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A RESPONSE OF NUTRIENT INTAKE, DIGESTIBILITY AND GROWTH RATE OF RABBITS (*Oryctolaguc cuniculus*) FED WATER SPINACH OR SWEET POTATO VINES WITH OR WITHOUT FIBER SUPPLEMENT

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ABSTRACT

*Two experiments were carried out to evaluate the effect of dietary fiber sources from vegetables and fiber supplements from Hymenache acutigluma or Wedelia trilobataon nutrient digestibility on nutrient digestibility and growth performance of rabbits. Both experiments were 2*3 factorial designs, with 3 replications. The first factor was vegetable [water spinach (WS) and sweet potato vines (SPV)]; the second one was fiber supplement with Wedelia trilobata (WT), Hymenache acutigluma (HA), or none. Experiment 1 was done on 4 male crossbred rabbits at 8 weeks of age in one experimental unit. In experiment 2, nutrient digestibility, nitrogen retention and caecum fermentation were determined on twelve-week old rabbits. The results showed that dry matter (DM) and organic intakes (OM) were similar (P>0.05) between vegetables and among fiber source supplements in the first experiment. The final weight and weight gain were significantly higher (P<0.05) for those treatment that animals fed with WS only compared to SPV in factor 1, and for treatment without fiber supplementation in factor 2. The higher benefits were found in the diets fed only SPV and the diet supplemented WT. In Exp. 2 the apparent digestibility of DM, OM were significantly higher than those animals fed the diet only WS (P<0.05), and the diets with or without supplemented with WT (P<0.05). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) digestibility values were significantly lower (P<0.01) in the diet with HA supplement. The caecal total volatile fatty acids (VFAs) were similar between WS and SPV diets, but significantly higher (P<0.05) in the diets with WT supplement and none compared to the supplemented HA. It was concluded that water spinach was superior to sweet potato vine as the basal diet for rabbits and that there were no nutritional benefits from offering higher fiber supplements.*

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1 INTRODUCTION

Crossbred rabbits (Local and improved pure breeds) are popularly raised in the Mekong delta, because of good natural conditions such as suitable ambient temperature, rich soil and available fresh water throughout the year. The local green feed resources are abundant in this region for both planted and natural plants such as sweet potato (*Ipomea batatas)* containing 32.9% NDF, 26.2%

ADF; water spinach *(Ipomoea aquatica)* containing 27.4% NDF, 19.2% ADF; Mom grass (*Hymenache acutigluma*) with 67.5% NDF, 32.4% ADF and Cuc (Wedelia trilobata) with 38.6% NDF, 29.6% ADF (Thu and Dong, 2011). However, there has been a limitation of studies on these feeds in the rabbit diets for further research and farmers' production. Therefore, the objectives of this study were to evaluate for rabbit production forages of sweet potato vine and water spinach supplemented with fiber sources from *Hymenache acutigluma* and Wedelia trilobata.

2 MATERIALS AND METHODS

2.1 Experiment 1. Feeding trial

2.1.1 Animals and experimental design

The experiment was conducted in the experimental farm and laboratories of Can Tho University. Seventy two male crossbred rabbits (local x improved breeds) at 8 weeks of age were allocated in a 2*3 factorial design, with 3 replicates and four male rabbits in one experimental unit. The first factor was two kinds of vegetables including of water spinach (WS) and sweet potato vines (SPV) as main feeds. The second factor was fiber source supplement; *Hymenache acutigluma (HA), Wedelia trilobata* (WT) or none. The rabbits had free access to water spinach or sweet potato vine, each with or without accessing to *Wedelia trilobata* or *Hymenache acutigluma* . The ratio of the two feeds in the diets was 1:1 based on DM. Paddy rice was supplemented to all the dietary treatments at the same level of 15g per day per rabbit to provide energy. The experimental period lasted for 8 weeks.

2.1.2 Feeds, feeding and management

Wedelia trilobata (WT) and *Hymenache acutigluma (HA)* were collected daily in the areas belonging to Can Tho University. Water spinach and Sweet potato vine were bought from one farm in the city. The animals were fed three times a day at 8:00h, 15:00h and 19:00h. Water was provided *ad libitum*. The refusals and spillage were collected and weighed daily in the morning to calculate the precise feed intake. The animals were vaccinated to prevent rabbit hemorrhagic and parasite diseases.

2.1.3 Measurements

The feeds and refusals were taken for analyses of dry matter (DM), crude protein(CP), ether extract (EE) and Ash following AOAC procedure (1990) and NDF and ADF were done according to Robertson and Van Soest *et al.* (1991). During the experiment the rabbits were weekly weighed individually. The daily feed intakes, growth rate and feed conversion ratios were measured and calculated. After finishing the experiment the rabbits were slaughtered for evaluating carcass and meat quality. The economic analysis was also done.

2.2 Experiment 2. Digestibility trial

2.2.1 Animals and experimental design

The second experimental design was similar to that of the feeding trial, however, thirty six growing male crossbred rabbits at 12-week of age were used. Diets were divided into 3 parts and fed at 7.00, 13.00 and 17.00. A 14 day adaptation period was done to ensure that all rabbits were acclimated to trial conditions. Afterwards, the feed offered, refusals, faeces and urine were collected for 7 days of the third week to measure feed and nutrient digestibility and nitrogen retention (McDonald *et al*., 2011). At the end of the third week the rabbits in each experimental unit were slaughtered at 9.00 am (3 hours post feeding) to get the caecum content which was treated immediately for measuring VFA concentration following the methods described by Barnett and Reid (1957).

2.2.2 Statistical analysis

The data from both experiments were analyzed by analysis of variance using the ANOVA of General Linear Model of Minitab Reference Manual Release 13.21 (Minitab, 2000). The Tukey test was used to compare the means of the criteria (Minitab, 2000). Economic analyses were done using current prices in Vietnamese Dong (VND) to compare differences of income and the feed cost in different treatment

3 RESULTS AND DISCUSSION

3.1 Feed composition and intake

The chemical composition of the feed ingredients in the trial is shown in Table 1.

Mom grass (*Hymenache acutigluma)* had the highest DM content (15.7%) compared to those of Cuc (Wedelia trilobata) (12.1%*),* water spinach (9.63%) and sweet potato vine (8.56%). These figures were similar to reports of Mo (2003), Phu (2004) and Hung (2006). Crude protein content was higher for sweet potato vine and water spinach. However, these values were slightly lower than those of Mo (2004) and Linh (2005) due to the effects of rainy season for the experiment. The NDF content was high in Mom grass (66.3%). The ADF content of Mom grass and Cuc was higher than those of sweet potato vine and water spinach. Paddy rice supplemented had DM and CP content of 87.4 and 6.68%, respectively.

Table 1: Chemical composition (% in DM, except for DM which is on fresh basis)

	DM	OM	CP	NDF	ADF	Ash
Water spinach	9.63	89.1	18.1	37.2	25.0	10.9
Sweet potato vine	8.56	87.6	18.8	41.4	29.6	12.4
Mom grass (*Hymenache acutigluma*)	15.7	90.7	12.4	66.3	36.9	9.32
Cuc (Wedelia trilobata*)*	12.1	84.5	10.0	41.8	34.3	15.5
Paddy rice	87.4	93.6	6.68	29.1	15.8	6.37

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

Table 2: Daily intakes of feeds and nutrients of growing rabbits (g, DM/rabbit/day)

Item	Main feed (MF)		Supplementation (S)			P		
	WS	SPV	None	HA	WT	MF	S	MF*S
Feed intake								
WS	33.4	0.00	22.0^{a}	14.7^{b}	13.4^{b}	***	**	**
SPV	0.00	31.7	22.3^{a}	13.2^{b}	12.1^{b}	***	***	***
HA	6.20	6.82	0.00	19.5	0.00	ns	***	ns
WT	6.48	7.30	0.00	0.00	20.7	ns	***	ns
PR	17.5	17.5	17.5	17.5	17.5	ns	ns	ns
Nutrient intake								
DM	63.0	62.7	61.1	64.4	63.0	ns	ns	ns
OM	56.7	56.0	54.9	58.3	55.8	ns	ns	ns
CP	8.58	8.64	9.27^{a}	8.70^{ab}	7.87^{b}	ns	*	ns
NDF	24.8	26.4	22.3^{a}	31.1^{b}	23.5^{a}	ns	***	ns
ADF	15.5	16.8	14.8^{a}	17.0^{b}	16.7^{ab}	ns	*	ns

DM:dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fiber, ADF: acid detergent fiber, WS: Water spinach, SPV: Sweet potato vine, HA: Hymenache Acutigluma, WT: Wedelia trilobata and PR: paddy rice.
$^{a, b}$ Means with different letters within the same rows are significantly different at the 5% level

The DM intake was not significantly different between main feeds (WS and SPV) and among different supplements (Table 2). These results were consistent with reports of Thu and Dong (2005) being from 51.4 to 61.5 g DM /rabbit/day in a study with sweet potato replacing para grass in growing rabbit diets.

Daily weight gain, feed conversion ratio and economic analysis

Daily weight gain, feed conversion ratio and economic analysis are shown in Table 3.

Table 3: Daily weight gain, feed conversion and economic returns of rabbits in the feeding trial

Item	Main feed (MF)		Supplementation (S)			P		
	WS	SPV	None	HA	WT	MF	S	MF*S
Initial weight, g	760	756	785	730	759	ns	ns	ns
Final weight, g	1863	1770	1902^{a}	1753^{b}	1796^{ab}	*	*	ns
DWG, g	16.0	14.8	16.7^{a}	14.6^{b}	14.8^{b}	*	*	ns
FCR	3.95	4.26	3.63^{a}	4.42^{b}	4.27^{b}	*	**	ns
Feed cost (VND/rabbit)	22,334	18,489	24,327	18,714	18,194			
Total expense (VND/rabbit)	42,334	38,489	44,327	38,714	38,194			
Total income (VND/rabbit)	55,900	53,100	57,050	52,575	53,875			
Profit (VND/rabbit)	13,566	14,611	12,723	13,861	15,681			

DWG: daily weight gain, FCR: feed conversion ratio
$^{a, b}$ Means with different letters within the same rows are significantly different at the 5% level

Final weight and daily weight gain were significantly higher in the WS diet and the diet including WS or SPV without supplement of HA or WT ($P<0.05$). The results of daily weight gain of crossbred rabbits fed local green foliages in the present experiment ranged from 14.8 to 16.0g. They are consistent with those (from 11.0 to 19.0g) of other reports in Vietnam by Linh (2005), Thu and Dong (2005), Hung (2006) and Dong *et al*. (2006). The values were also within the range reported by Samkol *et al.* (2006). They were slightly lower than those found by Phimmasan *et al*.

(2004); Hue and Preston (2006). Feed conversion ratio of the rabbits in all diets ranged from 3.63 to 4.42, and the WS diet had better FCR than the SPV diet ($P<0.05$). Significantly lower values were found in the diets without HA or WT supplementation ($P<0.01$). The economic analysis showed that benefits got from the SPV diet and diet supplemented with WT were higher than the rest of the diets due to lower cost of feeds, despite growth rate and feed conversion ratio of the WS diet and the vegetable diet without supplement being better. Thus the local green feed sources available can be used as staple feeds in the rabbit diets to get better benefits by farmers.

Mean values for slaughter weights, carcass traits and meat quality of growing rabbits.

Table 4: Mean values for slaughter weights, carcass traits and meat quality of growing rabbits

Item	Main feed (MF)		Supplementation (S)			P		
	WS	SPV	None	HA	WT	MF	S	MF*S
Live weight , g	2080	2008	2167	2013	1952	ns	ns	ns
Carcass weight, g	999	914	1033	930	907	ns	ns	ns
Carcass percentage, %	47.9	45.5	47.6	46.2	46.2	ns	ns	ns
Thigh meat weight, g	294	269	303	276	264	ns	ns	ns
Thigh/carcass ,%	29.4	29.3	29.3	29.7	29.1	ns	ns	ns
Lean meat weight, g	794	722	818	739	717	ns	ns	ns
Lean meat percentage,%	79.7	78.9	79.3	79.4	79.1	ns	ns	ns
Caecum weight, g	206	186	213	188	187	ns	ns	ns
Stomach weight, g	133	127	139	126	125	ns	ns	ns
Meat quality in fresh, %								
DM	24.2	24.1	24.6	24.0	23.9	ns	ns	ns
OM	95.1	95.1	94.9	95.1	95.3	ns	ns	ns
CP	19.1	19.0	19.1	18.9	19.2	ns	ns	ns
EF	6.78	6.94	7.20	6.82	6.56	ns	ns	ns
Ash	4.86	4.89	5.07	4.87	4.69	ns	ns	ns

DM: dry matter, OM: organic matter, CP: crude protein, WS: Water spinach, SPV: Sweet potato vine, HA: Mom grass and WT: Cuc, Carcass weight (without head, feet and offal); ns: none significant

The criteria of carcass, thigh meat, lean meat and meat quality were not significantly affected by the two kinds of vegetables, and three kinds of fiber supplement (none, HA or WT) (Table 4). Thu and Dong (2005) in a study of sweet potato vine replacing para grass in the diets reported that the carcass and lean meat percentage of growing crossbred rabbits were from 41.6 to 47.1% and from 67.8 to 79.2%, respectively. Crude protein content of rabbit meat in the present experiment was from 18.9 to 19.2%, while this was 22.5% in the study of Chuong (2003). In the current experiment paddy rice was the energy supplement, while in other experiments on pure improved breeds concentrates were mostly used for supplements.

Experiment 2: Digestibility trial

Chemical composition of feedstuffs used (Table 5) was similar to those in experiment 1, except for a slightly lower CP content of the SPV. Feed intakes ranged from 57.8 to 61.0g DM/day, and the values were closed between main feed and among fiber supplements.

Table 5:Chemical composition of feed ingredients (%DM, except for DM which is on fresh basis)

Feed	DM	OM	CP	NDF	ADF	Ash
Water Spinach (WS)	7.30	84.8	17.7	34.5	26.6	15.2
Sweet Potato (SPV)	8.37	81.8	16.7	39.9	24.6	18.2
Hymenache acutigluma (HA)	14.0	88.9	13.4	66.5	34.2	11.1
Wedelia trilobata (WT)	11.2	85.5	10.9	39.4	32.0	14.5
Paddy rice (PR)	87.4	93.6	6.68	29.1	15.8	6.4

The apparent DM digestibility was higher for the diets with WS than for those with SPV but there were no differences in crude protein digestibility (Table 6). Supplementing the vegetable component with the WT and HA tended to reduce digestibility coefficients although the differences were only significant for the HA supplement.

Table 6: Effect of vegetable source and fibrous supplements on apparent digestibility of dietary components, N retention and total volatile fatty acids (VFA) in the caecal contents

Item	Main feed (MF)		Supplementation (S)			P		
	WS	SPV	None	HA	WT	MF	S	MF*S
Feed intake (g DM/day)	61.0	57.8	59.4	59.0	58.9	ns	ns	ns
Apparent digestibility (%)								
DM	71.0	67.5	73.2[a]	62.9[b]	71.6[a]	*	***	ns
OM	71.5	68.0	73.8[a]	63.4[b]	72.2[a]	*	***	ns
CP	70.8	70.9	73.3	68.2	71.2	ns	ns	ns
NDF	56.4	52.8	62.1[a]	45.8[b]	56.0[a]	ns	**	ns
ADF	48.7	43.8	56.4[a]	35.2[b]	47.0[c]	ns	***	ns
Nitrogen balance (g/kgW$^{0.75}$)								
Nitrogen intake	1.07	0.99	1.08	1.07	0.95	ns	ns	ns
Nitrogen retention	0.64	0.60	0.67	0.63	0.57	ns	ns	ns
Total VFA, mM/g	77.7	77.8	77.5[ab]	72.8[a]	82.9[b]	ns	*	ns

VFAs: volatile fatty acids, [a, b] Means with different letters within the same rows are significantly different at the 5% level

Perez *et al.* (1996) stated that a high level of fibre in the diet leads to decreased retention time of ingesta and an increase of caecotrope production because of increasing bacterial fibrolytic activity, which in turn results in a reduction of diet digestibility (De Blas *et al.,* 1998). In a recent study of water spinach leaves fed to growing rabbits, Dong *et al.* (2006) reported that the DM digestibility and CP digestibility were from 62.7 to 73.0 and 82.0 to 84.5, respectively. Samkol, *et al.* (2006) reported DM, CP and NDF digestibilities were similar to those in the present study. Nitrogen retention of the rabbits did not differ among treatments (Table 6).

4 CONCLUSIONS

The conclusions of the study were that water spinach was better than sweet potato vine as the basal diet for rabbits. There were no nutritional benefits from offering high fibre supplements such as Wedelia trilobata and *Hymenache acutigluma* with exception of feed cost reduction.

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