11 ± 5.41^{ab}	7.12 ± 0.43^{a}	3.73 ± 3.35
Madura (M)	1.34 ± 0.38^{a}	4.74 ± 1.36^{a}	22.47 ± 5.55^{a}	1.34 ± 0.54^{c}	1.65 ± 0.17
Bali Flores (BF)	0.89 ± 0.28^{bc}	7.96 ± 1.85^{bc}	13.20 ± 3.16^{bc}	4.39 ± 1.92^{b}	3.04 ± 1.85
Bali Timor (BT)	0.54 ± 0.28^{c}	13.33 ± 7.38^{c}	9.99 ± 5.26^{c}	1.98 ± 0.64^{c}	2.33 ± 1.13

^{abc} Means in the same not having at least one common superscript differ significantly (p<0,05)

Covariance analysis showed that the cattle breeds had a significant effect (P <0.05) on the rate of eating concentrate, but did not have a significant effect (P> 0.05) on the rate of eating ammoniated rice straw. Sumba Ongole (SO) cattle had the highest feeding speed (P <0.05) among other cattle breeds. This is in agreement with Erina. [22] who said that each nation has a different level of eating speed which is influenced by various factors including the breeds, palatable level, feed structure, and digestibility. In this research, there was a negative influence between the speeds of eating concentrate with the digestibility of cattle as found in this research where nutrient digestibility of SO cattle was lower while eating rate of concentrate was higher. The higher the level of eating speed caused lower the level of digestibility because of the high rate of passage. The rate of passage was high due to the amount of concentrate consumed in a relatively short time making the rumen pH to be more acidic due to the nature of the concentrate having a high fermentable. As a result, microorganisms in the rumen become dead. Therefore, the digestion process is hampered because the digestive system of cattle is very dependent on microorganism's existents. Erina. [22] reinforces that the level of eating speed in cattle has a negative effect on digestibility, but has a positive effect on the level of palatability

4. Conclusion

Indonesian Native local breeds of Madura (M) and Sumba Ongole (SO) have a high performance compared to Bali Flores and Bali Timor, therefore it can be recommended for fattening used ammoniated rice straw and concentrate.

Conflict of interest

We certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript

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