Effects of Supplementation of Paddy Rice and/or Rice Grain and/or Rice Husk to Sweet Potato (*Ipomoea batatas*) Vines as Basal Diet on Feed Intake, Growth Performance and Digestibility of New Zealand White Rabbits

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ABSTRACT

An experiment was conducted to determine effects of supplementation of paddy rice and/or rice grain and/or rice husk to sweet potato (*Ipomoea batatas*) vines as basal diet diets for growing New Zealand White rabbits on feed intake, digestibility, average daily gain (ADG), feed conversion ratio (FCR) and economic returns. A total of 28 male New Zealand White growing rabbits at 6 weeks of age were allocated into 4 treatment groups with 7 rabbits each in single cages. Supplementations were designed as following: 1. Sweet potato vines (SPV): Basal diet without supplement, 2. PRG20: SPV plus raddy rice grain at 20 g/day, 3. BRG20: SPV plus broken rice grain at 20 g/day, 4. BRGH: SPV plus 16 g broken rice grain and 4 g rice husk in separate feed bowls. The experiment lasted 8 weeks following 1 week of adaptation. It was found that total DMI among the experimental and control groups were not significantly different (P>0.05), either in an absolute term (g/head/day) or as percentage of LW. Supplementation of paddy rice, broken rice and rice husk reduced forage intake. Supplementation had a positive effect on ADG and FCR (P<0.05). Moreover, grain supplementation to forage-based diet had a significant economic effect.

Key Words: New Zealand White Rabbits, Paddy Rice, Rice Grain, Rice Husk, Supplementation, Sweet Potato Vines

INTRODUCTION

Rabbits efficiently utilize fibrous feed by courtesy of their feeding and digestive strategies (Leng 2006). Rabbits can get energy from forages; they always have done in the wild state and their digestive system is developed for this purpose. Among other forages, sweet potato (*Ipomoea batatas*) vines is a common vegetable used for rabbit feeding in Vietnam as a basal and even the only diet. To improve the nutritional balance in diets based on forage, supplementation with highly digestible carbohydrate in the form of broken rice was not successful in the experiment reported by Hongthong Phimmmasan et al. (2004). By contrast, in other experiments (Khuc Thi Hue & Preston 2006; Doan Thi Giang et al. 2006), supplements rich in fibre gave positive results with rabbits fed diets based on water spinach. In the experiment reported by Nguyen Huu Tam et al. (2009) in which rabbits fed on water spinach had higher feed intake and live weight gain when they were supplemented with paddy rice. Recently, in the work by Nguyen Thi Duong Huyen et al. (2010), supplementation of paddy rice improved live weight gain but at the same time reduced feed digestibility of New Zealand rabbits fed on either sweet potato vines or water spinach. So far, there have been not yet any answer to the opposing effects of paddy rice on growth and digestibility of rabbits. The present study was aimed to test the hypothesis that there are some characteristics in the rice husk that have beneficial effects on growth of rabbits.

MATERIALS AND METHODS

Treatments and animals

A total of 28 male NZW growing rabbits at 6 weeks of age were allocated into 4 treatment groups with 7 rabbits each in single cages. The rabbits were fed sweet potato vines (SPV) as basal diet. Supplementations were designed as below:

1. Sweet potato vines (SPV): Basal diet.

2. PRG20: SPVplus paddy rice grain at 20 g/day.
3. BRG20: SPVplus broken rice grain at 20 g/day.
4. BRGH: SPVplus 16 g broken rice grain and 4g rice husk in separate feed bowls.

Feeding regime and management

The experiment was carried out at the experimental farm of Hanoi University of Agriculture. It lasted for 8 weeks following 7 days of feeding adaptation. Before the experiment began the rabbits were vaccinated against hemorrhagic diarrhea and drenched against intestinal parasites. The animals were fed three times a day at 8:00, 14:00, and 20:00 h in individual cages. Drinking water was made available at all times.

Data collection and measurements

All animals were individually weighed at the beginning and thereafter once a week until the end of the experiment to calculate the average daily gain (ADG) as the slope of the linear regression of live weight on raising time.

Total feed and faeces collections were taken over 7 consecutive days in the middle of the experiment. The feeds offered and refusals were collected and weighed with samples taken daily in the morning. Representative samples of faeces (10%) were collected daily from the total feaces collection and stored at -25°C. At the end of the 7 days the samples were bulked for individual animals. Feed and faeces samples were subjected to chemical analyses. Digestibility (%) was calculated as = (A-B/A)*100, where A and B are total nutrient intake and total nutrient in the faeces. Feed conversion ratio (FCR) was calculated as a ratio of DM intake/live weight gain.

Economic calculation

The total investment consists of fixed cost and changeable cost

1. Fixed cost: housing investment, water and electricity, animal, medicines, labour cost and other equipment. The fixed cost was the same among control block and experimental blocks.
2. Variable cost: different cost was set up in each block such as ration and supplementation. The changeable cost was calculated based on differences in weight gain, FCR, current rabbit price and current forage price in market at the time of conducting the experiment.

The final profit consists of increased profits and decreased cost. The final profit was calculated based on differences in weight gain, FCR, current rabbit price and current forage price in market at the time of conducting the experiment.

The rabbit price at the time of conducting the experiment was 70.000 VND/kg (like weight).

The forage price was calculated based on fresh biomass, then converted to dry matter.

Economic calculation in each block was calculated according to the equation below:

Final profits = (increased profits + decreased cost) – (increased cost + decreased profits).

Chemical analyses

Chemical analyses of diets and faeces were undertaken following the methods of AOAC (1990) for DM, OM, CP, EE and ash. NDF and ADF were determined following the procedures of Van Soest et al. (1991).

Statistical analyses

The experimental data were subjected to analyses of variance (ANOVA) made for a CRD model using the General Linear Model (GLM) of Minitab 16. Pair-wise comparisons of means were done using the Tukey's.

RESULTS AND DISCUSSION

Chemical compositions of feeds used in the experiement were presented in Table 1.

Feed intake

Feed intake as affected by supplementation is shown in Table 3. Although grain and forage DMI among blocks were significantly different, total DMI did not differ (P>0.05). The present results were significantly higher compared with a study by Nguyen Thi Duong Huyen et al. (2010) on sweet potato DMI (62.99 g/head/d) and water spinach DMI (51.42 g/head/d). Supharoek Nakkitset (2007) reported that DMI of rabbits fed water spinach was 66 g/head/d, this result was lower than the present result. This can be explained by the impact of adverse weather conditions during March. The average temperature was below 20°C and humidity was above 80%. This resulted in heat loss in rabbits, feed intake was therefore increased to meet their maintenance and growth requirements as well as to protest against cold stress. Because of high forage intake, total DMI was higher than previous studies, but lower when compared with a study by Doan Thi Giang et al. (2006) on New Zealand White rabbits, DMI were 119 and 121 g/head/d in the basal diets of water spinach and sweet potato, respectively.

Digestibility

Digestibility as affected by supplementation is presented in Table 4. There in NDF, ADF, and Lipid. Nguyen Thi Duong Huyen et al. (2010) reported that the digestibility of sweet potato and water spinach were 76.40% and 76.20%, respectively. These results were higher than the present study, however, Nguyen Kim Dong et al. (2006) showed that digestibility of Para grass (*Brachiaria mutica)* was 62.7%, it was lower compared with the present study. It is due to the fact that sweet potato is high in protein and low in fiber content compared with Para grass. Nguyen Kim Dong et al. (2006) supplemented water spinach in levels of 0, 25, 50, 75% with basal diets of Para grass, the digestibility was 62.7, 70.5, 71.7 and 73%, respectively.

Table 1. Chemical composition of feeds used in the experiement

Feed	DM (%)	CP (%DM)	NDF (%DM)	ADF (%DM)
Broken rice	88.14	7.61	5.31	3.32
Rice husk	90.17	2.19	80.04	56.32
Paddy rice	90.48	6.56	32.16	15.00
Sweet potato	11.36	25.13	36.12	22.40

Table 2. Chemical composition of the experimental diets

Diet	SPV	PRG20	BRG20	BRGH
DMI (g/head/day)	118.61	129.06	129.26	128.95
Grain DMI (%)	0.00	14.02	13.64	13.74
Sweet potato (%)	100.00	85.98	86.36	86.26
NDF (%DM)	36.12	35.57	31.92	33.98
CP (%DM)	25.13	22.53	22.74	22.57

Table 3. Feed intake as affected by supplementation

	Block 1 (SPV)	Block 2 (PRG20)	Block 3 (BRG20)	Block 4 (BRGH)
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Grain DMI	$0^{d} \pm 0$	$18.1^{a} \pm 0.00$	$17.63^{c} \pm 0.00$	$17.71^{b} \pm 0.00$
Forage DMI	$106.04^{a} \pm 3.82$	$90.77^{b} \pm 3.82$	$95.83^{ab} \pm 4.13$	$97.79^{ab} \pm 4.13$
Total DMI (g/head/d)	$106.04^{a} \pm 3.82$	$108.9^{a} \pm 3.82$	$113.5^{a} \pm 4.13$	$115.5^{a} \pm 4.13$
Total DMI (% liveweight)	$6.03^{a} \pm 0.15$	$5.67^{a} \pm 0.15$	$5.89^{a} \pm 0.16$	$5.92^{a} \pm 0.16$
CP intake (g/head/d)	$26.5^{a} \pm 0.85$	$24.73^{a} \pm 0.85$	$25.88^{a} \pm 0.92$	$26.18^{a} \pm 0.92$
NDF intake (g/head/d)	$39.45^{a} \pm 1.22$	$39.43^{a} \pm 1.22$	$35.51^{b} \pm 1.32$	$40.53^{a} \pm 1.32$

^{a,b}: within a row, means without a common superscript differ (P<0.05)

Table 4. Digestibility as affected by supplementation

Digestibility (%)	Block 1 (SPV)	Block 2 (PRG20)	Block 3 (BR20)	Block 4 (BRGH)
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
DM	$73.76^{a} \pm 1.42$	$70.56^{a} \pm 1.42$	$75.19^{a} \pm 1.53$	$73.15^{a} \pm 1.53$
OM	$74.58^{a} \pm 1.33$	$72.22^{a} \pm 1.33$	$76.13^{a} \pm 1.44$	$73.99^{a} \pm 1.44$
CP	$80.37^{a} \pm 1.09$	$77.7^{a} \pm 1.09$	$79.58^{a} \pm 1.18$	$79.1^{a} \pm 1.18$
NDF	$62.62^{a} \pm 2.09$	$54.5^{b} \pm 2.09$	$58.44^{ab} \pm 2.26$	$56.14^{a} \pm 2.26$
ADF	$59.4^{a} \pm 2.24$	$49.67^{b} \pm 2.24$	$54.93^{ab} \pm 2.42$	$53.24^{ab} \pm 2.42$
Lipit	$68.14^{a} \pm 1.77$	$63.94^{b} \pm 1.77$	$68.6^{a} \pm 1.91$	$65.89^{ab} \pm 1.91$

a,b: within a row, means without a common superscript differ ($P<0.05$)

Live-weight gain and feed conversion ratio

Live-weight gain and FCR as affected by supplementation is shown in Table 5. Live-weight gain among control block and experimental blocks were not significantly different ($P>0.05$). Initial live-weight of control block and experimental blocks averaged 1081 g. After 8 weeks of feeding trial, final live-weight averaged 2167.42 g and there were no significant differences among blocks. On average, live-weight gained 19.4 g each week.

Studied supplementation of Calliandra in basal diets of water spinach and Guinea grass (*Panicum maximum)* to feed New Zealand rabbits, the weight gains were 17.2, 16.6 and 18.8 g/head/d in relation with rations of water spinach, water spinach and Ghine grass, and water spinach and Calliandra. Khuc Thi Hue et al. (2006) reported that weight gains of rabbits fed 100% water spinach and Stylo grass, water spinach and Ghine grass, and water spinach and broken rice were 18.1, 22.4, 23.1 and 22 g/head/d, respectively. Nguyen Thi Duong Huyen et al. (2010) supplemented 0, 2, 3 and 4% paddy rice in rations of water spinach and sweet potato, the weight gains of rabbits were 19.83, 23.67, 23.58 and 24.03 g/head/d, respectively. The present results show that the digestibility as affected by supplementations was lower than the studies by Nguyen Thi Duong Huyen et al. (2010) and Khu Thi Hue et al. (2006). This leads to lower weight gains when compared with previous studies.

The feed conversion ratio among blocks were significantly different ($P<0.05$). The average of FCR was 5.8 kg DM/kg gain which was higher than a study by Supharoek Nakkitset et al. (2007) (3.6 kg DM/ kg gain) and higher than a study by Nguyen Thi Duong Huyen et al. (2010) (3.86 kg DM/kg gain in water spinach group and 4.71 kg DM/kg gain in sweet potato group).

Table 5. Live-weight gain and FCR as affected by supplementation

	Block 1 (SPV)	Block 2 (PRG20)	Block 3 (BR20)	Block 4 (BRGH)
	Mean ± SE	Mean ± SE	Mean ± SE	Mean ± SE
Initial live-weight (g/head)	$1101.43^{a} \pm 73.88$	$1095.71^{a} \pm 73.88$	$1051.67^{a} \pm 79.80$	$1073.33^{a} \pm 79.80$
Final live-weight (g/head)	$2068.57^{a} \pm 59.42$	$2221.43^{a} \pm 59.42$	$2185.00^{a} \pm 64.18$	$2236.67^{a} \pm 64.18$
Total weight gain (g/head)	$967.14^{a} \pm 61.09$	$1125.71^{a} \pm 61.09$	$1133.33^{a} \pm 65.99$	$1163.33^{a} \pm 65.99$
Average daily gain (g/head/d)	$17.19^{b} \pm 1.24$	$19.86^{a} \pm 1.24$	$20.55^{a} \pm 1.34$	$21.26^{a} \pm 1.34$
FCR	$6.36^{a} \pm 0.45$	$5.62^{b} \pm 0.45$	$5.64^{b} \pm 0.49$	$5.56^{b} \pm 0.49$

a,b: within a row, means without a common superscript differ ($P <0.05$)

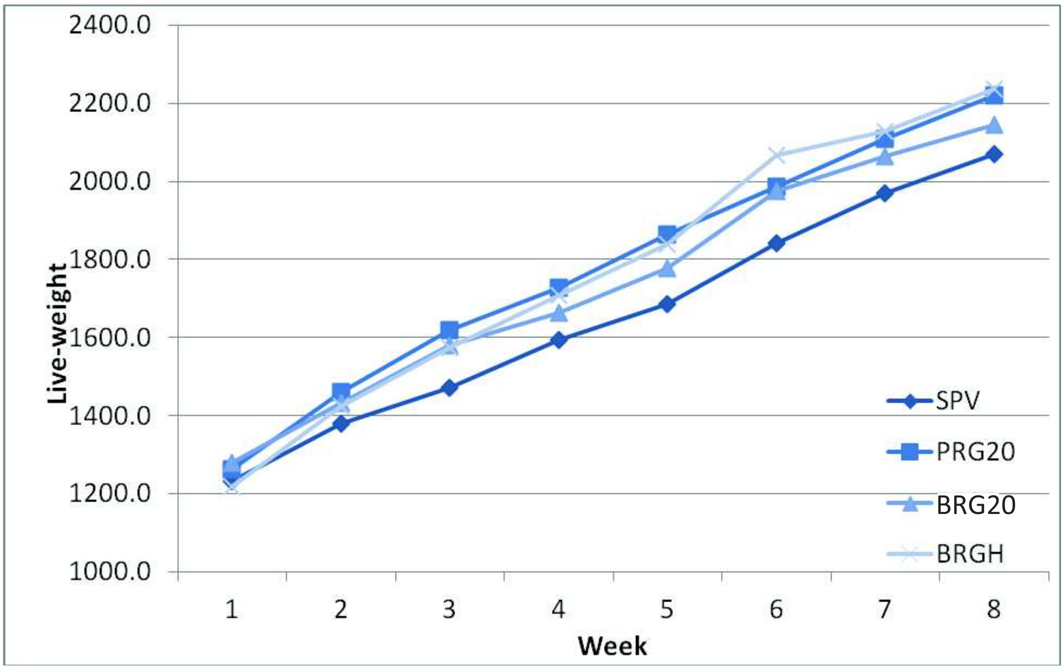

Figure 1. Live-weight gain within eight weeks

Table 6. Current feedstuff prices

Feedstuff	Biomass	Dry matter
Paddy rice	7.500 VND/kg	8.289.125 VND/kg
Broken rice	12.000 VND/kg	13.614.7 VND/kg
Rice husk	500 VND/kg	554.51 VND/kg
Sweat potato vines	2.000 VND/kg	17.196.9 VND/kg

The mean block 2,3,4 – block 1 differences for the weight gain, grain

Variable	Block 1 (SPV)	Block 2 (PRG20)	Block 3 (BRG20)	Block 4 (BRGH)
Weight gain (g)	0	+ 2.67	+ 3.36	+ 4.07
Grain DMI (g)	0	+ 18.1	+ 17.61	+ 17.71
Forage DMI (g)	0	- 7.65	- 6.98	- 7.37

Variable	Block 1 (SPV)	Block 2 (PRG20)	Block 3 (BRG20)	Block 4 (BRGH)
Increased profits (VND) (weight gain)	0	186.9	235.2	284.9
Reduced cost (VND) (forage intake decline)	0	131.4	120.0	126.6
Increased cost (VND) (grain supplementation)	0	150.0	240.0	194.0
Decreased profits (VND)	0	0.0	0.0	0.0
Differences (I + II – III – IV) (VND/head/day)	0	168.3	115.2	217.6

CONCLUSION

Total DMI among experimental groups and control group are not significantly different. Supplementation of paddy rice, broken rice and rice husk reduced forage intake. Effect of supplementation on weight gain was not found significant. Grain supplement to forage-based diet had a significantly economic effect.

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REFERENCES

Hongthong Phimmasan, Siton Kongvongxay, Chay Ty, Preston TR. 2004. Water spinach (*Ipomoea aquatica*) and Stylo 184 (*Stylosanthes guianensis* CIAT 184) as basal diets for growing rabbits. Livestock Research for Rural Development. Volume 16, Article # 34. Retrieved from: http://www.lrrd.org/lrrd16/5/hong16034.htm.

Khuc Thi Hue, Preston TR. 2006. Effect of different sources of supplementary fibre on growth of rabbits fed a basal diet of fresh water spinach (*Ipomoea aquatica*). Livestock Research for Rural Development. Volume 18, Article #58. Retrieved June 8, 2008, from http://www.lrrd.org/lrrd18/4/hue18058.htm.

Ly Thi Luyen. 2003. Effect of the urea level on biomass production of water spinach (*Ipomoea aquatica*) grown in soil and in water; Retrieved, from MEKARN Mini-projects. http://www.mekarn.org/msc2003-05/miniprojects/webpage/luyen.htm.

Nguyen Huu Tam, Vo Thanh Tuan, Vo Lam, Bui Phan Thu Hang, Preston TR. 2008. Effects on growth of rabbits of supplementing a basal diet of water spinach (*Ipomoea aquatica*) with vegetable wastes and paddy rice. Livestock Research for Rural Development. Volume 21, Article # 174. Retrieved, from http://www.lrrd.org/lrrd21/10/hang21174.htm.

Nguyen Kien Cuong, Duong Nguyen Khang, Preston TR. 2008. Digestibility and growth in rabbits fed a basal diet of sweet potato vines replaced with cassava foliage meal. In: Preston TR, Nguyen Van Thu, editors. Organic rabbit production from forages. Proceedings MEKARN Rabbit Conference. Cantho University, Vietnam, 25-27 November 2008. http://www.mekarn.org/prorab/cuong.htm.

Nguyen Quang Suc, Dinh Van Binh, Preston TR. 1996. Effect of housing systems (cages vesus underground shelter) on performance of rabbits. Livest Res Rural Develop. Volume. 8 (4): http://www.lrrd.org/lrrd8/4/suc84.htm.

Nguyen Thi Duong Huyen, Nguyen Xuan Trach, Preston TR. 2010. Effects of graded levels of paddy rice supplemented to water spinach (*Ipomoea aquatica*) or sweet potato (*Ipomoea batatas*) vines as basal diets on feed utilization and growth performance of New Zealand White rabbits http://www.mekarn.org/workshops/pakse/abstracts/Huyen_hua.htm.

Nguyen Thi Kim Dong, Nguyen Van Thu, Ogle RB, Preston TR. 2006b. Effect of supplementation level of water spinach (*Ipomoea aquatica*) leaves in diets based on Para grass (*Brachiaria mutica*) on intake, nutrient utilization, growth rate and economic returns of crossbred rabbits in the Mekong Delta of Vietnam. In: Proceedings of the MEKARN workshop on forages for pigs and rabbits. Phnom Penh, 22-24 August 2006. Phnom Penh (Cambodia): MEKARN.

Nguyen Thi Kim Dong, Nguyen Van Thu, Preston TR. 2006a. Effect of dietary protein supply on the reproductive performance of crossbred rabbits. In: Proceedings of the MEKARN Workshop on Forages for Pigs and Rabbits. Phnom Penh, 22-24 August 2006. Phnom Penh (Cambodia): MEKARN.

Pok Samkol, Preston TR, Leng RA. 2006b. Effect of offering leaves or stems of water spinach on patterns of eating, consumption of caecotropes and excretion of feces by growing rabbits. In: Proceedings of the MEKARN workshop on forages for pigs and rabbits. Phnom Penh, 22-24 August 2006. Phnom Penh (Cambodia): MEKARN.

Pok Samkol, Preston TR, Ly J 2006a. Effect of increasing offer level of water spinach (*Ipomoea aquatica*) on intake, growth and digestibility coefficients of rabbits. Livest Res Rural Develop. Volume 18, Article #25. Retrieved March 7, 2006, from http://www.lrrd.org/lrrd18/2/samk18025.htm.

Pok Samkol, Preston TR, Ly J. 2006. Digestibility indices and N balance in growing rabbits fed a basal diet of water spinach (*Ipomoea aquatica*) supplemented with broken rice. Livest Res Rural Developt. Volume 18, Article # 22. Retrieved June 8, 108, from http://www.lrrd.org/lrrd18/02/samk18022.htm.

Thi Giang D, Thi Hue K, Van Binh D, Thi Mui N. 2006. Effect of Guinea grass on feed intake, digestibility and growth performance of rabbits fed a molasses block and either water spinach (*Ipomoea aquatica*) or sweet potato (*Ipomoea batatas* L) vines. In: Workshop Seminar Forages for Pigs and Rabbits. Phnom Penh, 22-24 August 2006. Phnom Penh (Cambodia): MEKARN-CelAgrid.