Performance traits of growing rabbits given graded levels of broken rice and water spinach (*Ipomoea aquatica*) ad libitum

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Abstract

The present investigation was conducted in the ecological farm of CelAgrid-UTA Cambodia, near Phnom Penh. Sixteen crossbreed (Local x New Zealand White) growing rabbits, averaging 961 ± 145 g live weight were used in a randomized block design to study the effect of broken rice supplementation (0, 4, 8 and 12 g/day) to water spinach fed *ad libitum*. The animals were housed in individual cages made from wood and wire mesh.

As the level of broken rice was increased, the effective offer level of the water spinach also increased with the result that the rabbits selected more of the leaves than the stems at least until the 8 g/day level of broken rice was reached after which the consumed ratio of leaf to stem decreased. There was no effect of the level of broken rice on the growth rate or the feed conversion. On unsupplemented water spinach the growth rate was 18.1 g/day during the first 6 weeks of the trial, falling to 9.3 g/day from 7 to 12 weeks, the overall growth rate being 14 g/day.

The use of water spinach as the basis of rabbit production systems could be an appropriate low-cost technology for small-holder farmers.

Key words: *Broken rice, growth, rabbit, water spinach (Ipomoea aquatica).*

1. Introduction

The use of rabbits as a food and income source in developing countries continues to increase, with expanding interest in Eastern Europe, Africa, Asia, and Latin America. The ability of rabbits to reproduce and yield high quality meat on diets based on forages and agricultural byproducts (Cheeke and Raharjo, 1988), as well as their modest housing requirements, makes them well suited for subsistence agriculture (McNitt *et al.*, 2000).

Water spinach *(Ipomoea aquatica)* is an aquatic macrophyte which can be found easily in the villages of Cambodia and recently it is coming to play an important role in rabbit production. A preliminary study from Cambodia (Miech Phalla, 2002, unpublished data), showed that growth rates of rabbits fed water spinach *ad libitum* and 20 g broken rice per day resulted in a daily gain of 20 g/day. In a trial conducted by Hongthong Phimmasan *et al.* (2004), water spinach was reported to support an acceptable growth close to 20 g/day with a feed conversion accounting for 2.7 kg DM/kg gain in growing rabbits. Moreover,

recent observations made in Vietnam (Vo Thi Tuyet Nga, 2004) indicated that water spinach could be used to obtain a growth rate in rabbits of 20 g/day.

Broken rice is a by-product of rice milling. It is a palatable feed that can be used for all classes of livestock. Furthermore, its high energy density and low fiber content make it especially valuable in rations for growing chickens (Göhl, 1975), and ducks (Ngamsaeng Amornsak *et al.*, 2003; Bounlieng Khoutsavang, 2003; Nguyen Thi Kim Dong *et al.*, 2003; Sopha Xaypha, 2003). Moreover, Ly *et al.*, (2002) used broken rice and water spinach, and Chiv Phiny *et al.* (2003) broken rice and mulberry leaves, for feeding growing pigs. However, the use of combinations of broken rice and water spinach to feed rabbits has received only preliminary attention (Hongthong Phimmasan *et al.*, 2004; Vo Thi Tuyet Nga, 2004).

The aim of the present investigation was to determine performance traits or young rabbits fed water spinach *ad libitum* and graded levels of broken rice included in the ration.

2. Materials and methods

2.1. Location and climate

The experiment was carried out in CelAgrid-UTA Cambodia located in Rolous village, Rolous commune, Kandal Stoeung district, Kandal province, about 26 km from Phnom Penh, Cambodia. The average ambient temperature was 31.6 ± 1.60 ºC at midday (12: 00 am) during the trial (9 July to 30 September, 2004).

2.2. Experimental design and treatments

Sixteen crossbreed (Local x New Zealand White) rabbits with average live weight of 961 ± 145 g were allocated to four treatments according to a randomized block arrangement (Table 1) to study the effect of supplementary broken rice (0, 4, 8 and 12 g/day) in rations of water spinach given *ad libitum*. The rabbits were housed in individual cages constructed from wood and wire mesh. The dimensions of the cages were width 0.5 m, length 0.7 m and height 0.5 m.

Table 1. Experimental layout.

	Broken rice, g/day			
	0	**4**	**8**	**12**
Block 1	15	7	11	8
Block 2	2	4	3	14
Block 3	13	6	5	12
Block 4	9	10	1	16

2.3. Feeding and management

Water spinach was bought near the lake of Cheung Ek, Phnom Penh City. The water spinach (leaves attached to stems) was hung inside of the cage, by tying the stem portion to a wooden stick (Photo 1). The foliage was offered to the animals thrice per day

beginning in the morning at 8:00 am, 12:00 am in the middle of the day and 4:00 pm in the afternoon. The proportions of leaves and stems (fresh basis) in the water spinach were recorded daily in the feed offered and refused. Water was not supplied as earlier observations (Miech Phalla, personal communication) indicated that rabbits were able to satisfy their needs for water from that contained in the water spinach which has about 90% of moisture.

Broken rice was purchased from the local market. It was offered to the rabbits in a small metal bowl twice per day, in the morning at 8:00 am and 4:00 pm in the afternoon.

Photo 1. A bunch of water spinach hangs in the side of the cage.

2.4. Data collection

The rabbits were weighed at two-week intervals. Feed intake was recorded daily from weight of fresh materials offered minus residue in the next morning. Feed conversion ratio was calculated from individual daily DM intake and live weight gain. Feed samples were taken weekly for DM, ash, organic matter and N analysis.

2.5. Chemical analyses

Chemical analyses of the feed offered and refusals were undertaken following the methods of AOAC (1990) for ash and N. The DM content was determined using the microwave method of Undersander *et al.* (1993). Organic matter was calculated as 100 minus % ash.

2.6. Statistical analyses

The data were analysed using the GLM option of the Minitab (version 13.31, 2000) ANOVA software. When the "F" test was significant ($P<0.05$), the means were separated using the Tukey comparison option in the Minitab software. The initial live weight was used as covariate in the model to adjust for different live weights at start.

The following model was used: $Yijk = \mu + Ti + Pj + Ak + eijk$

- Yijk = Dependent variable
- μ = overall mean
- Ti = treatment effect
- Pj = period effect
- Ak = animal effect
- eijk = random error

3. Results and discussion

3. 1. Mortality

A rabbit in cage 7, fed on broken rice (4 g/day) died due to weather influence. However, all the other animals were healthy and no signal of discomfort was apparent.

3.2. Feed characteristics

As to be expected, broken rice was low in ash and N and, consequently, crude protein content (Table 2). Water spinach leaves had higher values of DM, ash, N and crude protein than stems of this macrophyte. Compared with other reports from the literature, water spinach leaves were low in DM, except *Azolla spp* and *Lemna spp* (Table 3). However, water spinach leaves were high in N and crude protein.

Table 2. Feed characteristics, % in dry basis.

	DM	**N**	**Crude protein**	**Ash**	**Organic matter**	**Proportion**
Broken rice	89.5	1.10	6.88	1.20	98.8	-
Water spinach						
Leaves	12.0	5.82	36.4	11.8	88.2	46.1
Stems	6.86	3.15	19.7	18.8	81.2	53.9

*Crude protein expressed as N*6.25*

Table 3. Literature values for chemical components of leaves from some trees, shrubs and aquatic macrophytes.

	DM, %	N, % in DM	Crude protein, % DM
Ipomoea aquatica#	**12**	**5.8**	**36**
Lemna spp##	6.6	5.2	32
Azolla spp##	6.8	4.1	25
Muntingia calabura###	37	3.6	22
Morus alba	33	3.5	22
Trichanthera gigantean	26	3.5	22
Gliricida sepium	27	3.3	20
Flemingia macrophylla	42	3.2	20
Desmanthus virgatus	37	3.1	20
Leucaena leucocephala	44	3.1	19
Hibiscus rosasinensis	21	2.5	16
Moringa oleifera	24	2.5	16

Sources: from Ly et al. (2001a); # present study; ## Ly et al. (2001b); ### Pok Samkol (2003).

3.3. Feed intake

There was no effect of the supplement of broken rice on intake of DM, crude protein and organic matter (Table 4). As the level of broken rice was increased, the effective offer level of the water spinach also increased (Table 4 and Figure 1). The result of this appeared to be that the rabbits selected more of the leaves than the stems at least until the 8 g/day, level of broken rice was reached after which the consumed ratio of leaf to stem decreased (Figure 2).

Table 4. Feed intake pattern (g/day) of rabbits fed water spinach offered *ad libitum* and graded level of broken rice.

	Broken rice, g/day					
	0	**4**	**8**	**12**	**SEM**	**Prob.**
DM						
Leaves	47.3	45.1	50.2	40.8	4.10	0.463
Stems	26.6	18.8	18.0	18.6	1.56	0.005
Broken rice	0.00	3.52	7.04	10.6	0.003	0.001
Total	73.9	67.4	75.2	70.0	5.35	0.37
Crude protein						
Leaves	17.3	16.4	18.4	15.2	1.44	0.38
Stems	5.62	4.11	3.87	4.01	0.283	0.004
Broken rice	0.00	0.24	0.49	0.73	0.003	0.001
Total	22.9	20.7	22.8	19.9	1.82	0.30
Crude protein, % of DM	31.0	30.7	30.3	28.4	3.64	0.36
Organic matter						
Leaves	41.6	37.0	44.2	36.0	3.74	0.40
Stems	20.9	13.6	14.0	14.1	1.15	0.002
Broken rice	0.00	3.49	6.96	10.5	0.003	0.001
Total	62.5	54.1	65.2	60.6	4.48	0.37
Offer/intake water spinach DM	1.69	1.96	1.91	2.17	0.064	0.002
Leaf/stem consumed (DM basis)	1.90	3.83	4.58	3.86	0.93	0.26

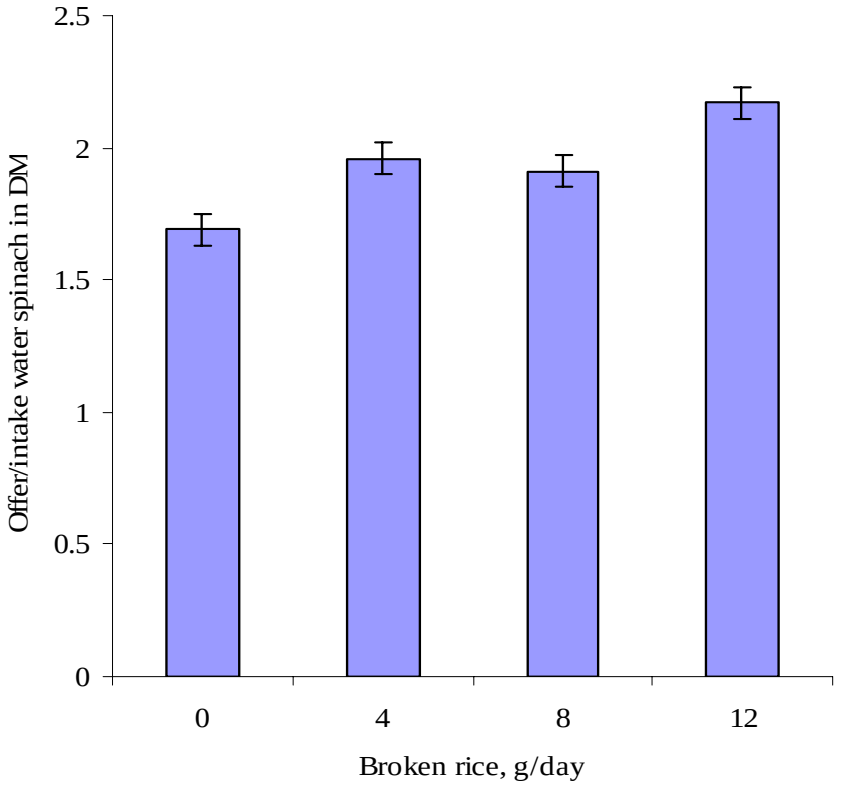

Figure 1. Effect of level of broken rice on the effective offer level (DM offered/DM consumed) of the water spinach.

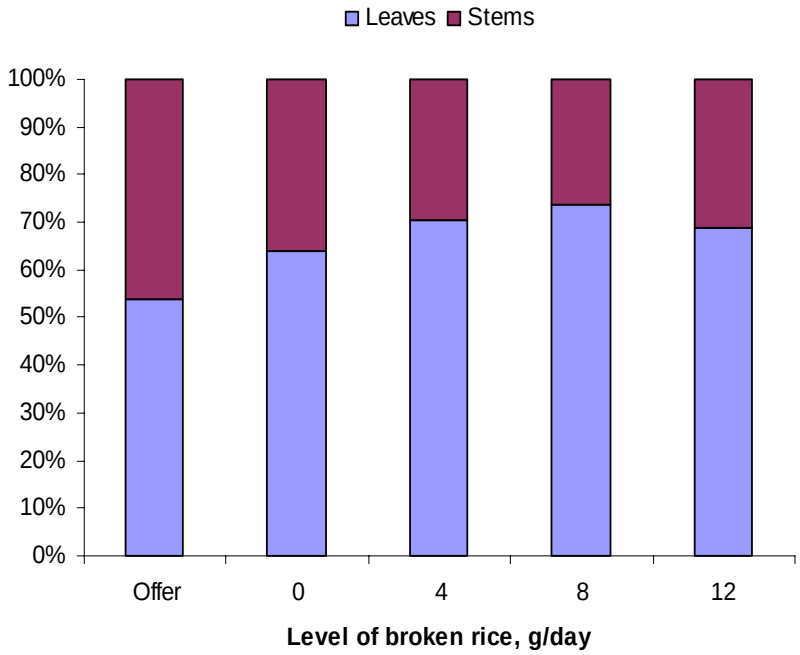

Figure 2. Proportions of leaves and stems (DM basis) in the water spinach offered and consumed.

3. 4. Growth and feed conversion

There was no effect of the level of broken rice on the growth rate or the feed conversion (Table 5). The rates of growth during the first 6 weeks (Figure 5) were only slightly less than the results reported by Honthong Phimmasan *et al.* (2004) (growth rate of 16 to 22 g/day over a weight range of 400 to 1000 g live weight). The much slower growth rate in the second period presumably was because the rabbits were reaching their mature live weight.

Table 5. Performance traits of rabbits fed water spinach ad libitum and graded level of broken rice.

	Broken rice, g/day					
	0	**4**	**8**	**12**	**SEM**	**Prob.**
Live weight, g						
Initial	685	748	722	670	77.1	0.90
6 weeks	1440	1277	1420	1348	135	0.85
12 weeks	1818	1597	1827	1767	142	0.71
Daily gain, g						
0-6 weeks	18.1	12.3	16.4	16.2	1.95	0.32
7-12 weeks	9.33	7.85	9.92	10.4	1.50	0.73
0-12 weeks	14.0	10.4	13.0	13.3	1.33	0.38
kg DM intake/kg gain						
0-6 weeks	4.22	6.21	4.69	4.56	0.603	0.22
7-12 weeks	8.16	10.8	8.19	6.65	1.80	0.55
0-12 weeks	5.31	7.69	5.90	5.22	0.92	0.34

Theoretically, supplementing the water spinach with broken rice should have increased the energy density and provided a more favourable ratio of protein to energy. The protein concentration in the unsupplemented diet was 31% which is considerably in excess of the recommended requirements of 15-16% (Lebas *et al.*, 1997). However, the more likely explanation for the lack of response to broken rice is the possible lack of insufficient indigestible fiber which, according to Lebas *et al.* (1997), should be at least 9 to 10% (Table 6). Based on the digestibility data from Paper I, and the recorded intakes, the levels of indigestible fiber in this experiment were less than half the recommended levels and decreased as the level of broken rice increased.

Table 6. Estimated levels of total and indigestible fiber in the diet compared with recommended levels from Lebas *et al.* (1997).

	Broken rice, g/day				
	0	**4**	**8**	**12**	**Lebas *et al.* (1997)**
Crude fiber, % in DM					
Total	11.6	10.5	9.9	9.7	13-14
Indigestible	4.1	3.8	3.5	3.5	9-10

An interesting question, which could be the subject of future research, is: why did the rabbits select leaves in preference to stems? Water spinach stems are twice as high in fiber as the leaves and theoretically provide a more balanced ratio of protein to energy, and close to the ideal level of fiber. Also in the study reported by Honthong Phimmasan *et al.* (2004), with stylosanthes as the forage, the intakes of fiber and of crude protein were close to recommended levels for these nutrients, yet growth rates were very low (5 to 6 g/day) and there was no response to supplementation with readily digestible energy in the form of broken rice. By contrast, replacing guinea grass (high in fiber) with water spinach foliage (low in fiber) as a supplement to concentrates, increased live weight gain from 25.5 to 31.4 g/day (Tran Hoang Chat *et al.*, 2005).

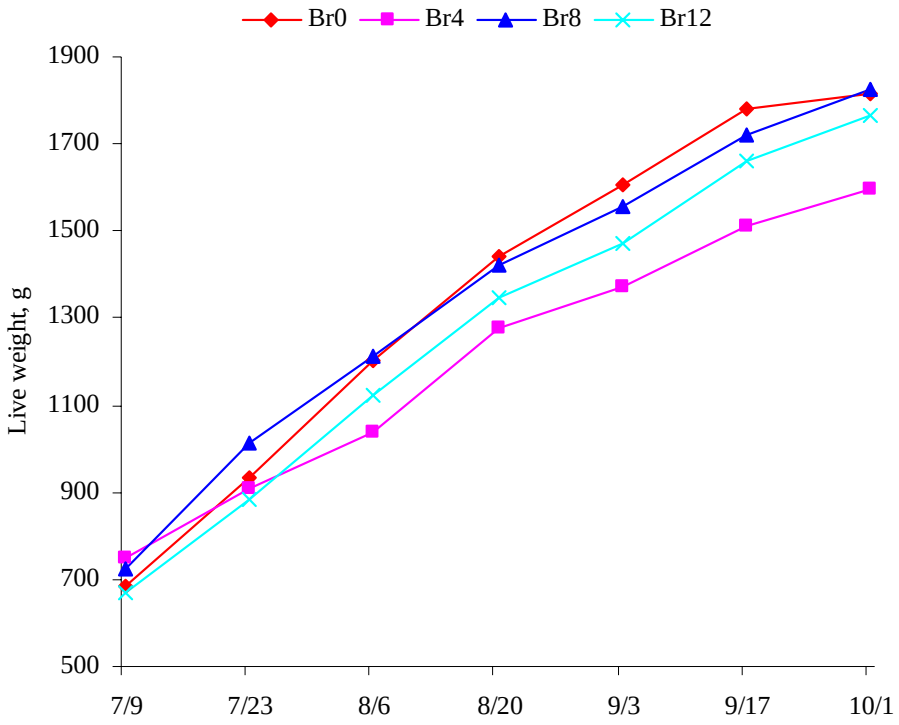

Figure 3. Growth curves of rabbits fed water spinach ad libitum and graded levels of broken rice.

Interestingly, values for both growth and feed conversion in the current study were higher than has been reported recently for rabbits fed a range of diets in other tropical countries (Table 7). The high nutritional potential of water spinach for rabbits is confirmed by the very high growth rate (31.4 g/day) that was recorded when it was given as a supplement to concentrates (Tran Hoang Chat *et al.* 2005).

Table 7. Performance traits of growing rabbits in tropical countries.

Main feed component	**LW gain, g/day**	**Feed conversion, kg DM/kg gain**	**References**	**Country**
Green grass	2.3- 3.1	29.6 – 40.1	Roy *et al.* (2002)	Pakistan
Whole cassava plant meal	11.2	6.0	Akinfala *et al.* (2003)	Nigeria
Sweet potato root & banana	10.0	7.0	Nguyen Quang Suc *et al.* (2000)	Vietnam
Pelleted commercial feed	14.8	7.8	Ramchum *et al.* (2000a)	Mauritius
African Star grass	7.7	10.9	Ramchum *et al.* (2000b)	Mauritius
Cottonseed cake & Soybean cake	10.2-11.7	4.4-4.6	Mbanya *et al.* (2005)	Cameroon
Water spinach	**14.0**	**5.3**	**This study**	**Cambodia**

4. Conclusions

- Fresh water spinach as the sole source of feed and water supported an acceptable growth rate in young rabbits of 14 g/day with a feed conversion of 5.3 kg DM/kg gain.
- There were no advantages from providing supplementary digestible energy in the form of broken rice.
- The use of water spinach as the basis of rabbit production systems could be an appropriate low-cost technology for small-holder farmers.

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