Research Article

Effects of Coconut Meat Waste Replacing Maize in the Diet on Feed Intake and Nutrient Digestibility of Fattening Beef Cattle

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Abstract | The objective of the experiment was to determine the proportion of coconut meat waste (CMW) utilization replacing maize in feed supplements on feed consumption, nutrient digestibility and weight gain of beef cattle. Four male Charolais crossbred cattle (363±14.1 kg) were used in Latin square design (4x4) on 4 periods (3 weeks/ period). The treatment replaced maize with coconut meat waste 0, 25, 50 and 75% (CMW0, CMW25, CMW50 and CMW75, respectively). The result showed that the dry matter (DM) intake tended to decrease (P>0.05) from CMW0 to CMW75. In detail, the DM per body weight was 1.64, 1.65, 1.50 and 1.47% corresponding to CMW0, CMW25, CMW50 and CMW75 treatments. The neutral detergent fiber consumption tended to increase (P>0.05) from CMW0 (2.97 kg) to CMW75 treatments (3.22 kg). However, the metabolism energy of CMW25 was higher than (P>0.05) CMW0, CMW50 and CMW75 (57.9, 54.7, 52.7 and 52.2 MJ/animal/day, respectively). Both DM and OM digestibility were not significantly different in this study but CP and NDF were otherwise. The CMW0 treatment was lower than (P<0.05) the CMW75 treatment for CP digestibility (71.5 & 75.6%) and NDF digestibility (54.5 & 64.3%). The weight gain of cattle was 576, 584, 537 and 459 g/animal/day (CMW0, CMW25, CMW50 and CMW75, respectively). It is concluded that 25% of coconut meat waste changes maize in the diet of fattening Charolais crossbred cattle to improved feed, nutrient intake, nutrient digestibility and daily weight gain.

Keywords | Supplement, Rumen, Ruminants, Waste, Energy feed, Crossbred cattle

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INTRODUCTION

The crossbred beef cattle (*Bos taurus* × *Bos indicus*) has higher beef performance compared to the local ones (*Bos indicus*), but they require higher-quality diets. Forage quality is important in the context of digestibility and the requirement for nutrients. However, the key factor in the design of diets for fattening cattle is the supply of energy from feed.

Agricultural by-products and local feed are very popular in the Mekong Delta, Vietnam. The coconut tree is an important source of edible by-products for animals as coconut meal is a byproduct of the extraction of oil (high protein). In a previous study, Duy and Khang (2016) showed that increasing amounts of coconut meal in the cattle diet improved growth rate, feed conversion and reduced methane. However, after mechanically extracting from the coconut meat production of coconut milk and coconut meat waste. Coconut meat waste (CMW) is very popular in the local market, the CMW contains low crude protein (5.81%), but is high in ether extraction and carbohydrate content in dry matter (Harnentis et al., 2022). Otherwise, Mat et al. (2022) suggested that further studies are necessary to enhance the integration of coconut products into the diets of animals to reduce feed costs and enhance production. In this context of livestock-related economics, feed utilization for high money income for farmers is very necessary. Charolais crossbred cattle is more popular than other breeds in the Mekong Delta, Vietnam. However, no information on using coconut meat waste supplemented in Charolais cattle diets is available.

Therefore, this study hypothesizes that the coconut meat waste levels could affect the feed intake and nutrient digestibility of beef cattle.

MATERIALS AND METHODS

Location and time

The experiment was carried out at the Hanh Cuong cattle farm, Chau Thanh district of An Giang province, Vietnam from March 2023 to June 2023. The feeds and refusals were analyzed at laboratory E205 of the Faculty of Animal Sciences, Agriculture University of Can Tho University.

Experimental design and feeds and feeding

Four male Charolais crossbreed cattle (Figure 1) were used in a 4x4 Latin square design and the average body weight was 363±1.41 kg.

The difference in treatment was maize (Figure 2) replaced by coconut meat waste (Figure 3). It was 0, 25, 50 and 75% corresponding to CMW0, CMW25, CMW50 and CMW75 treatments. The feed ingredient composition is presented in Table 1.

Table 1: Feed ingredient composition of diet in this study.

Ingredients (%DM)	CMW0	CMW25	CMW50	CMW75
Coconut meat waste	0.00	7.50	15.0	22.5
Maize	30.0	22.5	15.0	7.50
Soybean meal	8.00	8.00	8.00	8.00
Elephant grass	30.0	30.0	30.0	30.0
Rice straw	30.6	30.5	30.4	30.3
Premix	0.76	0.76	0.76	0.76
Urea	0.64	0.755	0.874	0.99
Total	100	100	100	100

CMW: coconut meat waste. CMW0, CMW25, CMW50 and CMW75: coconut meat waste at 0, 25, 50 and 75% replace for maize. DM: dry matter.

Measurements taken

Feed, nutrient and energy intakes

The maize, coconut meat waste, Soybean meal, urea and premix of each treatment were mixed and fed twice at 7:00 am and 1:00 pm. The elephant grass was fed twice at 8:00 am and 2:00 pm. Both rice straw and freshwater were supplied *ad libitum*. Each morning, refused feeds and freshwater were weighed. The daily feed intake and nutrient consumption were determined from feed and refusals.

Figure 1: The Charolais crossbred cattle in this study.

Figure 2: Maize.

The nutrients of feed, refusals and feces were analyzed for dry matter (DM), organic matter (OM) and crude protein (CP) in the procedure of AOAC (1990). However, the neutral detergent fiber (NDF) and acid detergent fiber (ADF) were determined standards by Van Soest et al. (1991).

Metabolizable energy (ME) was calculated by Bruinenberg et al. (2002), in which ME (MJ/animal/day) = 14.2 x DOM + 5.9 x DCP (with DOM/DCP<7.0; DOM is digestible organic matter and DCP is digestible crude protein) of the diets or ME (MJ/animal/day) = 15.1 x DOM (with DOM/DCP>7.0).

Links Researchers

Figure 3: Coconut meat waste.

Apparent nutrient digestibility

The experiment was conducted for 4 periods, and each period lasted for 3 weeks including two weeks for adaptation and one week for the collection of feces according to the procedure of McDonald et al. (2010). The nutrient digestibility in this study was DM, OM, CP, NDF and ADF.

Daily weight gains (DWG)

The Charolais crossbred cattle were weighed in the morning (two consecutive days) before feeding, at the beginning and end of each experimental period.

Statistical analysis

The General Linear Model option in the Minitab Reference Manual Release 20.3 (Minitab, 2021) was used and subjected to an analysis of variance (ANOVA). Data were analyzed using the model $y_{ijk} = \mu + T_i + A_j + P_k + e_{ijk}$; where y_{ijk}: = the dependent variable, μ: the overall mean, T_i = the effect of coconut meat waste (i = 1 to 4), A_j: the effect of Charolais crossbred cattle (j = 1 to 4), P_k= the effect of period (j = 1 to 4), e_{ijk} = the random error. The Tukey test was used in this study (P<0.05) for the paired comparison of two treatments.

RESULTS AND DISCUSSION

Chemical composition of feeds

The composition of feed in the present study is shown in Table 1.

Table 2: The nutrient composition of feeds (% DM basis) in this study.

Feeds	DM, %	In DM, %			
		OM, %	CP, %	NDF, %	ADF, %
Coconut meat waste	42.3	98.9	3.70	57.9	41.7
Maize	85.7	98.7	8.34	20.8	4.70
Soybean meal	85.4	93.5	43.3	17.2	10.9
Elephant grass	15.7	90.2	8.01	65.2	43.6
Rice straw	84.9	88.5	5.26	68.5	44.0
Urea	99.6		286		

DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber.

The nutrients of feed (Table 2) in the present study were similar to information from the previous authors for coconut meat waste, elephant grass and rice straw. According to Harnentis et al. (2022), the CP of CMW was 5.81%. The elephant grass, Rusdy (2016) reported the following range of NDF being 63.9-75.4%. Rice straw, Don et al. (2020) presented NDF and ADF values corresponding to 66.3-73.2% and 36.3-42.6%.

Feed and nutrient intakes

The feed intake and nutrient consumption of cattle are shown in Table 3.

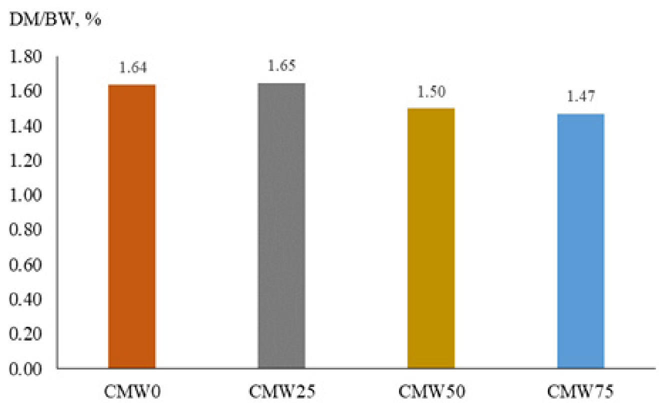

Figure 4: Effect of CMW on DM/BW.

The DM intake (kg/animal/day) in this study was not different (P>0.05) between treatments but it tended to lowest value in CMW75 (5.69 kg). In detail, the proportion of DM intake per BW (Figure 4) was not different (P>0.05) at CMW0 and CMW25 but it gradually decreased at CMW50 and CMW75 treatments (1.64, 1.65, 1.50 and 1.47%, respectively). The DMI/BW of cattle in this experiment was similar to those results of Kotupan and Sommart (2021) studied on Charolais-Thai native crossbred steers cattle for low DMI/BW with high energy feed in the diet. The CP intake (kg/animal/day) was significantly different (P<0.05) among treatments. However, both CMW0 and CMW25 were not different (P>0.05) and higher than the CMW50 and CMW75 treatments. It was 0.763, 0.757, 0.679 and 0.656 kg corresponding to CMW0, CMW25, CMW50 and CMW75 treatments. The CP consumption in this study was similar to that of 400 kg crossbred beef cattle reported by Filho et al. (2016) in Brazil being 0.688-0.80 kgCP with the daily weight gain of 0.5-0.75 kg/day. The daily NDF tended to increase from CMW0 to CMW25, CMW50 and CMW75 treatments (2.97, 3.14, 3.08 and 3.22 kg, respectively). The ME consumption of CMW0 was 54.7 MJ/cattle/day but increased in CMW25 (57.9 MJ) and decreased at CMW50 (52.7 MJ) and CMW75 treatments (52.0 MJ) but it was not different (P>0.05) group treatments (Figure 5).

Table 3: Feed, nutrient intake and output of experimental cattle.

Item	CMW 0	CMW 25	CMW 50	CMW 75	SEM	P
Feed intake, kgDM/cattle/day						
Coconut meat waste	0.00[d]	0.50[c]	0.89[b]	1.24[a]	0.037	0.001
Maize	1.92[a]	1.47[b]	0.87[c]	0.40[d]	0.040	0.001
Soybean meal	0.512[ab]	0.524[a]	0.466[ab]	0.432[b]	0.018	0.039
Elephant grass	1.75[a]	1.71[ab]	1.51[ab]	1.46[b]	0.065	0.047
Rice straw	2.00	2.02	1.97	2.06	0.051	0.681
Urea	0.048	0.052	0.051	0.057	0.002	0.115
Premix	0.049[ab]	0.051[a]	0.045[ab]	0.042[b]	0.002	0.039
Nutrient intake, kgDM/cattle/day						
DM	6.28	6.33	5.81	5.69	0.153	0.056
DM/BW, %	1.64	1.65	1.50	1.47	0.043	0.053
OM	5.71	5.75	5.27	5.16	0.139	0.051
CP	0.763[a]	0.757[a]	0.679[b]	0.656[b]	0.022	0.030
NDF	2.97	3.14	3.08	3.22	0.070	0.187
ADF	1.77[b]	1.94[ab]	1.97[ab]	2.11[a]	0.045	0.010
ME, MJ/cattle/day	54.7	57.9	52.7	52.0	1.570	0.128
Water intake, kg/cattle/day	28.2	28.4	26.8	27.5	1.280	0.805
Output						
Feces, kgDM/cattle/day	2.41	2.21	2.04	1.96	0.114	0.112

CMW0, CMW25, CMW50 and CMW75: coconut meat waste at 0, 25, 50 and 75% replace for maize. CMW: coconut meat waste, DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber, ME: metabolizable energy (MJ/kg DM), *: Bruinenberg *et al.* (2002), BW: body weight. [a, b, c] Means within rows with different letters were differ (P<0.05).

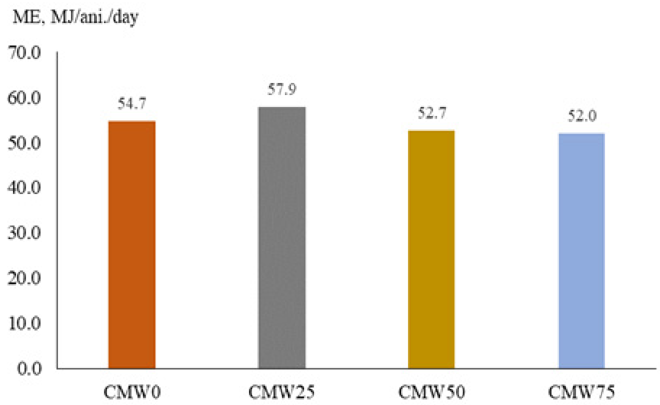

Figure 5: Effect of CMW on ME consumption.

Digestibility and digestive nutrient

The nutrient digestibility (%) and digestive nutrient (kg/animal/day) are presented in Table 4.

Table 4: Nutrient digestibility and digestible nutrients in the present study

Item	CMW0	CMW25	CMW50	CMW75	SEM	P
Nutrient digestibility, %						
DM	61.6	64.6	64.4	64.5	1.430	0.329
OM	63.4	66.2	65.8	66.6	1.360	0.389
CP	71.5[b]	74.2[ab]	74.3[ab]	75.6[a]	0.616	0.017
NDF	54.5[b]	60.0[ab]	62.3[ab]	64.3[a]	1.890	0.045
ADF	52.8	54.4	57.6	60.7	3.880	0.526
Digestible nutrient, kg/cattle/day						
DM	3.87	4.12	3.77	3.73	0.117	0.184
OM	3.62	3.83	3.49	3.44	0.104	0.128
CP	0.546	0.562	0.505	0.497	0.020	0.172
NDF	1.62[b]	1.91[ab]	1.93[ab]	2.07[a]	0.067	0.015
ADF	0.94[b]	1.08[ab]	1.15[ab]	1.28[a]	0.063	0.041

CMW0, CMW25, CMW50 and CMW75: coconut meat waste at 0, 25, 50 and 75% replace for maize. CMW: coconut meat waste, DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber. [a, b, c] Means within rows with different letters were differ (P<0.05).

Both DM and OM digestibility were not different (P>0.05) among treatments about 61.6-64.5% for DM and 63.4-66.6% for OM. The CP digestibility of CMW75 (75.6%) was higher than (P<0.05) CMW0 treatments (71.5%) but CMW75 was not different (P>0.05) with CMW25 (74.2%) and CMW50 treatments (74.3%). Similarly, NDF digestibility was increased from CMW0 to CMW25, CMW50 and CMW75 treatments (54.5, 60.0, 62.3 and 64.3%, respectively). The digestive nutrients (DM, OM and CP) were not different (P>0.05) among treatments.

Daily weight gain

The weight gain is shown in Table 5.

Table 5: Daily weight gain of cattle in this study.

Body weight	CMW 0	CMW 25	CMW 50	CMW 75	SEM	P
Initial BW, kg	378	379	382	382	2.340	0.566
Final BW, kg	390	391	393	391	2.070	0.783
Average weight gain (g/animal/ day)	576	584	537	459	92.00	0.768

CMW0, CMW25, CMW50 and CMW75: coconut meat waste at 0, 25, 50 and 75% replace for maize, CMW: coconut meat waste.

It was increased from CMW0 to CMW25 and was decreased at CMW50 and CMW75 treatments. As a result, daily weight gain was 576, 584, 537 and 459 kg/cattle/day corresponding to CMW0, CMW25, CMW50 and CMW75 treatments.

The maize was replaced by coconut meat waste from 0 to 25, 50 and 75% in this study. It showed that CMW25 was better than CMW0, CMW50 and CMW75 treatments for the items.

According to Harnentis et al. (2022) coconut meat waste contained high in EE and CF, especially mannans and galactomannans. Therefore, this by-product can be utilized as energy supplementation to ruminant diets. Freiria et al. (2021) concluded that fat supplementation for animals may decrease the forage dry matter intake. The lipids inhibit the growth of bacteria rumen, the result DMI/BW (%) in this study was reduced by the increase of CMW. As seen in this study, the use of low-quality coconut meat waste implied expansion of the NDF diet, indicating an attempt by the Charolais crossbred cattle to adapt to a lower-quality diet (Table 3). However, this adaptation was not fully effective at CMW75 treatment in preventing a decrease in voluntary consumption.

CONCLUSIONS AND RECOMMENDATIONS

A level of 25% coconut meat waste change maize in the diet of fattening Charolais crossbred cattle improved feed, nutrient intake, nutrient digestibility and daily weight gain. The result of the study is recommended as an appropriate strategy for the utilization of local market-produced coconut meal waste in cattle production. The fermentation of coconut meat waste should be studied in ruminant diets.

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NOVELTY STATEMENT

Determining the level of coconut Meat Waste Replacing Maize in the Diet of Charolais crossbred cattle is new.

AUTHOR'S CONTRIBUTION

NBT conceived, designed and performed the experiments. NBT analyzed the data. NBT and HXN wrote the paper. All authors reviewed and approved the final manuscript.

Conflict of interest

The authors have declared no conflict of interest.

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