Research Article

Charolais Crossbred Cattle 9–12 Months Period: The Difference of Neutral Detergent Fiber in The Diet on Feed Intake, Nutrient Digestibility and Weight Gain

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Abstract | The experimental Charolais crossbred cattle was conducted at a Hanh Cuong farm in An Giang prefecture, Vietnam. Four male cattles at 9 months were used in the Latin Square design (4 x 4) to determine the effects of neutral detergent fiber (NDF) on feed intake, nutrient digestibility and weight gain. The NDF levels used in the experiment were 43, 47, 51 and 55 (% dry matter intake) corresponding to NDF43, NDF47, NDF51 and NDF55 treatments. Dry matter intake per body weight of NDF43 (2.40%) treatments tended to (P>0.05) high compared to the NDF47 (2.20%), NDF51 (2.22%) and NDF55 (2.16%) treatments. Total metabolism energy inclined to decrease (P>0.05) from NDF43 to NDF55 treatments. It was 42.8, 38.4, 35.5 and 35.6 MJ/cattle/day (NDF43, NDF47, NDF51 and NDF55 treatments, respectively). The DM digestibility (%) of the NDF43 treatment (64.4%) was not various (P>0.05) with NDF47 (63.3%), NDF51 (61.4%) and NDF55 treatments (55.8%). However, DM digestibility value (kg/cattle/day) was not different (P>0.05) among NDF treatments. It was highest on the NDF43 (3.13 kg) and lowest on the NDF55 treatments (2.51 kg). Moreover, the CP digestibility value (kg/cattle/day) was not different (P>0.05) among NDF treatments. It was 0.466, 0.382, 0.415 and 0.392 g corresponding to NDF43, NDF47, NDF51 and NDF55 treatments. The average weight gain was the same as digestive CP in the present study. It was 552 g for NDF43 treatment and 517 g for NDF55 treatment. Therefore, the levels of NDF well for Charolais crossbred cattle in this study from high to low were 43, 47, 51 and 55%. The likely benefit of 51% NDF will be an increase in the utilization of fibrous roughage and daily weight gain from 9 to 12 months of age in the Charolais crossbred cattle diet.

Keywords | Ruminants, Rumen, Digestion, Forage quality, Fiber, Beef cattle

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INTRODUCTION

In tropical developing countries, the feed of beef cattle needs low-cost forages and utilization of local feed (Ghedini and Moura, 2021). The proportion of forage is higher than feed supplements in the diet.

The quality of feed will affect the requirement for nutrient supplements for cattle by the digestibility of forage. Therefore, the diet will be high-fiber which will impact on fiber digestibility of the rumen. However, the fiber component in the cell wall (neutral detergent fiber, NDF) is very important comprising such as hemicellulose, cellulose and lignin. According to Mertens (2014), the NDF is the key to evaluate the quality of ruminant feed. In beef cattle, more than 16 months of age shows that increasing NDF in the diets had a decreased tendency for nutrient digestibility, nitrogen retention, and daily weight gain by our study. However, the information from Duarte *et al*., (2018) concluded that the ruminal protozoa concentration of calves is lower than adult animals. Moreover, Hue (2010) reported that the calves will stress after weaning and then will recover at 9-12 months of age. Thus, the best for the beginning performance is 9 months of age on cattle.

Therefore, feed intake and nutrient digestibility of Charolais crossbred cattle from 09 to 12 months affected by dietary NDF levels is the hypothesis in this study.

MATERIALS AND METHODS

Location and time

The experimental cattle was conducted March 2023 to June 2023 at Hanh Cuong cattle farm, Chau Thanh district of An Giang province and the Animal Sciences Faculty (Laboratory E205), Agriculture University of Can Tho University.

Experimental design and feeds and feeding

A total of 4 male Charolais crossbred cattle at 9 months (117±11.1 kg) were used in this study (Latin square design 4x4) with four levels of NDF such as 43, 47, 51 and 55% (NDF43, NDF47, NDF51 and NDF55, respectively). The ratio of ingredients in diets is shown in Table 1.

Table 1: The ingredients of experimental diets (% DM basis).

Ingredient, %	NDF43	NDF47	NDF51	NDF55
O. turpethum vines	53.4	40.1	26.8	13.7
Elephant grass	12.0	12.0	11.9	11.9
Rice straw	14.5	27.7	40.8	53.8
Soybean meal	1.00	2.99	4.97	6.94
Concentrate	19.0	16.9	14.9	12.9
Urea	0.10	0.34	0.57	0.80
Total	100	100	100	100

NDF43, NDF47, NDF51 and NDF55 treatment contained neutral detergent fiber at 43, 47, 51 and 55% based on dry matter.

The concentrate composition (% in DM basis) was from rice bran, broken rice, soybean meal, dicalcium phosphate, salt, premix vitamins and minerals (51.7, 20.8, 24.7, 1.14, 1.14 and 0.57, respectively).

Measurements taken

Feeds, feeding, and measurements taken: The *O. turpethum* vines and rice straw were bought from local farmers but the farm was elephant grass product for cattle. In this study, individual cages per cattle were collecting feces advantageously. The amount of feeds offered and refusals were daily determined by weighing. The daily fixes 2 times at 7:00 am and 1:00 pm were concentrate, soybean meal, and urea to the animals, then at 8:00 am, 10:00 am, 3:00 pm, 6:00 pm, and 10:00 pm were given *O. turpethum* vines, elephant grass, and rice straw. In the morning, water intake was weighed before feeding.

Feed, nutrient and energy intakes: The feed analysis and and leftovers were measured using the method of AOAC (1990), encompassing parameters such as DM (dry matter), OM (organic matter) and CP (crude protein). Opposite, neutral detergent fiber (NDF) and acid detergent fiber (ADF) were adhered to the procedure of Van Soest *et al.* (1991). However, the metabolizable energy was calculated from Bruinenberg *et al.* (2002) method such as ME (MJ/animal/day) = 15.1 x DOM (with DOM/DCP>7.0); ME (MJ/animal/day) = 14.2*DOM + 5.9*DCP (DOM/DCP<7.0); DCP denotes digestible crude protein and DOM refers to digestible organic matter of the diets.

Apparent nutrient digestibility: The apparent digestibility of DM, OM, CP, NDF and ADF was analyzed by methods of McDonald *et al.* (2010) with three weeks/period including dietary adaptation (2 weeks) and sampling (1 week).

Daily weight gains (DWG): In the early morning, the electrical scale (Tru-Test, Limited Auckland, New Zealand) was used to determine the body weight of cattle over 2 consecutive days of each experimental period at the beginning and at the end.

Statistical analysis

The data of the experiment was subjected to analysis of variance using the ANOVA of General Linear Model (GLM) of Minitab Reference Manual Release 20.3 (Minitab, 2021). The statistical equation for this model was $y_{ijk} = \mu + T_i + A_j + P_k + e_{ijk}$; where y_{ijk}: = the dependent variable, μ: the overall mean, T_i = the effect of NDF levels (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), and e_{ijk} = the random error. The treatment mean was compared by the Tukey test of the Minitab (α = 0.05).

RESULTS AND DISCUSSION

Chemical composition of feeds

The nutrients of feed in the experimental Charolais crossbreed cattle (Table 2) were similar some reported another author. The Rusdy (2016) study on elephant grass reported the following range of NDF being 63.9-75.4%. Don *et al.* (2020) presented NDF and ADF values of rice

Links Researchers

Table 2: Chemical composition of feeds (% DM basis).

Feed	DM %	DM %			
		OM	CP	NDF	ADF
O. turpethum vines	13.9	85.3	11.8	37.2	33.5
Elephant grass	15.0	89.7	7.59	63.0	40.7
Rice straw	83.6	91.3	5.43	69.0	41.1
Soybean meal	85.2	93.6	44.9	24.1	16.9
Rice bran	87.9	88.9	9.80	24.9	14.2
Broken rice	86.0	99.6	7.99	6.98	1.82
Concentrate	87.1	89.7	17.8	20.3	11.9
Urea	99.4		286		

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

Feed and nutrient intakes

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

Items	NDF43	NDF47	NDF51	NDF55	SE	P
Dry mater intake, kgDM/Cattle						
O. turpethum vines	2.25	1.53	1.03	0.38	0.062	0.001
Elephant grass	0.463	0.462	0.493	0.438	0.023	0.477
Rice straw	1.13	1.49	2.05	2.66	0.131	0.001
Soybean meal	0.080	0.134	0.236	0.293	0.015	0.001
Concentrate	0.90	0.76	0.71	0.56	0.023	0.001
Urea	0.018	0.015	0.026	0.032	0.002	0.002
Nutrient intake, kgDM/Cattle/day						
DM	4.84	4.39	4.54	4.37	0.172	0.292
OM	4.23	3.86	4.00	3.90	0.156	0.411
CP	0.612	0.538	0.581	0.548	0.021	0.142
ADF	1.52	1.43	1.52	1.52	0.062	0.069
NDF	2.09	2.08	2.31	2.45	0.101	0.110
ME*, MJ	42.8	38.4	35.5	35.6	3.100	0.485
DM/BW, %	2.40	2.20	2.22	2.16	0.083	0.257
CP/DMI, %	12.7	12.3	12.8	12.5	0.202	0.314
Water, kg	9.91	9.91	15.6	16.3	2.160	0.142
Output, kgDM/Cattle						
Feces	1.71	1.72	1.75	1.86	0.128	0.821

DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber, ME: metabolizable energy (MJ/kgDM), *Bruinenberg *et al.* (2002), BW: body weight. NDF43, NDF47, NDF51 and NDF55 treatment contained neutral detergent fiber at 43, 47, 51 and 55% based on dry matter. a, b, c, d: Means within a row with different superscripts differ significantly (P≤0.05).

straw corresponding to 66.3-73.2% and 36.3-42.6%. In the present study, the *O. turpethum* vines had NDF and ADF values 37.2% and 33.5%, respectively. It was similar to previous findings of Chau and Thu (2014) in the Mekong Delta (39.0% and 30.8%, respectively). Concisely, the *O. turpethum* vines was a main effect of NDF and metabolic energy to Charolais crossbred cattle, while basic forage was elephant grass and rice straw.

Digestibility

Table 4: Nutrient digestibility and digestible nutrients.

Items	NDF43	NDF47	NDF51	NDF55	SE	P
Digestibility, %						
DM	64.4	63.3	61.4	55.8	3.750	0.438
OM	66.2	65.7	63.4	58.7	3.640	0.494
CP	76.2	71.0	74.8	70.9	2.720	0.510
ADF	54.0	50.2	50.4	46.1	5.160	0.763
NDF	56.3	56.1	60.3	59.8	4.560	0.866
Digestive nutrients, kgDM						
DM	3.13	2.79	2.79	2.51	0.233	0.386
OM	2.82	2.54	2.54	2.34	0.208	0.499
CP	0.466	0.382	0.415	0.392	0.026	0.201
ADF	0.833	0.726	0.769	0.697	0.092	0.748
NDF	1.19	1.18	1.39	1.49	0.149	0.430

DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber, ME: metabolizable energy (MJ/kgDM), **Bruinenberg *et al.* (2002), BW: body weight. NDF43, NDF47, NDF51 and NDF55 treatment contained neutral detergent fiber at 43, 47, 51 and 55% based on dry matter. a, b, c, d; Means within a row with different superscripts differ significantly (P≤0.05).

Daily weight gain

Table 5: Average weight gain (AWG) of cattle in this study.

Items	NDF43	NDF47	NDF51	NDF55	SE	P
Initial BW, kg	195	194	198	196	1.820	0.540
Final BW, kg	207	205	210	207	1.820	0.467
BW gain, g/cattle/day	552	538	560	517	67.20	0.969

BW: body weight. NDF43, NDF47, NDF51 and NDF55 treatment contained neutral detergent fiber at 43, 47, 51 and 55% based on dry matter.

The nutrient intake tended to decrease (P>0.05) from NDF43 to NDF55 treatments. The DM consumption was not deifferent (P>0.05) from NDF43 to NDF55 treatment (4.84 and 4.37 kgDM/cattle, day, respectively). It was like to the previous of Filho *et al.* (2023) on crossbred cattle 210 kg need to 4.00-5.60 kg DM/day for daily weight gain of about 0.30-0.80 kg. The value of CP intake was not various (P>0.05) between four treatments. It was 12.7, 12.3, 12.8 and 12.5% corresponding to NDF43, NDF47, NDF51 and NDF55 treatments. However, the NDF intake (kg/cattle/day) was not reduced (P>0.05) for NDF43, NDF47, NDF51 and NDF55 treatments (2.09, 2.08, 3.31 and 2.45, respectively). As result, the ME consumption was decrease (P>0.05) from 42.8 to 38.4, 35.5 and 35.6 MJ/cattle/day (Figure 1) coresponding to NDF43, NDF47, NDF51 and NDF55 treatments. Additionally, a study by Kongphitee *et al.* (2018) suggested that increasing levels of NDF reduced ME intake in the diet.

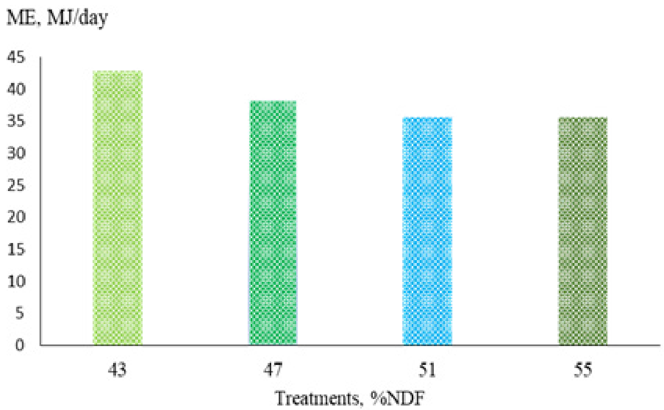

Figure 1: The metabolizable energy intake.

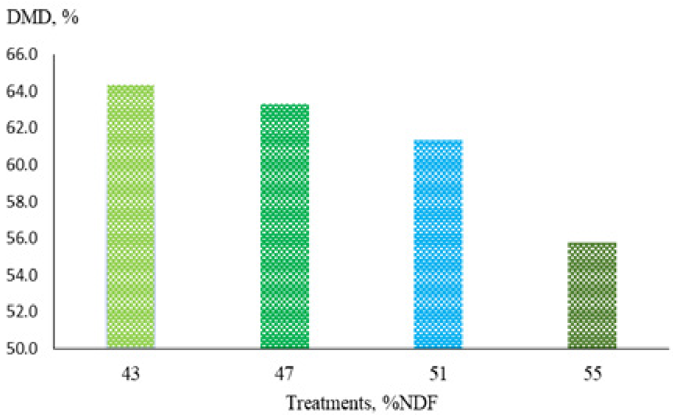

Figure 2: The DM digestibility of four NDF levels in the experimental cattle.

The nutrient digestibility and digestive nutrient were lowest for NDF55 treatment (P>0.05). The NDF43 treatment was higher DM digestibillity than (Figure 2) NDF47, NDF51 and NDF55 treatments (64.4, 63.3, 61.4 and 55.8%, respectively). It was like to the conclusion by Konka *et al.* (2015), who showed that the increasing NDF in the diets reduced DM digestibility of ruminant. The previous study on Charolais crossbred cattle (more than 16 months) showed that DM digestibility of NDF47, NDF51 and NDF55 was not different (P>0.05) but NDF59 treatment was lower (P<0.05) than NDF47 treatment (Truong and Thu, 2022). It explained that the ruminal protozoa concentration of calves is lower than adult animals (Duarte *et al.*, 2018). Although the CP intake per DM was not different (P>.05) in Table 3, but CP digestibility did reduce (P>0.05) from 76.2 to 70.9 corresponding to NDF43 and NDF55 (P>0.05). However, NDF digestibility was increased from NDF43 to NDF55 (56.3 and 59.8%, respectively) and it was not various (P>0.05) in the experiment study. Therefore, AWG tended to be low (P>0.05) in the NDF55 treatment from Table 5.

To our knowledge, the post-weaning period was a critical window for the rumen of the calf. Moreover, the NDF was the main effect on feed intake presented by Tham and Udén (2013). Besides that, the source of NDF affects the digestion of microorganisms. It interprets that high amounts of NDF in the cell wall are considered to limit the digestive activity of microorganisms such as reducing quickly ferment from soluble carbohydrates (Konka *et al.*, 2015). Moreover, the NDF depends on the structure of plant cell walls. The difference in the cell wall structure of plants (NDF) is the chemical composition of cellulose, hemicellulose, lignin, pectin and protein molecules in the middle wall, the primary wall and the secondary wall. The structural change of NDF in plants is influenced by their varieties, ages, parts and the harvested time, which affects the dry matter and nutrient digestibility in ruminants. The above results explained that the structural components of plant feed material such as low NDF can affect the digestibility of Charolais crossbred cattle, which will increase the nutrient digestibility of feed (Sari *et al.*, 2018). As a result, the average weight gain on Charolais crossbred cattle was the lowest value for NDF55 and the highest value for NDF43 treatments (517 and 552 g/cattle/day).

Ghedini and Moura (2021) suggested that low-cost forages in beef cattle production need to the feed of utilization of local feed. However, these crossbred cattle require higher-quality diets, while the utilization of locally available low-cost forages is usually applied to beef cattle are high-fiber diets (Mwangi *et al.*, 2019; Favero *et al.*, 2019). According to Harper and McNeill (2015), the higher NDF content in the diet can be considered a more feasible target in the tropical cattle system. Arelovich *et al.* (2008) also indicated that NDF intake had a relationship with DM intake and net energy for growth. Therefore, ME, nutrient digestibility and AWG for crossbred beef cattle could be reduced by increasing NDF levels in diets.

CONCLUSIONS AND RECOMMENDATIONS

Increasing NDF in the diets from 43.0 to 55.0% had a decreased tendency for feed intake, nutrient digestibility, digestive nutrients and everyday weight gain of Charolais crossbred cattle from 9 to 12 months of age. This study has shown that the 51% NDF in the diet tended to be higher in forage utilization, nutrient digestibility and promising application. The likely benefit will be an increase in the utilization of fibrous roughage and daily weight gain.

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NOVELTY STATEMENT

The Charolais crossbreed cattle are developing from female Zebu crossbred with frozen sperm of high-producing beef cattle (Charolais) by artificial insemination method. Both crossbred and the results of an experiment are new in a 9-12 months of age.

AUTHOR'S CONTRIBUTION

Truong N.B conceived, designed and performed the experiments; Truong N.B analyzed the data; Truong N.B, Trung N.B and Hanh N.T.B 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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