

A RESPONSE OF FEED UTILIZATION, NUTRIENT DIGESTIBILITY, GROWTH AND ECONOMIC RETURN OF CROSSBRED RABBITS TO REPLACEMENT OF BROCCOLI LEAVES (*BRASSICA OLERACEA*) TO PARA GRASS (*BRACHIARIA MUTICA*) AS A BASAL DIET

Nguyen Thi Kim Dong

College of Applied Biology, Tay Do University, Vietnam

Corresponding author: Nguyen Thi Kim Dong; Email: ntkdong@tdu.edu.vn

ABSTRACT

The objective of the study was to evaluate the effects of Broccoli leaf replacement in the basal diets of Para grass on nutrient digestibility, growth performance and economic returns of crossbred rabbits. The sixty rabbits were arranged in a complete randomized design with 5 treatments and 3 replications. The treatments were Broccoli leaf (BL) replacement to paragrass (DM basis) at levels of 0 (BL0), 20 (BL20), 40 (BL40), 60 (BL60) and 80% (BL80). The dry matter (DM) intake was not significantly different among treatments. The CP intake was significantly higher ($P < 0.01$) for the BL60 and BL80 treatments (12.2 and 12.5 g/rabbit/day, respectively) as compared to the others. The significantly higher daily weight gains (21.8 and 21.4 g/rabbit/day) were in the BL60 and BL80 treatments ($P < 0.01$). The apparent digestibility of DM, OM, EE and NDF increased proportionally to the increasing levels of Broccoli leaf replacement in diets. The differences were statistically significant ($P < 0.01$), except for EE digestibility ($P > 0.05$). The nitrogen intake and nitrogen retention ranged from 1.31 to 1.42 g/kg $W^{0.75}$ and 0.70 to 0.78 g/kg $W^{0.75}$, however they were not significantly different among the treatments ($P > 0.05$). The results of this study indicated that Broccoli leaves could be used as a plant protein source for feeding rabbits. The levels of Broccoli leaves from 60 to 80% (DM basis) in Para grass as basal diet gave better growth performance and economic benefits.

Key words: *Broccoli leaves, crossbred rabbits, nutrient digestibility, para grass, weight gain*

INTRODUCTION

In recent year, rabbit production has a considerable potential in the developing countries due to low rabbit raising investment, short generation interval, high reproductive yield, rapid growth rate and the ability to utilize forages and by-products as major diet components. Besides rabbit meat is high quality, being high in protein (21.3%), low in fat content (6.80%) and low cholesterol (45 mg/kg) reported by Owen (1992). In the Mekong delta of Vietnam rabbit production can be integrated into small farming systems, the rabbits were mainly fed locally available feed resources including natural grasses, crop residues, wild vegetables and agro-industrial byproducts, etc... While Para grass (*Brachiaria mutica*) is popularly used for feeding rabbits. Nguyen Thi Vinh Chau (2015) reported that rabbits normally consumed diets containing high proportion of roughage and protein supplementation. Protein could be also obtained from plant feed sources. Broccoli leaves is vegetable by-product left at markets as wastes with a large amount daily and high CP content (16.0- 17.3%) (Nguyen Van Thu and Nguyen Thi Kim Dong, 2011). The problem is how to treat them in order not to make polluted environment and convert vegetable protein to animal protein for better income (Nguyen Van Thu, 2019). Therefore, this study aimed to evaluate the effect of Broccoli leaves in a basal diet of para grass on the nutrient utilization and growth performance and economic returns of growing rabbits.

MATERIALS AND METHODS

Location and time

This trial was conducted from April to July in 2019 at the Experimental farm in Binh An village, Binh Thuy district, Can Tho city. The chemical analysis of feeds and refusals were done at the laboratory of the Department of Animal sciences, Faculty of Agriculture of Can Tho University.

Experimental design

The crossbred rabbits (New Zealand x local rabbit) at 60 days of age were arranged in a complete randomized design with 5 treatments and 3 replications. The treatments were Broccoli leaf replacement of para grass in the diets at levels of 0, 20, 40, 60 and 80% (DM basis), while para grass was fed *ad libitum*. The concentrate and fresh soya waste were supplied with the same amount of 10-20 and 100-200 g/rabbit/day, respectively, for all dietary treatments. Four rabbits (balanced sex) were in per experimental unit and experimental period lasted 8 weeks. While the nutrient digestibilities and utilization of the rabbits in different treatments were observed and measured at 12-week old for 6 consecutive days.

Feeds, feeding and management

Para grass, Broccoli leaves and soya waste were daily collected in Can Tho city. The animals were fed three times a day at 7:00h, 14:00h and 18:00h. The feeds and refusals were recorded separately and daily. The diets were adjusted every week following their live weights. The refusals and spillage were collected and weighed daily in the morning to calculate the feed intake. Fresh water was available for all rabbits almost all day and night time. The animals were vaccinated to prevent some diseases, especially rabbit Hemorrhagic and parasite diseases.

Measurements taken

Chemical composition of feeds. Refusals and feces. They were taken for analysis of DM, OM, CP, EE, Ash and NDF following procedures of AOAC (1990) and Van Soest et al. (1991), respectively.

Daily feed and nutrient intakes. Feed and nutrients were daily measured and calculated. The economic analysis was also done among the treatments.

Daily weight gain and feed conversion ratio. All rabbits were individually weighed weekly.

Apparent feed and nutrient digestibility. Feed and nutrient intakes and feces were weighed for calculations following method suggested by Mc Donald et al. (2012)

Nitrogen retention. Urine of the rabbits were collected, weighed and analyzed nitrogen (AOAC, 1990) for a measurements.

Statistical analysis

The data of the experiment were analyzed by analysis of Variance using the ANOVA of General Linear Model of Minitab Reference Manual Release 16.1.0 and the comparison of significant difference between two treatments, Tukey's test was used (Minitab, 2010). Economic analyses were done using current prices in Vietnamese Dong (VND) to compare differences of income and the feed cost in different treatments.

RESULTS AND DISCUSSION

The chemical composition of feed ingredients

Table 1 showed that DM, CP and NDF contents of Broccoli leaves (BL) were consistent with the results (10.3% DM 17.1% CP and 28% NDF) reported by Nguyen Van Huyen (2010) that of para grass (PG) (20.3%). The CP content of Broccoli leaves (16.3%) was considerably higher than that of para grass (10.0%), while the NDF content (26.0%) was lower as compared to that of para grass (67.3%). Thus, replacement of PG by BL enhanced dietary protein for the rabbits. The NDF content of PG in this study was similar to the value (65.4%) stated by Truong Thanh Trung and Nguyen Thi Kim Dong (2014). Soya waste had similar

DM and CP contents with the values of 10.4% DM and 20.3% CP (Nguyen Van Thu, 2017). Soya waste and concentrate were protein and other nutrient supplements for rabbits. The values of DM, CP and EE of concentrate were similar to those reported by Nguyen Van Thu and Nguyen Thi Kim Dong (2014).

Table 1. The chemical composition of feeds (%DM basis) used in the experiment

Feed	DM	OM	CP	EE	NDF	Ash
Broccoli leaves	8.25	90.5	16.3	5.30	26.0	9.50
Para grass	20.3	90.6	10.0	4.60	67.3	9.40
Soya waste	10.4	94.4	20.5	10.0	47.6	5.50
Concentrate	87.0	94.0	20.0	5.63	23.3	6.00

DM: dry matter, OM: organic matter, CP: crude protein, EE: ether extract, NDF: neutral detergent fiber

Feed and nutrient intakes

Table 2. Feed and nutrient intakes (gDM/rabbit/day) of rabbits in diets of the experiment

Item	Treatments					±SE/P
	BL0	BL20	BL40	BL60	BL80	
Fresh Para grass	259 ^a	214 ^b	144 ^c	107 ^{cd}	82.0 ^d	8.66/0.001
Fresh Broccoli leaves	-	143 ^d	281 ^c	382 ^b	440 ^a	11.5/0.001
Para grass (DM)	52.6 ^a	43.4 ^b	29.2 ^c	21.7 ^d	16.6 ^e	1.76/0.001
Broccoli leaves (DM)	-	11.8 ^d	23.2 ^c	31.5 ^b	36.2 ^a	0.95/0.001
DM	72.7	75.5	72.9	74.5	74.1	2.15/0.89
OM	66.7	69.3	66.9	68.4	68.2	1.95/0.87
CP	10.4 ^c	11.4 ^{bc}	11.6 ^b	12.2 ^a	12.5 ^a	0.25/0.001
EE	4.17	4.22	4.34	4.46	4.70	0.08/0.06
NDF	41.6 ^a	38.7 ^a	32.3 ^b	30.0 ^b	27.9 ^b	1.27/0.001

BL0: 100% para grass, BL20, BL40, BL60 and BL80: Broccoli leaves replaced at levels of 20, 40, 60 and 80% of para grass amount consumed in the BL0 diet (DM basis), respectively ; ^{a, b, c, d, e} Means with different letters within the same rows are significantly different at the 5% level.

The PG intake was significantly different ($P < 0.001$) among the treatments (Table 2). The PG intake significantly decreased with increasing levels of BL. The highest value (52.6g/rabbit/day) was in the BL0 treatment, the lowest (16.6g/rabbit/day) being in the BL80 treatment. Total DM intakes ranged from 72.7 to 75.5 g/rabbit/day that are in within a range of the data (72.6 - 76.5g/rabbit/day) (Nguyen Thi Kim Dong, 2014). The CP intake significantly raised ($P < 0.01$) in the diets included BL and the lower value for animals fed PG only (BL0), possibly, due to higher CP content in the BL. The CP intake in the present study is consistent with those stated by Nguyen Thi My Kim (2012) from 12.9 - 13.8 g/rabbit/day and Nguyen Thi Vinh Chau and Nguyen Van Thu (2014^a) from 10.6-13.7 g/rabbit/day. The NDF intake significantly reduced ($P < 0.01$) when increasing levels of BL in the diets, due to low NDF concentration in the BL.

Growth rate, feed conversion ratio and economic returns

The final live weight tended to increase with increasing the levels of BL replacement, the highest being in the BL60 treatment. However, there were no significant differences among the diets ($P > 0.05$). The daily weight gain was significantly higher ($P < 0.01$) for the rabbits fed

60% and 80% BL in the diets (21.8 and 21.4g/day, respectively) as compared to those fed only PG (16.8g/day). This was explained that the animals had higher CP, but lower NDF intakes in the BL60 BL 80 treatments than those in the rest ones, because of a higher amount of BL consumption. The results in final live weight and daily weight gain of a present study are in an agreement with the findings of previous research works on crossbred rabbits of Nguyen Thi Vinh Chau and Nguyen Van Thu (2014^b) (1,685-2,167g/animal and 13.9-20.9g /rabbit/day); Nguyen Thi Kim Dong and Nguyen Van Thu (2020) (1,775- 2,087 g/ animal and 16.1-19.4 g/rabbit/day), respectively. The FCR was not significantly different among the diets in this study (P>0.05). These values were acceptable and similar to the data of 3.37 to 3.63 indicated by El-Tahan et al. (2012), but being better than the results of 4.9-6.0 and 5.0 to 5.8, reported by Akinfala et al. (2003) and Nguyen Van Dat (2016), respectively. The effects of Broccoli leaf intake on CP intake and Broccoli leaf intake on daily weight gain of rabbits were presented in regression equations following $y = 0.054x + 10.51$ with $R^2 = 0.96$ and $y = -0.002x^2 + 0.207x + 17.02$, with $R^2 = 0.878$, respectively.

Due to all rabbits were carefully vaccinated and good taken care, their survival rate got 100%. The economic analysis was done for 8 weeks, the result showed that total expenses were closed a mong the treatments. However, due to the better daily weight gain and final live weight with increasing BL in the diets which gave more benefits. The results indicate that the promising diets for the rabbits could be up 60 to 80% BL.

Table 3. Daily weight gain, feed conversion ratio and economic returns of the rabbits fed different diets in the experiment

Item	Treatments					±SE/P
	BL0	BL20	BL40	BL60	BL80	
Initial live weight (g)	728	704	717	710	732	74.1/0.99
Final live weight (g)	1,670	1,821	1,812	1,931	1,928	65.1/0.09
Daily weight gain (g/rabbit)	16.8 ^b	19.9 ^{ab}	19.6 ^{ab}	21.8 ^a	21.4 ^a	0.82/0.01
FCR	4.33	3.80	3.73	3.40	3.50	0.24/0.12
Total expense (000 ³ VND/rabbit)	99.017	101.100	101.077	101.721	102.858	-
Total income (000 ³ VND/rabbit)	133.600	145.680	144.960	154.480	154.240	-
Profit (000 ³ VND/rabbit)	34.583	44.580	43.883	52.759	51.382	-

^{a, b} Means with different letters within the same rows are significantly different at the 5% level

Apparent nutrient digestibility and nitrogen retention

The results of nutrient digestibility were showed in Table 4, 5 and 6

Table 4. Chemical composition (%DM) of feeds of digestibility period

Feed	DM	OM	CP	EE	NDF	Ash
Broccoli leaves	8.06	90.5	16.2	5.30	25.9	9.5
Para grass	20.1	90.6	11.2	4.60	65.3	9.4
Soya waste	10.1	94.4	20.5	10.0	48.3	5.6
Concentrate	87.0	91.2	20.0	5.63	23.6	8.8

Note: DM: dry matter, OM: organic matter, CP: crude protein, EE: ether extract, NDF: neutral detergent fiber

Feed and nutrient intakes

Table 5. Feed and nutrient intakes of rabbits in the diets of digestibility period

Item	Treatments					±SE/P
	<i>BL0</i>	<i>BL20</i>	<i>BL40</i>	<i>BL60</i>	<i>BL80</i>	
DM	72.2	71.6	68.5	65.6	68.0	1.70/0.11
OM	66.1	65.5	62.7	60.2	62.4	1.54/0.11
CP	11.0 ^b	11.5 ^{ab}	11.5 ^{ab}	11.4 ^{ab}	11.9 ^a	0.17/0.05
EE	4.23	4.28	4.22	4.12	4.28	0.08/0.67
NDF	40.5 ^a	35.7 ^b	29.3 ^c	25.5 ^c	24.9 ^c	1.07/0.001

a, b, c Means with different letters within the same rows are significantly different at the 5% level

Chemical compositions of feeds used in digestibility period were similar to those of the whole experiment. Feed intake values of the growing rabbits ranged from 65.6 to 72.2 gDM/day. There were no significant differences ($P>0.05$) among of diets for DM and OM intakes in the present study. The significantly higher ($P<0.05$) CP intake was found in the BL80 treatment. The NDF intake was significantly higher in the BL0 diet as compared to those in the other diets ($P<0.01$) and tended to reduce with increasing the levels of BL replacement in the diets. The explanation was the NDF concentration in BL was lower than para grass.

Table 6. Apparent nutrient digestibility (%) and nitrogen retention (g/kg $W^{0.75}$) of rabbits

Item	Treatments					±SE/P
	<i>BL0</i>	<i>BL20</i>	<i>BL40</i>	<i>BL60</i>	<i>BL80</i>	
<i>Digestibility (%)</i>						
DM	55.6 ^c	63.6 ^b	69.7 ^{ab}	73.2 ^a	75.2 ^a	1.38/0.001
OM	59.7 ^c	65.6 ^{bc}	70.6 ^{ab}	73.7 ^a	75.5 ^a	1.31/0.001
CP	77.3	82.7	80.9	82.3	83.7	1.65/0.14
EE	66. ^b	70.8 ^{ab}	77.9 ^{ab}	79.0 ^{ab}	80.9 ^a	2.63/0.01
NDF	46.2 ^c	50.6 ^{bc}	53.3 ^{abc}	59.1 ^a	58.7 ^a	1.79/0.002
<i>Nitrogen balance (g/kg $W^{0.75}$)</i>						
Nitrogen intake	1.42	1.38	1.38	1.31	1.39	0.03/0.32
Nitrogen retention	0.70	0.74	0.75	0.77	0.78	0.03/0.78

a, b, c Means with different letters within the same rows are significantly different at the 5% level

The apparent digestibility of DM, OM, EE and NDF were improved with the increase of BL in the diets. The DM and OM digestibility coefficients were significantly lower ($P<0.01$) in the diets involved PG only (55.6 and 59.7% respectively), the highest values were found for rabbits fed 80% BL in the diet (75.2 and 75.5% respectively). There were no significant

differences on the CP digestibility ($P>0.05$). The EE digestibility was significantly higher ($P<0.05$) in the diets included BL than that in the diet with PG only. The NDF digestibility was significantly different among the diets ($P<0.01$), the lowest and highest results were found in the BL0 and BL60 diets (46.2 and 59.1% respectively). The explanation was that high fiber content in PG leading high intake of fiber for rabbits consumed large amount of PG. Gidenne et al. (1998) and Perez et al. (1996) stated that an increase of fiber leads to decrease of retention time and an increase of caecotrophe production because of increasing bacterial fibrolytic activity which in turn results in a reduction of digestibility of diets (Gidenne et al., 1998; De Blas et al., 1998). The digestibility coefficients of DM, OM and NDF were similar to the findings (63.8-73.8% DMD, 64.0-77.9% OMD and 50.7-56.9% NDFD) found by Nguyen Thi Vinh Chau (2015). The nitrogen retention had tendency to increase slightly with increasing levels of BL in the diet, however no significant differences were found among the diets ($P>0.05$).

CONCLUSION

The results of this study indicated that increasing proportion of Broccoli leaves to replace Para grass in the growing crossbred rabbit diets improved feed utilization, nutrient digestibility, daily weight gain and profits. The levels of Broccoli leaves from 60 to 80% (DM basis) replacing Para grass gave better growth performance and economic benefits.

ACKNOWLEDGEMENT

Chemicals, equipment and Lab works of this research is provided by the Can Tho University Improvement Project VN14-P6, supported by a Japanese ODA loan. The Authors also thank Dept. of Animal Sciences of College of Agriculture, Can Tho University for facilitating the equipments using and Laboratory works of the experiments.

REFERENCES

- Akinfala, E. O., Matanmi, O. and Aderibigbe, A. O. 2003. Preliminary studies on the response of weaned rabbits to whole cassava plant meal basal diets in the humid tropics. Livestock Research for Rural Development. Vol. 15 (4), from : <http://www.cipav.org.co/Irrd/Irrd/4/akîn.htm>
- AOAC. 1990. Official methods of analysis (15th edition). Washington, DC. Volume 1, pp. 69-90.
- De Blas, E. and Gidenne, T. 1998. Digestion starch and sugars. In: The Nutrition of the Rabbit (Editors: C De Blas and J. Wiseman). CABI Publishing. Wallingford. Pp. 17-38.
- El-Tahan, H.M., Amber, K. and Morsy, W.A. 2012. Effect of dietary starch levels on performance and digestibility of growing rabbit. In: Proceedings 10th world rabbit congress – September 3-6, 2012 – Aharm El-Seikh-Egypt, pp. 501-505.
- Gidenne, T. Pinheiro, V., Facao, E. and Cunha, L. 1998. Consequences d'une deficiencia en fibres alimentaires sur la digestion et le transit; premiers resultats chez le lapin adulte. 7emes Journ. Rech. Cunicole Fr. Lyon, pp. 147-150.
- McDonald, P., Edwards, R. A., Greehalgh, J. F. D., Morgan, C. A., Sinclair, L. A. and Wilkinson, R. G. 2012. Animal Nutrition. 7th Edition. Prentice Hall/Pearson, Harlow, England.
- Minitab. 2010. Minitab reference manual release 16.2.0. Minitab Inc.
- Nguyen Thi Kim Dong. 2014. Effect of different replacement levels of *Paederia tomentosa* for Para grass (*Brachiaria mutica*) in diets on feed utilization, growth rate, apparent nutrient digestibility and economic returns of Crossbred rabbits. Journal of Animal Science and Technology, National institute of Animal Sciences, Vietnam. No.50, pp. 39-48.

- Nguyen Thi My Kim. 2012. Effect of dietary glutamic acid supplement on growth rate, carcass quality and nutrient digestibility of Californian. BSc thesis. College of Agriculture, Can Tho University.
- Nguyen Thi Vinh Chau and Nguyen Van Thu. 2014a. Effect of dietary neutral detergent fiber NDF levels on growth rate, nutrient digestibility, carcass quality and caecum fluid parameter of crossbred rabbits (New Zealand x Improved breeds) in the Mekong Delta. *Cantho University Journal of Science*. No. 35, pp. 38-47
- Nguyen Thi Vinh Chau and Nguyen Van Thu. 2014b. Effects of dietary metabolizable energy levels on growth rate, carcass quality nutrient and caecal parameter of crossbred rabbits (New Zealand x Local rabbits) in the Mekong Delta. *Journal of Science, Can Tho University*. Vol. 28b, No. 28b, pp. 36-45.
- Nguyen Thi Vinh Chau. 2015. A study on the optimum levels of dietary nutrients for meat crossbred rabbits (New Zealand x local) in the Mekong delta of Vietnam. PhD. Thesis. Can Tho University, Vietnam (in Vietnamese).
- Nguyen Van Dat. 2016. Determination of appropriate levels of metabolizable energy, crude protein and fiber in diets of growing New Zealand rabbits fed on available green forages. PhD. Thesis. Vietnam National University of Agriculture (in Vietnamese).
- Nguyen Van Thu and Nguyen Thi Kim Dong. 2011. Rabbits, feeding technology and product processing. Nong nghiep Publishing. Ho Chi Minh City.
- Nguyen Van Thu and Nguyen Thi Kim Dong. 2014. Effect of utilization of *Arachis pintoi* in diets on feed intakes, growth performance and economic returns of Guinea fowls. *Journal of Animal Science and Technology, National institute of Animal Sciences, Vietnam*. August, 2014. No. 49, pp. 35-43.
- Nguyen Van Thu. 2017. Effect of different replacement levels of *Paederia tomentosa* to Paspalum grass in diets on nutrient utilization, growth rate and economic returns of Crossbred rabbits. *Journal of Animal Science and Technology, National institute of Animal Sciences, Vietnam*. No. 81, pp. 69-78.
- Nguyen Thi Kim Dong and Nguyen Van Thu. 2020. Effect of brewery waste supplement in basal *Brassica cauliflora* Lizz diets on feed intakes, nutrient digestibility, growth performance and economic returns of crossbred rabbits (New Zealand x Local). *Journal of Animal Science and Technology, National institute of Animal Sciences, Vietnam*. No. 49, pp. 46- 55.
- Nguyen Van Thu. 2019. Recent production status, research results and development conditions of rabbit production in Vietnam - A review. *Can Tho University Journal of Science*. DOI: 10.22144/ctu.jen.2019.004. Vol. 11, No. 1 (2019), pp. 30-35
- Owen, J. B. 1992. Genetic aspects of appetite and food choice. *Animals. J. Agric. Sci.* 119, pp. 151-155.
- Perez, J. M., Gidenne, T., Bouvarel, I., Arveux, P., Bourdillon, A., Briens, C., Le Naour, J., Messenger, B. and Mirabito, L. 1996. Apports De Cellulose Dans L'alimentation Du Lapin En Croissance. Ii. Consequences Sur Les Performances Et La Mortalite. *Ann. Zootech.* 45, pp. 299-309.
- Truong Thanh Trung and Nguyen Thi Kim Dong. 2014. Effect of dietary metabolizable energy levels on feed utilization, nutrient digestibility, growth rate and carcass performance of Californian rabbits in Mekong delta. *Journal of Animal Science and Technology, National institute of Animal Sciences, Vietnam*. October, 2014. No. 50, pp. 20-30.
- Van Soest, P. J., Robertson, J. B. and Lewis, B. A. 1991. Symposium: Carbohydrate methodology, metabolism and nutritional implications in dairy cattle: methods for dietary fiber, and non-starch polysaccharides in relation to animal nutrition. *J. Dairy Sci.* 74, pp. 3585-3597.

Received date: 26/8/2020

Submitted date: 06/9/2020

Acceptance date: 21/10/2020

Opponent: Dr. Tran Hiep