THE USE OF WATER HYACINTH (*EICHHORNIA CRASSIPES*) FOR IMPROVING METABOLIZABLE ENERGY INTAKE, NUTRIENT DIGESTIBILITY AND ECONOMIC RETURN OF LOCAL YELLOW CATTLE

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ABSTRACT

The objective of this study was to determine the optimum levels of water hyacinth (WH) in cattle rice straw diet by evaluating nutrient and energy intakes, digestibility and economic return. Four local male cattle with average live weight of 214.5 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 (DM basis) corresponding to the WH0, WH25, WH50 and WH75 treatments. The urea-molassesblock was supplemented in all the diets to balance CP intake for the all treatments. The results showed that daily DM, OM and NDF intakes were significantly different (P<0.05) among the treatments and they were gradually reduced from the WH0 to WH75 treatment due to the higher moiture content of WH. However the metabolizable energy (ME) intake was higher for the WH50 treatment, because of the digested DM improvement. The rumen pH, N-NH_3 and total VFA concentrations were not significantly different (P>0.05) among the treatments with a good rumen environment for microbial activities. It was also found that the daily weight gain was significantly different (P<0.05) among the treatments with the highest value for the WH50 treatment. The conclusion was that fresh WH could be replaced rice straw in cattle diet for improving dietary nutrient digestibility, metabolizable energy and possitive live weight change. The optimum level of WH replacement to rice straw in cattle diet could be 50%.

Keywords: *water plants, forages, ruminants, rumen parameters, growth*

INTRODUCTION

Local cattle are popularly raised for meat and cash income by many farmers in the villages of Vietnam due to their well adaptation to diseases and poor quality diets. This has also allowed the diversification of the beef cattle production under the pressure of raising the exotic breeds with higher dietary nutrient requirements. Traditionally the farmers feed the local cattle rice straw during the dry season, thus they are normally low in growth performance due to the low nutrients of rice straw. In many cases their malnutrition are occurred, then health is succumbed (Nguyen Van Thu et al., 1993). In the Mekong delta of Vietnam water hyacinth (WH) grows well in canals, ponds and rivers, and in many cases it causes the environmental problems. It has been also under-utilized for ruminant production in Mekong delta of Vietnam (Nguyen Van Thu and Nguyen Thi Kim Dong, 2009). Fresh WH contains higher water, crude protein (CP) and neutral detergent fiber (NDF) concentrations compared to rice straw. This hinted the idea that the fresh WH could replace the rice straw dietsof cattle to improve the dietary quality for enhancing the growth performance of local cattle and social-economic return of the producer in cases of utilizing WH without any payments. Therefore, this study aimed to evaluate the possibility of using water hyacinth levels replacing rice straw in the local cattle diets for recommendations of improving income and better use of locally available feed resources.

MATERIALS AND METHOD

Location and time

The experiment was conducted at the experimental farm in Binh Thuy district, Can Tho City and Department of Animal Science, College of Agriculture, Can Tho City from September, 2018 to Febuary, 2019.

Experimental design

Four local male cattle with average live weight of 214.5kg were allocated to 4 diets according to a Latin square design. The treatments were fresh water hyacinth levels replacing rice straw at 0 (WH0), 25 (WH25), 50 (WH50) and 75% (WH75) in the diet (DM basis).

Feeds and feeding

Feeds were offered the animals twice a day at 7:00 AM and 2:00 PM. The fresh WH was collected from the canals around the farm and chopped into 10-20cm long before feeding. The urea-molasses block containing 320g CP/kgDM was made at the University and supplemented in all the diets in order to adjust the similar crude protein intakes with a level of 210gCP/100kgBW per day. The experimental period was 14 days including 7 days for adapation to diets and 7 days for sampling.

Measurements taken

They included feeds, nutrient intakes and digestibilities, rumen parameters and N balance During the 7 days collection period, feeds offered and refused, feces and urine were collected daily, and the rumen liquid was collected before and 3 hours post feeding, weighed and pooled weekly for analysis.

Samples analysis

The samples were analyzed for DM (dry matter), OM (organic matter), CP (crude protein), neutral detergent fiber (NDF) and Ash. DM, OM, Ash and nitrogen (N) were analyzed according to the standard methods of AOAC (1990) and NDF was determined by the methods of Van Soest et al. (1991). While metabolizable energy was calculated following the method suggested by Bruinenberg et al. (2002).

ME = 15.1 * DOM; with DOM/DCP > 7

ME = 14,2 * DOM + 5,9 * DCP; with DOM/DCP < 7

In which: *DOM: digestible organic matter, DCP: digestible crude protein*

Rumen NH_3-N concentration was determined by the method of Kjeldahl and by Barnet and Reid (1957) for rumen volatile fatty acids (VFAs) concentration. Apparent digestibility coefficients for DM, OM, CP and NDF and nitrogen retention were determined by the method of McDonald et al. (2002).

Statistical analysis

The data were calculated by Excel software and subjected to an analysis of variance (ANOVA) using the General Linear Model procedure of Minitab 16.2 (Minitab, 2010) based on the Latin square design with the following the model:

$Y_{ij} = \mu + r_i + C_i + t_{k(ij)} + \varepsilon_{ij}$

In which:

Yij: Observed measurement; µ: Overall mean;

r_i: Row effect (period); c_i: Column effect (cattle);

$t_{k(ij)}$: Treatment effect; ε_{ij}: Overall error.

When the F test was significant (P<0.05), then Tukey's test for paired comparisons was used.

RESULTS AND DISCUSSION

Chemical compositions of feeds

The chemical compositionsand metabolizable energy of feeds were presented in Table 1.

Table 1. Chemical composition (%DM) of feeds used in the experiment

	DM	OM	CP	NDF	Ash	ME,MJ/kgDM*
Rice straw	82.1	83.1	4.37	71.7	16.9	6.68
Water hyacinth	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

*Note: DM: Dry matter, OM: Organic matter, CP: Crude protein, Ash: total mineral, NDF: Neutral detergent fiber, *Bruinenberg et al. (2002)*

The DM and NDF contents of WH were much lower than rice straw, however the CP content of WH was higher than that of rice straw (11.5 vs. 4.37%, respectively). The DM, OM, CP and NDF contents of WH in the experiment were higher than those of reproted by Le Thuy Trieu (2009), which were 7.0, 79.6, 9.40 and 51.2%, respectively. However, the CP content of WH (11.5%) was lower than that stated by Nigam (2002) being 13.3% CP.

Daily feed, nutrients and ME intakes

The daily feed, nutrients and ME intakes were presented in Table 2.

Table 2. Daily feed, nutrient (kg) and ME intakes (DM basis) of cattle fed different WH levels

	Treatments				P	±SE
	WH0	*WH25*	*WH50*	*WH75*		
Water hyacinth (WH)	0.00^{a}	0.903^{b}	2.11^{c}	2.56^{d}	0.001	0.127
Rice straw (R)	3.71^{a}	2.53^{b}	1.93^{c}	0.813^{d}	0.001	0.134
Multi-nutrient cake	0.847^{a}	0.668^{a}	0.388^{b}	0.389^{b}	0.001	0.084
WH replacement, %	0.00^{a}	26.2^{b}	52.2^{c}	75.9^{d}	0.001	0.328
DM	4.56^{a}	4.34^{a}	4.19^{a}	3.76^{b}	0.002	0.108
OM	3.80^{a}	3.63^{a}	3.51^{a}	3.16^{b}	0.002	0.088
CP	0.459	0.465	0.459	0.465	0.974	0.019
NDF	2.54^{a}	2.42^{a}	2.33^{a}	2.09^{c}	0.001	0.059
ME(MJ/day)*	33.8^{ab}	32.9^{ab}	34.7^{a}	31.0^{b}	0.041	0.986

*Note: WH0, WH25, WH50 and WH75: WH replacing rice straw at the levels of 0, 25, 50 and 75%, respectively. DM: Dry matter, OM: Organic matter, CP: Crude protein, NDF: Neutral detergent fiber, Different letters of a,b and c in the same row showed statistically significant differences at a level of 5%. *Bruinenberg et al. (2002).*

Table 2 showed that daily DM and OM intakes of cattle were significantly different ($P<0.05$) among the treatmnets, with the higher values for the WH0, WH25 and WH50 treatments. This probably caused by increasing fresh WH gradually with higher moisture content of WH compared to rice straw, which caused the bulky size of the diets in the rumen. The daily CP intake was not significantly different ($P>0.05$) among the treatments.While NDF intake was gradually low with the replaced WH treatments and was significantly different ($P<0.05$)

among the treatments, because WH is lower in NDF content compared to rice straw. The daily ME intake of was significantlly different ($P<0.05$) among the treatments with the highest value for the WH50 treatment (34.7 MJ), while the lowest value of ME intake for the WH75 treatment. The significant increase of ME intake in the WH50 treatment was due to the improvement of dietary DM and NDF digestibility (in Table 3) based on the principle suggested by Bruinenberg et al. (2002).

Apparent nutrient digestibility and nitrogen balance

The nutrient digestibility and nitrogen balance was showed in Table 3.

Table 3. Apparent nutrient digestibility and nitrogen retention of cattle fed different WH levels

	Treatments				**P**	**±SE**
	WH0	***WH25***	***WH50***	***WH75***		
App.digestibility, %						
DM	55.3^{b}	56.5^{b}	63.0^{a}	62.1^{a}	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						
N intake	73.4	75.0	73.3	74.3	0.919	2.87
N retention	27.3	28.3	28.9	27.2	0.967	3.93
N retention g/kg$W^{0,75}$	0.482	0.502	0.51	0.48	0.941	0.064
Initial. live weight,kg	215	216	213	214	0.096	1.04
Final live weight, kg	217	220	219	220	0.126	1.24
Daily weight gain, g	250^{a}	334^{ab}	448^{c}	403^{bc}	0.004	32.4

Table 3 indicated that DM digestibility was significantly different ($P<0.05$) among the treatments with the higher values for the WH50 and WH75 treatment. Similarly there was a trend of gradual improvement of OM, CP and NDF digestibility ($P>0.05$) for the WH replacement treatments. The CP digestibility of the treatments in the present study (from 67.5-69.7%) was consistent to those reported by Vo Duy Thanh (2008) being 67.5-69.7% when cattle fed ensilaged WH residues (pressing), rice straw and supplemented of multi-nutrient cake with the CP intake of 0.22kgCP/100kg LW. The improvement of nutrient digestibility was probably due to the reduction of fiber content in the WH replacement diets. Although nitrogen retention was higher for the WH50 treatment, however this was not statiscally significant ($P>0.05$). It was found that the daily weight gain was significantly different ($P<0.05$) among the treatments with the highest value for the WH50 treatment. Nguyen Van Thu (2011) also concluded that fresh water hyacinth used for feeding cattle and its replacement at level of 50% to Para grass (DM basis) could improve nutrient intakes, rumen parameters, microbial N supply and daily weight gain.

Rumen environment of cattle

Rumen parameters of cattle fed WH were presented in Table 4.

In Table 4 the rumen pH and N-NH_3 and total VFAs concentrations before and 3h post feeding were not significantly different (P>0.05) among the treatments. The pH values were similar before and 3h post feeding, while the N-NH_3 and VFAs concentrations were higher for the 3h post feeding in different treatments. When replacing para grass by WH in growing cattle diets, Nguyen Van Thu (2011) also stated that there was no significant difference in pH and N-NH_3 before and 3h post feeding among the treatments. However, total VFAs concentrations were higher at 3h post feeding and they were significantly different among the treatments with the highest value for the WH50 treatment and the lowest value for WH100. In summary the rumen environment of cattle supplemented fresh water hyacinth was good for the rumen microbial activities.

Table 4. The pH value and N-NH_3 and total VFAs concentration of cattle fed different WH levels

	Treatments				**P**	**±SE**
	WH0	***WH25***	***WH50***	***WH75***		
pH						
Before feeding	7.09	7.03	7.05	7.08	0.948	0.099
3 h post feeding	7.08	7.10	7.10	7.03	0.923	0.128
N-NH_3, mg/100ml						
Before feeding	14.2	14.6	14.7	14.0	0.934	1.27
3h post feeding	22.8	22.4	21.7	20.8	0.600	1.50
Total VFAs, mM						
Before feeding	82.4	83.5	81.8	82.7	0.981	4.19
3h post feeding	84.6	88.8	91.0	88.8	0.722	5.56

Economic analysis

The economic benefit of cattle fed water hyacinth was demostrated in Table 5.

Table 5. Economic analysis (VND/animal/day) from daily weight gain of the treatments

Item	**Treatments**			
	WH0	***WH25***	***WH50***	***WH75***
Feed cost	11,190	11,086	13,223	12,112
Income	17,500	23,380	31,360	28,210
Difference	6,310	12,294	18,137	16,098
Compared to WH0, %	100	133	160	118

Note: Water hyacinth: 500 VND/kg, rice straw: 1500 VND/kg and multi-nutrient cake: 7,000 VND/kg

CONCLUSION

The conclusion was that fresh WH could be replaced rice straw in cattle diet for improving dietary nutrient digestibility, metabolizable energy and daily weight gain. The appropriate level of WH replacement to rice straw in cattle diet could be 50%.

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REFERENCES

AOAC. 1990. Official methods of analysis, 15th ed., Association of official analytical chemist, Washington, DC.

Barnett, A. J. G. and Reid, R. L. 1957. Studies on the production of volatile fatty acids from grass by rumen liquor in an artificial rumen, The volatile fatty acid production from grass, Journal of Agricultural Science, 48, pp. 315–321.

Bruinenberg, M. H.*†, Valk, H. *, Korevaar, H. ‡ and Struik, P. C. 2002. Factors affecting digestibility of temperate forages from semi natural grasslands, ID TNO Animal Nutrition, Crop and Weed Ecology Group, Wageningen, The Netherlands.

Nigam, J. N. 2002. Bioconversion of water–hyacinth (*Eichhornia crassipes*) hemicellulose acid hydrolysate to motor fuel ethanol by xylose–fermenting yeast, Biochemistry Division, Regional Research Laboratory, Jorhat, Assam 785 006, India.

McDonald, P., Edwards, R. A., Greenhalgh, J. F. D., and Morgan, C. A. 2002. Animal Nutrition, 6th Edition, Longman Scientific And Technical, New York, pp. 560–570.

Minitab. 2010. Minitab reference manual release 16.2.0, Minitab Inc.

Nguyen Van Thu. 2011. Effects o water hyacinth in local cattle diets on nutrient utization, rumen parmeters and mirobial protein systhesis. SAADC2011 Proceedings. Thailand. Pp. 422

Nguyen Van Thu and Nguyen Thi Kim Dong. 2009. The use of water hyacinth. In Proceedings of Int. workshop Livestock, Climate change and the Environment. Mekarn Program. An Giang University 11-2009. http://www.mekarn.org/workshops/environ/proenv/thuctu.htm

Nguyen Van Thu, Nguyen Thi Kim Dong, Nguyen Van Hon and Vo Ai Quac. 1993. Effect of molasses-urea cake on performance of growing and working local buffaloes and cattle Livestock Research for Rural Development (LRRD). Vol 5. No.1: 1-9.

Van Soest, P. J., Win, R. H, and Moor, L. A. 1987. Estimation of the true digestibility of forage by the *in vitro* digestion of cell walls, Proc, 10th, Int. Grassl., Congress, Helsinki, pp. 348 – 441.

Vo Duy Thanh. 2008. Effect of the replacement of ensilaged water hyacinth residue to rice straw on rumen parameters, nutrient digestibility and nitrogen retention of local cattle. BSc thesis. Can Tho University.

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