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Effect of replacing fresh water hyacinth (*Eichhornia crassipes*) to rice straw diet on feed intake, rumen fermentation and weight gain of Lai Sind cattle

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ABSTRACT

Four local male cattle with average live weight of 290 kg were arranged in a Latin-square design with four treatments, which included fresh water hyacinth (WH) replacing rice straw at levels of 0, 25, 50 and 75% in the diets [dry matter (DM) basis]. The aim of this study was to find out the optimum level of fresh WH in cattle diet based on nutrient digestibility, rumen parameters, nitrogen retention and daily weight gain. The multi-nutrient cake containing 323 g CP/kg DM was supplemented in all the diets to adjust the daily crude protein intake to 210 g/100 kg body weight. The results of the study showed that daily DM, organic matter and metabolizable energy intakes were significantly different ($P<0.05$) among the diets. While rumen pH, N-NH_3 and volatile fatty acid concentration were not significantly different ($P>0.05$) among the treatments. The daily nitrogen retention and weight gain were 0.482, 0.502, 0.510 and 0.480 g/kg$W^{0.75}$ and 250, 334, 448 and 403 g for the WH25, WH50, WH75 and WH100 treatments, respectively. The results indicated that feeding the fresh WH to replace rice straw up to 75% in local cattle diet could improve metabolizable energy intake, nutrient digestibility and growth performance. The optimum level of WH replacement to rice straw in the diet was 50%.

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1 INTRODUCTION

Cattle production is a traditional activity and plays an important role for small farmers in rural area in Vietnam. Vietnam is an agricultural and tropical climate country which produces the enormous agricultural by-products and plants annually. The farmers have used those products as feed for ruminants. Water hyacinth (WH), which has large bio-mass and fast grows with productivity of about 150 tons/ha/year (Nguyen Bich Ngoc, 2000), is available in most canals and rivers in the Mekong Delta of Vietnam. In many cases, it has caused the problems of environment and the waterway transportation. WH (*Eichhornia crassipes*) has been also concerned as a potential feed for rabbits (Nguyen Van Thu and Nguyen Thi Kim Dong, 2010) and it could be ensiled for feeding goat and sheep (Nguyen Van Thu, 2016). However, it has not yet been studied to use as a staple feed source for cattle. Therefore, the aim of this study was to find out the optimum level of fresh WH in cattle diet based on nutrient digestibility, rumen parameters, nitrogen retention and daily weight gain for a recommendation of applicable feeding.

2 MATERIALS AND METHODS

2.1 Location of this study

The experiment was conducted in the experimental farm and laboratory of College of Agriculture and Applied Biology, Can Tho University from December, 2008 to February, 2009.

2.2 Treatments and design

The animals were four Lai Sind male cattle with average live weight of 290 kg. Latin-square design was used in this study. It included four treatments (WH0, WH25, WH50 and WH75), which consisted of fresh WH levels replacing rice straw at levels of 0, 25, 50 and 75% in the diets (dry matter basis), respectively.

Table 1: Dietary feed ingredients of the experiment (%DM)

Feed, %DM	Treatments			
	WH0	WH25	WH50	WH75
Rice straw	82	65.6	47	25
WH	0	21.9	47	75
Multi-nutrient cake	18	12.5	6	0
Chemical composition of diets, %DM				
Nutrients				
DM	81.50	28.1	16	10.8
OM	83.3	83.6	83.83	84.2
CP	9.40	9.42	9.40	9.62
NDF	61.7	61.3	60.85	59.7
ME, MJ/kgDM	6.77	7.09	7.47	7.9

DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ME: metabolizable energy.

2.3 Feeding and management

Rice straw was fed *ad-libitum.* A multi-nutrient cake containing 323 g CP/kg DM was supplemented for WH0, WH25 and WH50 treatments to adjust the daily crude protein intake to 210 g/100 kg BW. Each experimental period lasted for 12 days including seven days for adaptation and five days for sample collecting. The feed was fed at 6:30 and 13:30. Firstly, multi-cake was fed, then fresh WH and the last was rice straw. Water and feeds offered and refused were measured daily. Feces and urine were collected daily during sample collecting periods. Rumen fluid was taken by stomach tube in order to measure $N\text{-}NH_3$ and volatile fatty acids before and three hours after feeding.

2.4 Chemical analysis

Dry matter (DM), organic matter (OM), crude protein (CP) and total ash (Ash) of the samples were determined according to standard methods of AOAC (1990). Neutral detergent fiber (NDF) was analyzed by the method of Van Soest *el al.* (1991). Apparent nutrient digestibility of DM, OM, CP, NDF and nitrogen balance were determined by the methods described by McDonald *el al.* (1998) and volatile fatty acid (VFA) analysis following Barnet and Reid (1957).

2.5 Statistical analysis

The data were compiled in Microsoft Excel software and analyzed by ANOVA using the General Linear Model procedure of Minitab Release 16.2.0 (Minitab, 2010). The Tukey test for paired comparisons was used for identifying differences at $P<0.05$.

3 RESULTS AND DISCUSSION

3.1 Chemical composition of feed ingredients

The data on chemical composition of the feeds are in Table 1.

Table 2: Chemical composition of feed ingredients used in experiment (% DM except for DM on fresh basis)

Ingredients	DM	OM	CP	NDF	Ash	ME, MJ/kgDM*
Rice straw	82.1	83.1	4.37	71.7	16.9	6.68
WH	8.40	84.5	11.5	55.7	15.5	8.29
Multi-nutrient cake	78.7	84.3	32.3	16.2	15.7	7.17

*DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, Ash: total ash, *: calculated according to NIAS (1995)*

3.2 Feed intake

DM and OM intakes were gradually downward and significantly different among the treatments (P<0.05) with the lowest value for the WH75 treatment (Table 3). Nguyen Thi Dan Thanh (2010) reported that using fresh WH to replace para grass at 25, 50, 75 and 100% levels for feeding growing cattle with the average live weight of 210 kg showed that DM intake ranged 3.18-3.32 kg/day. The CP intakes were similar for all the treatments (P>0.05), while NDF intake of the WH75 treatment was significantly lower than that of other treatments (P<0.05). There was a significant difference in ME intakes among the treatments (P<0.05) with the highest value for the WH50 treatment.

Table 3: Mean values for feed intakes of the cattle fed different proportions of rice straw and WH leaves

	WH0	WH25	WH50	WH75	P	SEM
WH (kg DM/day)	0.00^{d}	0.903^{c}	2.11^{b}	2.56^{a}	0.001	0.127
Rice straw (kg DM/day)	3.71^{d}	2.53^{c}	1.93^{b}	0.813^{a}	0.001	0.134
Actual WH intakes (%)	0.00^{d}	26.2^{c}	52.2^{b}	75.9^{a}	0.001	0.328
MUC (g DM/day)	847^{a}	668^{a}	388^{b}	0^{c}	0.001	0.084
DM (kg/day)	4.56^{a}	4.10^{a}	4.43^{a}	3.37^{b}	0.002	0.108
OM (kg DM/day)	3.80^{a}	3.43^{a}	3.71^{a}	2.85^{b}	0.002	0.088
CP (g DM/day)	436	430	452	330	0.741	32.2
NDF (kg DM/day)	2.79^{a}	2.42^{a}	2.62^{a}	2.01^{b}	0.001	0.059
ME (MJ/day)	30.8^{ab}	29.2^{ab}	33.2^{a}	26.7^{b}	0.041	0.986

a, b, c, d: Means with different letters within the same rows are different at P<0.05
MUC: multi-nutrient cake DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ME: metabolism energy, WH0, WH25, WH50, WH75: WH replacing rice straw at levels of 0, 25, 50, 75%, respectively

3.3 Rumen parameters

The N-NH_3 and VFA values of rumen fluid after feeding three hours were higher than those values before feeding while pH values tended to remain constant (Table 4). The N-NH_3 values of treatments in experiment were higher than the results of Nguyen Thi Dan Thanh (2007) being 8.4 mg/100 ml rumen fluid of cattle was supplied cotton meal at 200 g/100 kg BW. According to Preston and Leng (1987), N-NH_3 concentration in rumen fluid should be in the range of 15 - 25 mg/100 ml. The higher value of this parameter indicated that rumen function was good. On the contrary, the lower N-NH_3 value leaded to reducing the microorganism system of rumen. The pH values in rumen of sheep fed fresh WH and para grass reported by Le Thuy Trieu (2009) being from 6.70 to 6.75 were rather lower than results in this study. The N-NH_3 and VFAs values at before and after feeding in that study had a similar trend to those of the present study.

Table 4: N-NH3 concentration, VFA, pH values of rumen fluid of cattle

Items	Treatments				P	SEM
	WH0	WH25	WH50	WH75		
N-NH_3, mg/100ml						
Before feeding	14.2	14.6	14.7	14.0	0.934	1.27
3 hours after feeding	22.8	22.4	21.7	20.8	0.600	1.50
pH						
Before feeding	7.09	7.03	7.05	7.08	0.948	0.099
3 hours after feeding	7.08	7.10	7.10	7.03	0.923	0.128
VFA, µM/ml						
Before feeding	82.4	83.5	81.8	82.7	0.981	4.19
3 hours after feeding	84.6	88.8	91.0	88.8	0.722	5.56

VFAs: volatile fatty acids, WH0, WH25, WH50, WH75: WH replacing rice straw at levels of 0, 25, 50, 75%, respectively

3.4 Apparent digestibility, nitrogen balance and daily weight gain

The apparent nutrient digestibility, nitrogen balance and daily weight gain are shown in Table 5.

The apparent digestibility of nutrients comprising DM, OM, CP, NDF of WH50 diet was higher than the others but no significance (P>0.05) was found. Nitrogen intakes among diets were similar while nitrogen retention increased from WH0 to WH50

treatments and decreased in the WH75 treatment. Above results leading to the weight gain result of WH50 diet had higher values than the WH0 and WH25 treatments ($P<0.05$). This study's results were similar to these of cattle reported by Nguyen Thi Dan Thanh (2010) and Tran Kim Chi (2015). A study of Begum *el al*. (2000) showed that body weight gain of bull calves (average weight 68 kg) fed 40% rice straw and 60% WH leaves in diets was higher than the result of cattle in diets with 40% rice straw and 60% road side grass (115 g/day and 107 g/day, respectively). They concluded that the combination of fresh WH leaves with rice straw and concentrate could be used for calves without any adverse effect on growth of animals. The using of fresh WH replaced para grass at 75% level (DM basis) remained normal rumen parameters ($N\text{-}NH_3$, VFAs, pH) and weight gain for growing sheep (Le Thuy Trieu, 2009).

Table 5: Nutrient digestibility, nitrogen intakes, nitrogen retention and daily weight gain of cattle fed fresh WH replacing rice straw

	Treatments				P	SEM
	WH0	WH25	WH50	WH75		
Apparent digestibility, %						
DM	55.3	56.5	63.0	62.1	0.042	2.41
OM	59.0	60.0	65.4	64.9	0.072	2.34
CP	61.2	65.5	67.3	66.8	0.185	2.63
NDF	58.3	58.9	64.3	63.7	0.221	3.14
Nitrogen balance, g/day						
Intake	73.4	75.0	73.3	52.8	0.919	2.87
Feces	22.6	25.9	24.5	19.6	0.274	2.97
Urine	22.5	20.8	20.0	18.3	0.252	3.55
Nitrogen retention	27.3	28.3	28.9	14.9	0.967	3.93
Initial weight, kg	215	216	213	214	0.096	1.04
Daily weight gain, g	250^{a}	334^{ab}	448^{c}	303^{ab}	0.004	32.4

DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, WH0, WH25, WH50, WH75: WH replacing rice straw at levels of 0, 25, 50, 75%, respectively

4 CONCLUSION

Feeding fresh WH to replace rice straw in local cattle diet could improve intake, nutrient digestibility and growth performance. The optimum level of WH replacement to rice straw in the diet was 50%.

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