



## Effect of Feeding Head Lettuce, Water Spinach, Ruzi grass or *Mimosa pigra* on Feed Intake, Digestibility and Growth in Rabbits

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**ABSTRACT :** The performance of growing rabbits fed Ruzi grass (*Brachiaria ruziziensis*), head lettuce (*Lactuca sativa*) residue, *Mimosa pigra* and water spinach (*Ipomoea aquatica*) was studied in an experiment using 64 rabbits (4 males and 4 females per treatment) of 2 breeds, New Zealand White and a crossbred between New Zealand White and native breed. The rabbits had an average initial weight of 668 g, were about 6 weeks old and were housed in individual pens. The foliages were fed *ad libitum* and a commercial concentrate was fed at a restricted level of 2% of body weight on a dry matter (DM) basis. In the digestibility experiment, the rabbits, 4 per foliage and males only, were fed the same foliages as in the growth experiment but without concentrate. Daily weight gain was lower in the group fed Ruzi grass, 14.8 g/d ( $p < 0.001$ ) compared to 17.6, 18.5 and 18.4 g/d for head lettuce, *Mimosa pigra* and water spinach, respectively. Feed intake and feed conversion ratio were lowest for the rabbits fed water spinach, 66 g DM/d and 3.6 kg DM/kg live weight, respectively. The New Zealand White breed had a higher daily gain than the crossbred rabbits ( $p < 0.05$ ), 18.0 and 16.7 g/d, respectively. There were no significant differences in feed intake, growth or feed conversion ratio due to sex. The digestibility coefficients of DM, organic matter, crude protein, crude fiber, neutral detergent fiber and acid detergent fiber were significantly lower ( $p < 0.001$ ) in the rabbits fed Ruzi grass. Breed and sex had no effect on digestibility. In conclusion, feeding head lettuce residue, *Mimosa pigra* and water spinach resulted in higher growth rate and digestibility than feeding Ruzi grass and can be recommended as alternative feeds. (**Key Words :** Growth, Digestibility, Rabbits, Head Lettuce, Water Spinach, Ruzi Grass, *Mimosa pigra*, Breed, Sex)

### INTRODUCTION

Rabbits have potential as meat producing animals in the tropics due to characteristics such as small body size, short generation interval, rapid growth rate and ability to utilise forages or agricultural by-products. Rabbits could contribute significantly to solving the problem of meat shortage (Taylor, 1980; Lebas, 1983). Ruiz-Feria et al. (1998) reported that rabbits could subsist on inexpensive diets based on forages under small-scale farm conditions in arid and tropical regions. Agricultural by-products, foliages and weeds such as sugar cane, cassava root meal, rice bran, natural grasses and *Leucaena* can be used as dietary ingredients for rabbits (Lukefahr and Cheeke, 1991; Ha et

al., 1996; Ruiz-Feria et al., 1998). Delgado et al. (1999) reported that the demand for human food from animal products is continually increasing. Meat from rabbits has a low cholesterol level, high protein/energy ratio and is relatively rich in essential fatty acids (Iraqi, 2003).

Head lettuce (*Lactuca sativa*) is a vegetable commonly grown by upland farmers in South East Asia and the residues from head lettuce after grading is found in quite large quantities. *Mimosa pigra* is a weed that is spread by seeds over many areas in South East Asia. Vearasilp et al. (1981) reported a potential use of *mimosa* as a livestock feed resource with relatively high protein content, 200 g crude protein (CP)/kg dry matter (DM). Water spinach (*Ipomoea aquatica*) is an aquatic plant cultivated for human food and used for pigs and other animals in South East Asia. The fresh leaves and stems of water spinach have a CP content of between 200 and 310 g/kg DM (Men et al., 2000). Water spinach can be fed as a basal diet to rabbits (Phimmasan et al., 2004; Samkol, 2005) and appears to have a high potential as a forage source for rabbits (Phimmasan, 2003). Ruzi grass

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(*Brachiaria ruziziensis*) has been promoted as a good grass for improving pastures for cattle in the tropics. According to a report from FAO (1990) this grass can tolerate drought and can grow at altitudes from 100 m up to 1,200 m. The protein content at 45 days of age is reported to be about 75 g CP/kg DM (Narmsilee et al., 2003).

The objective of this study was to evaluate the effect of feeding head lettuce (*Lactuca sativa*) residue, mimosa (*Mimosa pigra*) or water spinach (*Ipomoea aquatica*) compared to Ruzi grass (*Brachiaria ruziziensis*) on growth performance, feed intake and digestibility in rabbits.

## MATERIALS AND METHODS

### Location and climate of the study area

The experiment was conducted at the Demonstration Farm of the Royal Project Foundation, Chiang Mai, Thailand. The climate in this area is tropical monsoon, with a wet season from May to October and a dry season from November to April. The rainfall during the experiment was around 875 mm and the temperature was 31°C in the daytime and 23°C at night. The relative humidity varied between 75 and 88% during 24 h. The experiment started in late June and finished in October 2006.

### Animals and management

Weaned rabbits, pure New Zealand White (NZW) and crossbreds between native rabbits and New Zealand White (NN), 6 weeks old and weighing 668 g (SD = 16.5) were used. The rabbits, 32 animals of each breed and equal numbers of males and females, were confined in individual cages. Before the start of the experiment the rabbits were dewormed using Ivermectin injection, 0.1 ml/kg BW. Four male rabbits from each treatment in the growth experiment were used in the digestibility experiment.

### Feeds and feeding systems

A commercial feed for growing pigs was used as the basal diet in the growth experiment. Major ingredients in the commercial concentrate were maize and rice bran as energy sources and soybean meal and fishmeal as protein sources. The concentrate was fed at a level of 2% (in DM) of BW.

The foliages used in the experiment were Ruzi grass, head lettuce residue, mimosa and water spinach. Head lettuce residue was collected every day from the pack house of the Royal Project Foundation. Before being offered the head lettuce residue was air-dried for 10 to 12 h. Mimosa was collected from the fields around the farm and cut approximately 15 cm from the top, (leaves and stem included), and the leaves from the part >15 cm from the top were also included. Ruzi grass was planted in the farm and

was harvested at 45 to 60 days of age. Mimosa and Ruzi grass were harvested once per day at about 17.00 h. Water spinach was bought fresh every day from the market.

The foliages were hung in the cage and offered *ad libitum* at a level of 120% of the average individual intake the previous week. Clean water was available at all times.

The diets were fed twice daily at 7.00 h and 16.00 h with 50% of the feed at each occasion. The head lettuce residue was fed 3 times a day at 7.00 h, 12.00 h and 17.00 h to increase the level of offer and feed intake because the head lettuce residue had very low DM content and fermented quickly if offered in large amounts at the same time.

In the digestibility experiment the rabbits continued on the same treatment and were fed the same foliages as in the growth experiment, but without concentrate.

### Experimental design

The experimental design of the growth experiment was a Completely Randomized Design (CRD) with three factors: four kinds of foliages: Ruzi grass, head lettuce residue, mimosa and water spinach, two breeds of rabbits: New Zealand White and a crossbred between New Zealand White and native breed and two sexes. The experimental design in the digestibility experiment was a CRD with the same four kinds of foliages and two breeds. Both experiments had four replicates.

### Data collection and analysis

The rabbits in the growth experiment were weighed at the beginning of the experiment and then every 7 days, always in the morning before feeding. Feed offered and refused was weighed every day to calculate feed intake and determine feed conversion ratio from DM intake. The feeds and feed residues were sampled every day for analysing the chemical composition. Foliages in the field were sampled every 3 days to analyse DM.

In the digestibility experiment feed offered and feed residues were weighed and recorded every day. Faeces were collected every day, feed, hair or other contaminations were removed and the samples were kept in plastic bags in a freezer until analysed.

The feed, feed residues and faeces were analysed for DM, ash, N, ether extract (EE) and crude fiber (CF) according to AOAC (2000). Neutral detergent fiber (NDF) and acid detergent fiber (ADF) was analysed according to Van Soest and Robertson (1985). The gross energy (GE) in the samples was measured by a Bomb calorimeter. Digestible energy (DE) for the concentrate and metabolisable energy (ME) for the foliages and concentrate was estimated according to Noblet and Perez (1993) as mentioned by NRC (1998).

**Table 1.** Chemical composition of the experimental feeds in the growth experiment (means and SD)

	Ruzi grass	Head lettuce	<i>Mimosa pigra</i>	Water spinach	Concentrate
n	5	5	5	5	3
DM (g/kg)	174 (6.6)	39 (3.9)	363 (31.1)	62 (5.9)	894 (0.4)
In g/kg DM					
OM	899 (9.3)	884 (9.1)	923 (0.9)	881 (7.6)	908 (0.2)
Ash	101 (9.3)	115 (9.5)	77 (0.9)	119 (7.6)	92 (0.2)
CP	89 (10.0)	188 (12.7)	177 (8.4)	252 (38.6)	136 (0.3)
EE	40 (0.4)	45 (2.9)	34 (3.6)	41 (1.0)	66 (2.1)
CF	266 (31.4)	127 (2.2)	220 (18.5)	126 (6.3)	54 (0.4)
GE (MJ/kg DM)	17.1 (0.5)	15.8 (0.5)	19.6 (0.9)	14.7 (0.5)	19.4 (0.4)
DE (MJ/kg DM) <sup>1</sup>	7.8 (0.2)	11.8 (0.4)	11.9 (0.5)	9.7 (0.4)	13.6 (0.1) <sup>2</sup>
ME (MJ/kg DM) <sup>3</sup>	7.7 (0.2)	11.3 (0.4)	11.5 (0.5)	9.2 (0.3)	13.3 (0.1)

<sup>1</sup> DE = GE×digestibility for GE. <sup>2</sup> DE = 4.151-(122×% ash)+(23×% CP)+(38×% EE)-(64×% CF). <sup>3</sup> ME = DE×(1.003-(0.0021×% CP)) (NRC, 1998).

**Table 2.** Chemical composition of foliages in the digestibility experiment (mean and SD)

	Ruzi grass	Head lettuce	<i>Mimosa pigra</i>	Water spinach
n	3	3	3	3
DM (g/kg)	183 (0.6)	40 (1.2)	347 (1.0)	63 (2.3)
In g/kg DM				
OM	893 (5.2)	881 (3.0)	924 (1.2)	879 (6.0)
Ash	107 (5.2)	119 (3.0)	76 (1.2)	121 (6.0)
CP	89 (7.4)	190 (17.3)	178 (5.0)	284 (5.1)
EE	40 (0.6)	44 (1.2)	34 (2.0)	42 (1.0)
CF	296 (8.0)	126 (1.2)	231 (10.0)	123 (5.2)
NDF	628 (2.5)	251 (3.5)	500 (5.5)	322 (3.5)
ADF	424 (6.0)	224 (7.1)	339 (7.0)	263 (5.0)

Number of samples of head lettuce and *Mimosa pigra* for ADF and NDF were 5.

### Statistical analysis

The data were analysed using the ANOVA GLM option of the Minitab version 14.12 software (Minitab, 2004). The means were compared using Tukey's pairwise comparison test. The statistical model for the growth experiment was:  $Y_{ijkl} = \mu + T_i + B_j + S_k + \beta W_l + e_{ijkl}$  where  $T_i$  = treatment,  $B_j$  = breed and  $S_k$  = sex. All interactions were tested and included in the model if they were significant. Initial weight ( $W_l$ ) was used as a covariate in the model.

The model for the digestibility experiment was the same as for the growth experiment, but since all animals were male, sex was not included.

## RESULTS AND DISCUSSION

### Chemical composition and nutrient content of the feeds

The chemical composition of the experimental feeds is shown in Table 1 and 2 for the growth trial and the digestibility trial, respectively. Water spinach and head lettuce residue had a high protein content of 252 and 188 g, respectively. According to Gang et al. (2006) and Chhay and Preston (2006), the CP content in water spinach was 232 and 256 g/kg DM, respectively, similar to the present results.

Head lettuce residue and water spinach, both used as vegetables for human consumption, had a low DM content of about 40 and 62 g/kg, respectively. Many different

vegetables or vegetables residues have been shown to have low DM content e.g. cabbage residues (37 to 102 g DM/kg), as reported by Ngu and Ledin (2005) and sweet potato vines (119 g DM/kg), according to Lam and Ledin (2005). Also the fibre content of head lettuce residue and water spinach was low, 127 and 126 g/kg DM, respectively, compared to some other vegetable varieties such as cabbage and cauliflower, 186 and 119 g/kg DM, respectively (Gupta et al., 1993).

The mimosa contained 177 g CP/kg DM similar to values obtained by Hong and Quac (2005) who reported that the DM content of mimosa was 360 g and the CP, NDF and ADF content, 207, 534 and 379 g/kg DM, respectively. The CP content of Ruzi grass was 89 g/kg DM, which is in agreement with Narmsilee et al. (2003).

### Feed intake and digestibility

Effects of foliage, breed and sex on feed intake are shown in Table 3. Foliage had a significant effect on feed intake, more important than the effects of breed and sex. Total DM intake for the groups fed mimosa and head lettuce residue, 96 and 81 g/day, respectively, was higher than for the groups fed Ruzi grass or water spinach, 70 and 66 g/day, respectively ( $p < 0.001$ ). The rabbits fed water spinach had the significantly lowest DM intake expressed in  $g/W^{0.75}$  and the highest DM intake was in the group fed mimosa. The DM intake expressed as  $g/kg W^{0.75}$  was in general lower

**Table 3.** Effect of foliages, breed and sex on feed intake

	Feed intake g DM/d			DM intake		Energy intake	
	Foliage	Concentrate	Total	In % of BW	g/kg W <sup>0.75</sup>	DE	ME
<b>Foliage</b>							
Ruzi grass	42 <sup>b</sup>	28 <sup>b</sup>	70 <sup>bc</sup>	5.2 <sup>b</sup>	55 <sup>b</sup>	0.7 <sup>c</sup>	0.7 <sup>c</sup>
Head lettuce	49 <sup>b</sup>	32 <sup>a</sup>	81 <sup>b</sup>	5.3 <sup>b</sup>	58 <sup>b</sup>	1.0 <sup>b</sup>	0.9 <sup>b</sup>
<i>Mimosa pigra</i>	63 <sup>a</sup>	33 <sup>a</sup>	96 <sup>a</sup>	6.2 <sup>a</sup>	68 <sup>a</sup>	1.2 <sup>a</sup>	1.1 <sup>a</sup>
Water spinach	34 <sup>c</sup>	33 <sup>a</sup>	66 <sup>c</sup>	4.4 <sup>c</sup>	48 <sup>c</sup>	0.8 <sup>c</sup>	0.7 <sup>c</sup>
<b>Sex</b>							
Female	48	31	80	5.3	58	0.9	0.9
Male	46	31	77	5.2	57	0.9	0.8
<b>Breed</b>							
NZW	47	32	79	5.2	57	0.9	0.9
NN	47	30	77	5.3	58	0.9	0.9
SE	4.5	0.9	4.9	0.3	3.3	0.04	0.03
<b>Level of significance</b>							
Foliage	***	***	***	***	***	***	***
Breed	NS	*	NS	NS	NS	NS	NS

<sup>a, b, c</sup> Means within foliage, sex or breed in a column with different superscripts are significantly different ( $p < 0.05$ ). \*  $p < 0.05$ ; \*\*\*  $p < 0.001$ .

NS = Non-significant NZW = New Zealand White; NN = Crossbred between New Zealand White and Native breed.

than the values reported by Phimmasan (2005), 66.9, 83.3 and 75.8 g/kg W<sup>0.75</sup> for Guinea grass, native grass and Stylo 184, respectively. The high water content in the vegetable foliages probably affected intake negatively. The DM content can be improved by air-drying the foliages before feeding. Arias et al. (2003) reported that the greatest disadvantage of vegetable wastes used as feeds is the low DM content, resulting in low DM intake. The DM intake can also be improved by offering high fibre feeds such as maize stubble or maize cobs at the same time as the vegetables. Ngu and Ledin (2005), using vegetable wastes as feeds for goats, included natural grass in the experimental diet to improve DM intake and fibre balance in the gut. The DM intake of rabbits increased significantly when water spinach or sweet potato wines was offered together with Guinea grass (Gang et al., 2006).

The protein and fibre intake are presented in Table 4. Total CP intake was significantly highest in the group fed mimosa, 15.6 g/day, and lowest in the group fed Ruzi grass, 7.7 g/day, corresponding to 16.2 and 11.0% of diet DM, respectively. According to Lei et al. (2004) the best growth performance was obtained with diets containing 16 to 20% CP. There were no significant differences in total DM, DE, ME, CP and fibre intake due to breed or sex and no interactions between foliages, breed and sex with the exception of concentrate intake, which was higher for the NZW rabbits. Since the NZW rabbits consumed more concentrate than the crossbred rabbits, intake of CP and fibre from concentrate was higher for the NZW rabbits.

Low DM and poor fibre content in head lettuce residue and water spinach may be negative factors leading to a risk of fibre deficiency. According to Yin Chang et al. (2007)

**Table 4.** Effect of foliages, breed and sex on protein and fiber intake

	Protein intake (g/d)			Fiber intake (g/d)		
	Total	Foliage	Concentrate	Total	Foliage	Concentrate
<b>Foliage</b>						
Ruzi grass	7.7 <sup>c</sup>	3.9 <sup>c</sup>	3.8 <sup>b</sup>	14.4 <sup>b</sup>	11.2 <sup>b</sup>	1.5 <sup>c</sup>
Head lettuce	13.7 <sup>b</sup>	9.4 <sup>b</sup>	4.3 <sup>a</sup>	8.0 <sup>c</sup>	6.2 <sup>c</sup>	1.7 <sup>b</sup>
<i>Mimosa pigra</i>	15.6 <sup>a</sup>	11.1 <sup>a</sup>	4.5 <sup>a</sup>	17.1 <sup>a</sup>	13.9 <sup>a</sup>	1.8 <sup>a</sup>
Water spinach	12.6 <sup>b</sup>	8.1 <sup>b</sup>	4.5 <sup>a</sup>	6.0 <sup>d</sup>	4.0 <sup>d</sup>	1.8 <sup>a</sup>
<b>Sex</b>						
Female	12.6	8.4	4.3	11.7	9.1	1.7
Male	12.1	7.9	4.2	11.1	8.5	1.7
<b>Breed</b>						
NZW	12.6	8.3	4.3	11.5	8.9	1.7
NN	12.1	8.0	4.2	11.3	8.8	1.6
SE	0.9	0.8	0.1	1.0	0.9	0.1
<b>Level of significance</b>						
Foliage	***	***	***	***	***	***
Breed	NS	NS	**	NS	NS	**

<sup>a, b, c</sup> Means within foliage, sex or breed in a column with different superscripts are significantly different ( $p < 0.05$ ). \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

NS = Non-significant, RG = Ruzi grass; NZW = New Zealand White; NN = Crossbred between New Zealand White and Native breed.

**Table 5.** Effects of foliages and breed on the digestibility (%) in rabbits

	DM	OM	GE	CP	EE	CF	NDF	ADF
Foliage								
Ruzi grass	48.7 <sup>d</sup>	52.4 <sup>d</sup>	45.6 <sup>d</sup>	52.4 <sup>c</sup>	51.7 <sup>b</sup>	30.7 <sup>c</sup>	40.3 <sup>c</sup>	41.9 <sup>b</sup>
Head lettuce	79.3 <sup>a</sup>	81.6 <sup>a</sup>	74.3 <sup>a</sup>	80.0 <sup>a</sup>	64.0 <sup>a</sup>	59.4 <sup>a</sup>	57.8 <sup>b</sup>	63.6 <sup>ab</sup>
Mimosa pigra	57.6 <sup>c</sup>	61.0 <sup>c</sup>	60.7 <sup>b</sup>	50.6 <sup>c</sup>	38.2 <sup>c</sup>	45.7 <sup>b</sup>	42.6 <sup>c</sup>	39.3 <sup>b</sup>
Water spinach	72.6 <sup>b</sup>	75.4 <sup>b</sup>	65.8 <sup>b</sup>	76.7 <sup>b</sup>	36.8 <sup>c</sup>	55.8 <sup>a</sup>	67.1 <sup>a</sup>	67.8 <sup>a</sup>
Breed								
NZW	64.4	67.8	60.9	64.3	46.8	47.2	51.0	53.3
NN	64.7	67.5	62.3	65.5	48.5	48.5	52.9	53.0
SE	1.9	1.7	2.1	1.8	3.1	2.6	2.3	2.5
Level of significance								
Foliage	***	***	***	***	***	***	***	****
Breed	NS	NS	NS	NS	NS	NS	NS	NS
Foliage×breed	NS	NS	NS	NS	NS	**	***	***

<sup>a, b, c</sup> Means within foliage, sex or breed in a column with different superscripts are significantly different (p<0.05). \*\* p<0.01; \*\*\* p<0.001.

NS: Non-significant. NZW = New Zealand White; NN = Crossbred between New Zealand White and Native breed.

diets containing fibre with high digestibility can cause diarrhoea. It is not clear what the minimum fibre intake for prevention of diarrhoea in rabbits should be. Reports from Blas et al. (1994) and Gidenne and Jehl (2000) examining the effect of low fibre diets to rabbits, showed that a sharp decrease in fibre level from 19% to 9% in the diet doubled the risk of digestive trouble. The population of cellulolytic bacteria decreased in the caecum, and the microbial ecology system in the caecum became unbalanced, which may cause death from diarrhoea. In this study the fibre intake from head lettuce and water spinach was 8.0 g and 6.0 g/day, respectively, around 10% of DM intake. The fibre requirement in growing rabbits at 4 to 12 weeks of age is about 11.2 g/kg BW/d (FAO, 1997). These requirements are almost twice the fibre intake in this study, but all the experimental rabbits survived and there was no mortality during the experiment. It may be that since only a low amount of concentrate was used in this study most of the starch in the feed was digested in the fore gut of the animal, which would have meant that starch was not available in the caecum for the group of harmful bacteria (*E. coli*/Clostridia) and the fibre content in lettuce head was enough for the cellulolytic bacteria to increase the population and to control the balance of micro-organisms in the caecum.

Bennegadi et al. (2001) reported that a lower content of fibre in the diet causes a slowing down of the digesta transit resulting in a longer retention time, mainly in the caecum, and an increased fermentation rate of feed particles. The vegetables had a lower fibre content but a higher digestibility of fibre than for the other two foliages which can be a consequence of longer retention time of feed particles in the caecum, or that the fibre was of a different quality.

The DE intake was higher for the animals fed mimosa and head lettuce residue than for the animals fed water spinach and Ruzi grass, 1.2 MJ, 1.0 MJ, 0.8 MJ and 0.7 MJ

DE/d, respectively, corresponding to 1.1 MJ, 0.9 MJ, 0.7 MJ and 0.7 MJ ME/d, respectively. Energy intake per day was similar to the values of 1 MJ and 0.8 MJ ME/d, respectively, for Guinea grass and *Spilanthes acmella* reported by Phimmasan (2005) but lower than the energy requirement recommended for growing rabbits by NRC (1977) and FAO (1997), 2.5 MJ DE/d.

The digestibility coefficients of the nutrients are presented in Table 5. The digestibility coefficients of DM, organic matter (OM), GE, CP, CF, NDF and ADF were significantly higher for the rabbits fed head lettuce residue and water spinach than for the rabbits fed Ruzi grass and mimosa. Arias et al. (2003) reported a comparable *in vitro* digestibility of 71.2% for DM in lettuce. The digestibility of DM and CP of water spinach was lower than reported by Gang et al. (2006), 86.1% and 84.7% and Samkol (2005) 80.5%, and 80.1%, respectively. The digestibility coefficient of GE was lowest in the group fed Ruzi grass, 45.6%, lower than for mimosa, water spinach and head lettuce residue, 60.7, 65.8 and 74.3%, respectively. The group fed head lettuce had the highest digestibilities for all nutrients except for NDF and ADF. Fibre digestibility was highest in water spinach, 67.1 and 67.8%, for NDF and ADF, respectively. Ruzi grass and mimosa had generally low digestibilities, e.g. 52.4 and 50.6% for CP, respectively. The legume foliage had lower digestibility than the vegetable foliages but was similar to Ruzi grass. Narmsilee et al. (2003) reported that the digestibility of Ruzi grass for DM, OM and CP was 61%, 67.9% and 46.5%, respectively.

Breed had no significant effect on digestibility but there was a significant interaction between foliages and breed for CF, NDF and ADF digestibility.

#### Growth and feed conversion ratio

The rabbits consuming mimosa, water spinach and head lettuce residue had significantly higher final weight and daily gain than the rabbits fed Ruzi grass (Table 6). The

**Table 6.** Effect of foliages, breed and sex on growth performance

	Initial weight (g)	Final weight (g)	Average daily gain (g)	FCR (g DM/g LWG)
Foliage				
Ruzi grass	652	2,103 <sup>b</sup>	14.8 <sup>b</sup>	4.8 <sup>ab</sup>
Head lettuce	689	2,418 <sup>a</sup>	17.6 <sup>a</sup>	4.6 <sup>b</sup>
<i>Mimosa pigra</i>	671	2,488 <sup>a</sup>	18.5 <sup>a</sup>	5.2 <sup>a</sup>
Water spinach	659	2,465 <sup>a</sup>	18.4 <sup>a</sup>	3.6 <sup>c</sup>
Sex				
Male	679	2,379	17.4	4.7
Female	660	2,357	17.4	4.4
Breed				
NZW	663	2,425	18.0	4.4
NN	673	2,312	16.7	4.7
SE	25.4	91.7	1.0	0.3
Level of significance				
Foliage	NS	***	***	***
Breed	NS	*	*	NS
Foliage×breed	NS	NS	NS	*

<sup>a,b,c</sup> Means within foliage, sex or breed in a column with different superscripts are significantly different ( $p < 0.05$ ) \*  $p < 0.05$ ; \*\*\*  $p < 0.001$ .

NS = Non-significant NZW = New Zealand White; NN = Crossbred between New Zealand White and Native breed; FCR = Feed conversion ratio.

daily weight gain was highest in the group fed mimosa followed by water spinach and head lettuce residue, 18.5, 18.4 and 17.6 g/d, respectively, but there was no significant difference between these three diets. Growth rates of 14.0 g/d have been reported for rabbits fed water spinach *ad libitum* as a sole feed (Samkol, 2005), about 18.1 g/d with broken rice (Phimmasan et al., 2004) and 31.4 g/d when supplemented with molasses block and concentrate at 2% and 3% (DM) of BW, respectively (Chat et al., 2005).

The NZW rabbits consumed more concentrate and thereby more CP and fibre than the crossbred rabbits, and also had a higher intake of protein and fibre in foliages, but not significantly so. This resulted in a significantly higher daily gain for the NZW rabbits than for the crossbreds. The higher intakes may explain part of the difference in growth rate, but probably the NZW rabbits, being selected for meat production, were also more efficient in metabolising and using the nutrients for tissue growth.

The lowest feed conversion ratio (FCR) was found in the group fed water spinach, 3.6 g DM/g LWG, and the highest in the group fed mimosa, 5.2 g DM/g LWG ( $p < 0.001$ ). There was an interaction between foliages and breed for FCR ( $p < 0.05$ ). Sex had no significant effect on growth rate or FCR.

## CONCLUSIONS

Head lettuce residue, mimosa and water spinach can be fed to growing rabbits as a roughage and will result in a better growth performance as compared to feeding Ruzi grass. Head lettuce residue, mimosa and water spinach had high protein content. Fibre content was low and water content high in head lettuce residue and water spinach. The low fibre content did not cause any problems in this study

but needs to be paid attention to. To increase intake of feeds with high water content wilting for some hours can be recommended.

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