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A response of feed utilization, nutrient digestibility and growth rate of crossbred rabbits to sugarcane stalk residue in the basal diet with *Operculina turpethum* supplementation

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ABSTRACT

An experiment was carried out at the experimental farm and laboratory of Can Tho University to evaluate feed utilization, nutrient digestibility and growth rate of crossbred rabbits. It was a factorial design in which the first factor was length of sugarcane stalk residue (SSR) (3 and 10 cm in length) fed ad-libitum, and the second factor was different supplement of operculina turpethum (OT) (0, 100, 200 and 300 g/rabbit/day) with three replications and four rabbits per experimental unit. Results show that SSR intake was slightly higher (P>0.05) for rabbits fed 3 cm in length and gradually decreased with increasing supplement of OT in the diets (P<0.05), while OT intakes were remarkably increased (P<0.05). Total dry matter, crude protein, ether extract and metabolizable energy intakes were higher for rabbits given SSR at 3 cm long (P<0.05) and when increasing the levels of OT supplement (P<0.05). Digestibility coefficients of DM and CP were higher for animals offered 3 cm long SSR (P<0.05), and NDF values were clearly improved with increasing OT supplement in the diets (P<0.05). The higher nitrogen intake and retention were found for rabbits fed 3 cm SSR (P<0.05) and supplemented with 300 g OT/rabbit/day. Daily gain and final live weight were significantly higher for rabbits fed 3 cm length SSR and supplemented with 300 g OT per animal per day (P<0.05). It was concluded that rabbits fed 3 cm long SSR and supplemented with 300 g OT per animal per day in the diet had better growth rate and gave higher economic returns.

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1 INTRODUCTION

Para grass (*Brachiaria mutica*) is popularly fed ruminants and rabbits in the Mekong Delta of Vietnam because the grass has good growth and nutrient contents and particularly the fiber source. *Operculina turpethum* is used for offering protein in the diets. Sugarcane talks have a high sugar content, which could be used for supplying energy source to monogastric animals (Preston and Leng, 1987). Nguyen Quang Suc *el al.* (1995) concluded that sugarcane is an important source of fiber and energy for the rabbits. Peeled sugarcane stalk, supplemented with protein-rich feeds (soybean seed and Canada bean foliage), could replace concentrates and grass for lactating and fattening rabbits. In an early trial in Mauritius, coarsely chopped sugarcane was successfully

used to replace one and a half of the balanced concentrate feed ration with no consequent drop in performance. In a complementary trial, the same authors found that, fed *ad lib*, rabbits chose to replace up to 40% of their balanced concentrate feed with chopped sugarcane (Lebas *el al*., 1997). In Vietnam, sugarcane production has been developed well with 268,300 ha in production year 2016-2017 (Bao moi, 2018). Sugarcane stalks are popularly pressed to make fresh juice for human consumption, besides the main product of sugar. In the process of making the juice, the lower parts of the stalks with more bud-eyes become the residues; however, the studies on their utilization as animal feed resources has been limited. Therefore, this study aimed to determine nutrient utilization and performance of growing rabbits based on sugarcane stalk residue (SSR) associated with *Operculina turpethum* supplementation for improving the meat production and farmers' income.

2 MATERIALS AND METHODS

2.1 Experiment1: Feeding trial

2.1.1 Animals and experimental design

The experiment was carried out at Experimental farm in Can Tho city. Ninety-six young crossbred rabbits (local × improved breeds) at 6 weeks of age with similar live weight around 739 ± 4.50 g were arranged in a factorial design with two factors. The first factor was length of SSR (3 and 10 cm length) fed *ad-libitum*, while the second one was supplementation levels of *Operculina turpethum* (OT) (0, 100, 200 and 300 g/rabbit/day) with three replications and 4 rabbits (sexual balance) per experimental unit. Para grass, soya waste and dried sweet potato waste were also given with the same amount to all dietary treatments to provide protein and energy. The experimental period was 10 weeks.

Fig. 1: Operculina turpethum

Fig. 2: SSR

Fig. 3: Dried sweet potato waste

2.1.2 Feeds, feeding and management

OT and Para grass were daily collected surrounding the farm, and soya waste was daily bought from soya milk factory. SSR was a lower part left of sugarcane tree after selection a good part to make sugarcane juice for human. Before feeding, SSR was cut to small pieces of 3 cm and 10 cm in length.

Dried sweet potato waste was bought in an occasion used throughout the experiment. The animals were fed three times a day at 8:00, 14:00 and 18:00. *Operculina turpethum* and SSR were offered and recorded daily. Fresh water was available for all rabbits almost all day and night time. The refusals and spillage were daily collected and weighed in the morning to calculate feed intake. The animals were vaccinated to prevent some diseases, especially rabbit Hemorrhagic and parasite.

2.1.3 Measurements

The feeds and refusals were taken for analyses of dry matter (DM), organic matter (OM), crude protein (CP), ether extract (EE) and ash following the procedure of AOAC (1990) and neutral detergent fiber (NDF) according to Van Soest *el al*. (1991). At the beginning of the experiment, four rabbits per experimental unit were weighed individually and then weekly. Daily feed intakes, growth rate, and feed conversion ratio were measured and calculated. The economic analysis was also done among the treatments.

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, two rabbits at the age of 12 weeks were used per experimental unit. The animals had two weeks for adaptation and one week for fecal collection. Feeds and refusals were daily measured. Urine was also collected for nitrogen analysis to calculate nitrogen retention. DM, CP, EE

and NDF digestibility was implemented according to McDonald *el al*. (2002).

2.3 Statistical analysis

Data from both experiments were analyzed variance (ANOVA) using General Linear Model of Minitab Reference Manual Release 16.1.0 (Minitab, 2010). The Tukey test was used to compare the means of the criteria (Minitab, 2010). Economic analyses were done using current prices in Vietnamese dong (VND) to compare the differences of income and the feed cost in different treatments.

3 RESULTS AND DISCUSSION

3.1 Experiment 1: Feeding trial

3.1.1 Feed characteristics

OT had higher CP and EE contents, but lower NDF component as compared to those of Para grass (Table 1), while SSR contained the lowest CP value. The DM and CP contents of OT in this experiment are similar to the values (11.2% DM and 15.2% CP) reported by Pham Duc Thang (2008). Dried sweet potato waste had higher metabolizable energy (ME) concentration as compared to other feeds to provide energy for the rabbits.

Table 1: Chemical composition of feed ingredients in feeding experiment (%, DM)

Feed ingredient	DM	OM	CP	EE	NDF	Ash	ME, MJ/kg DM
Operculina turpethum	10.3	98.2	15.4	6.50	35.2	1.80	10.7
Sugarcane stalk residue	25.9	97.5	3.60	4.44	22.0	2.58	9.20
Para grass	18.7	89.3	12.9	3.46	57.6	10.7	9.21
Soya waste	13.6	97.3	20.0	10.0	35.3	2.70	11.3
Dried sweet potato	77.8	97.1	5.06	1.05	24.7	2.90	13.5
Extracted soy bean	90.2	91.0	43.2	2.50	27.5	9.00	11.4

DM: dry matter, OM: organic matter, CP: crude protein, EE: ether extract, NDF: neutral detergent fibre, ME: metabolizable energy (Maertens el al., 2002)

3.1.2 Feed and nutrient intakes in the feeding experiment

Daily intake of OT was similar between two sizes of SSR length (P>0.05). However, there was considerably increase of OT intakes corresponding to increasing levels of OT in diets (P<0.05), while SSR intake significantly decreased (P<0.05). Rabbits fed 3 cm long SSR tended to have higher intake, but there was no significant difference (P=0.09) (Table 2). The total daily intakes of DM, OM, CP and ME were higher for animals fed 3 cm long SSR (P<0.05), as a result of short SSR pieces make the rabbits rodent efficiently. The intakes of DM, OM, CP, EE, NDF and ME increased with increasing levels of OT in the diets, reaching the highest values for the OT300 diet (P<0.05), possibly due to graded supplements of OT in the diets. The daily DM intakes in the present study are in agreement with the results (57.5-62.7gDM/rabbit), but they are lower in CP intakes (10.4- 11.0gCP/rabbit) reported by Ly Hoa Nguyet (2011).

Table 2: Daily intakes of feeds and nutrients of growing rabbits in feeding experiment (g/rabbit)

Item	SSRL		OT level (OTL)				SE/P	
	3 cm	10 cm	OT0	OT100	OT200	OT300	SSRL	OTL
OT	15.5	15.5	-	10.3^{a}	20.6^{b}	30.9^{c}	-	2.72/0.001
SSR	17.7	16.0	22.0^{a}	17.6^{b}	14.1^{bc}	13.7^{c}	0.66/0.09	0.94/0.001
DM	62.8	61.2	57.4^{a}	61.3^{b}	63.0^{c}	66.2^{d}	0.23/0.001	0.32/0.001
OM	59.0	57.5	54.8^{a}	58.0^{b}	59.0^{b}	61.3^{c}	0.22/0.001	0.32/0.001
CP	7.66	7.47	6.92^{a}	7.49^{b}	7.75^{bc}	8.09^{c}	0.06/0.05	0.87/0.001
EE	2.60	2.57	2.09^{a}	2.41^{b}	2.76^{c}	3.10^{d}	0.02/0.19	0.02/0.001
NDF	18.4	18.1	15.6^{a}	17.5^{b}	19.0^{c}	20.8^{d}	0.09/0.06	0.13/0.001
ME(MJ/rabbit)	0.69	0.68	0.63^{a}	0.67^{b}	0.70^{c}	0.74^{d}	0.01/0.001	0.002/0.001

OT: Operculina turpethum, SSRL: sugarcane stalk residue length. OT0, OT100, OT200, OT300: Operculina turpethum supplemented in diets at levels of 0, 100, 200 and 300g/rabbit/ day.

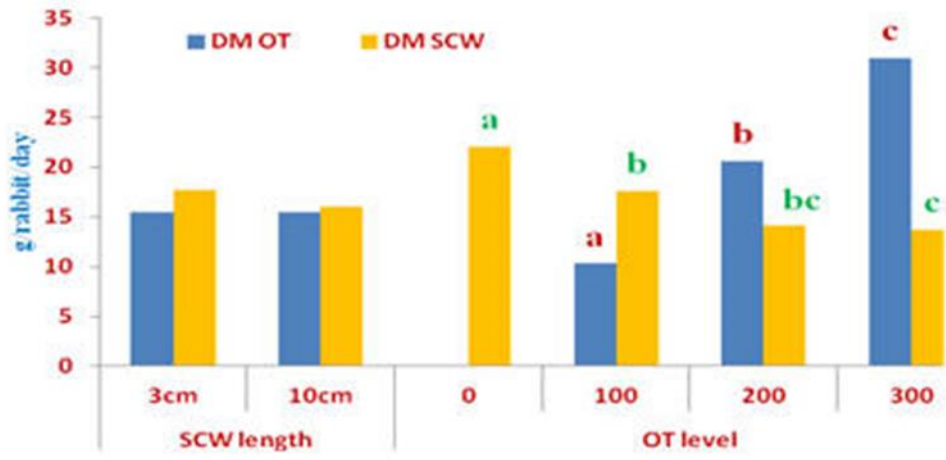

Fig. 4: Daily intakes of OT and SSR (g DM/day)

3.1.3 Growth rate, feed conversion ratio and economic analysis in feeding experiment

Daily weight gain (DWG) and final live weight (FLW) were significantly higher for the rabbits offered 3 cm long SSR than those given 10 cm long SSR ($P<0.05$). The explanation is that the animals had higher intakes of DM and other nutrients such as OM, CP and ME. The findings of DWG and FLW gradually increased corresponding to increasing OT supplement in the diets, getting the highest values in the OT300 diet ($P<0.05$), probably due to higher intakes of DM, CP, EE and ME. The DWGs of rabbits in this study are consistent with those found by Nguyen Truong Giang (2010) (DWG from 15.2 to 20.0 g/day) in which crossbred rabbits fed sweet potato and Para grass supplemented with molasses. Also, the values obtained in the present trial are within the data cited by Nguyen Thi Vinh Chau and Nguyen Van Thu (2014b) (DWG from 13.9 to 20.9 g/day and FLW from 1685 to 2167 g/rabbit). Besides, the DWG of rabbits in this study is also within the ranges (16.2 to 19.8 g/day) reported by Do Khanh Linh (2017). Feed conversion ratio (FCR) was better for rabbits fed 3 cm long SSR ($P<0.05$), as a result of higher DWG. The obtained values for FCR were consisted with the results from 3.48 to 3.73 and from 3.36 to 3.94 found by Do Khanh Linh (2017) Nguyen Van Thu (2017), respectively. However, these results are better than those of 4.5 to 5.5 and 4.6 to 5.2 indicated by Phiny and Kaensombath (2006) and Nakkitset (2007), respectively. There was a close linear relationship between CP intake and DWG of rabbits shown in Figure 5.

Table 3: Daily weight gain, final live weight (g/rabbit) and economic returns (VND) of growing rabbits

Item	SSRL		OT level (OTL)				SE/P	
	3 cm	10 cm	OT0	OT100	OT200	OT300	SSRL	OTL
ILW	740	738	741	742	736	736	3.18/0.57	4.50/0.70
FLW	2,078	1,964	1,930^{a}	2,005^{b}	2,032^{b}	2,117^{c}	10.1/0.001	14.3/0.001
DWG	19.1	17.5	17.0^{a}	18.0^{b}	18.5^{b}	19.7^{c}	0.14/0.001	0.19/0.001
FCR	3.29	3.49	3.38	3.40	3.41	3.37	0.02/0.001	0.03/0.76
Feed cost	22,750	23,170	20,650	22,050	23,450	29,050		
Total expense	92,750	93,170	90,650	92,050	93,450	99,050		
Total income	135,070	127,660	125,450	130,325	132,080	137,540		
Profit	42,320	34,490	34,800	38,275	38,630	38,490		

OT: Operculina turpethum, SSRL: sugarcane stalk residue length, ILW: initial live weight, FLW: final live weight, DWG: daily weight gain. Means with different letters within the same rows are significantly different at the 5% level.

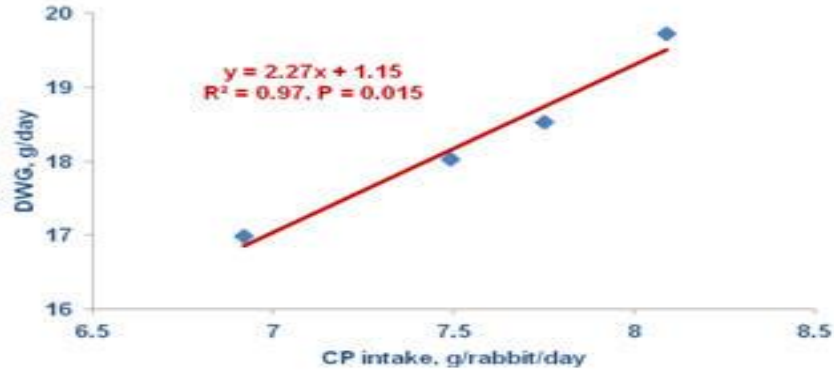

Fig. 5: Relationship between CP intake (g/rabbit/day) and DWG of rabbits

The economic analysis was done and showed that the feed cost and total expense were lower for rabbits fed 3 cm long SSR and for the OT0 diet. However, higher income was found in the short SSR length and the OT200, OT300 diets, resulting in more benefits in these diets. The results indicated that the promising diets giving better economic returns for rabbit production could be supplemented *Operculina turpethum* at levels of 200-300 g/rabbit/day. There were no significantly different interactions between SSR length and levels of OT in all criteria of the feeding experiment (P>0.05).

3.2 Experiment 2: Digestibility trial

3.2.1 Feed characteristics

Table 4: Chemical composition of feed ingredients in digestibility experiment (% DM basis)

Feed ingredient	DM	OM	CP	NDF	Ash	ME, MJ/kg DM
Operculina turpethum	11.0	90.2	15.0	32.5	9.80	10.7
Sugarcane stalk residue	25.9	97.5	3.43	22.0	2.50	9.20
Para grass	18.5	89.3	12.9	57.6	10.7	8.25
Soya waste	11.2	95.1	20.8	33.9	4.90	11.3
Dried sweet potato	94.5	97.3	2.68	14.9	2.70	13.4
Extracted soybean	90.2	91.0	43.2	27.5	9.00	11.4

DM: dry matter, OM: organic matter, CP: crude protein, NDF: neutral detergent fibre, ME: metabolizable energy (Maertens el al., 2002)

Chemical composition of feeds used (Table 4) was similar to those in feeding trial.

3.2.2 Daily intakes of feed and nutrients of growing rabbits in digestibility experiment

Daily intakes of DM and most of nutrients such as OM, CP, NDF and ME of the rabbits between two factors were slightly higher than those obtained in the feeding trial. It may be due to the data recorded in one week of the 12- week-old rabbits in digestibility experiment.

Table 5: Daily intakes of feed and nutrients of growing rabbits in digestibility experiment (g/rabbit)

Item	SSRL		OT level (OTL)				SE/P	
	3 cm	10 cm	OT0	OT100	OT200	OT300	SSRL	OTL
DM	75.4	72.5	64.20^{a}	68.6^{a}	77.1^{b}	85.9^{b}	0.80/0.018	1.13/0.001
OM	71.1	68.2	61.3^{a}	64.8^{a}	72.4^{b}	80.2^{b}	0.79/0.018	1.12/0/001
CP	9.45	8.92	7.53^{a}	8.98^{b}	9.35^{c}	10.9^{d}	0.04/0.001	0.06/0.001
NDF	22.3	21.9	18.4^{a}	20.4^{b}	23.1^{c}	26.4^{d}	0.17/0.09	0.23/0.001
ME	0.80	0.78	0.70^{a}	0.73^{a}	0.80^{b}	0.92^{b}	0.008/0.05	0.01/0.001

OT: Operculina turpethum, SSRL: sugarcane stalk residue length. OT0, OT100, OT200, OT300: Operculina turpethum supplemented in diets at levels of 0, 100, 200 and 300g/rabbit/ day. Means with different letters within the same rows are significantly different at the 5% level.

3.2.3 Apparent digestibility of dietary nutrients, nitrogen retention of growing rabbits

The apparent digestibility coefficients of OM and CP were significantly higher (P<0.05) in the 3 cm long SSR. These values tended to be improved when increasing OT supplements in the diets, but being not significantly different (P>0.05) (Table 6). The results are also in agreement with the findings that the digestibility indices of DM and CP were improved with increasing water spinach levels offered in the diets (Samkol el al., 2006). The obtained DM and CP digestibility values are similar to those (65.4 to 75% DMD, 74.3 to 80.6% CPD and 66.2 to 67.8% DMD) of studies reported by Akinfala el al. (2003), Nguyen Thanh Tung (2012) and Nguyen Thi Vinh Chau and Nguyen Van Thu (2014a), respectively. However, the results in this experiment are lower than those (80.5-85.4 % CPD) found by Huynh Thu Thao (2011).

Table 6: Apparent digestibility (%) of dietary nutrients and nitrogen retention of growing rabbits

Item	SSRL		OT level (OTL)				SE/P	
	3 cm	10 cm	OT0	OT100	OT200	OT300	SSRL	OTL
Apparent digestibility (%)								
DMD	71.9	68.5	67.5	69.1	70.4	73.7	1.17/0.054	1.66/0.09
OMD	73.0	69.6	68.8	70.5	71.3	74.7	1.12/0.046	1.58/0.10
CPD	79.0	73.8	74.6	75.5	77.4	78.2	1.22/0.008	1.73/0.45
NDFD	40.8	34.1	25.8^{a}	35.4^{ab}	40.4^{ab}	48.3^{b}	2.61/0.09	3.70/0.004
Nitrogen balance (g/kg $W^{0,75}$)								
N intake	1.16	0.94	0.90^{a}	1.03^{ab}	1.09^{b}	1.19^{b}	0.03/0.001	0.04/0.002
N retention	0.86	0.64	0.65^{a}	0.75^{ab}	0.80^{b}	0.79^{b}	0.02/0.001	0.03/0.032

DMD, OMD, CPD, NDFD: digestibility of DM, OM, CP and NDF, respectively. Means with different letters within the same rows are significantly different at the 5% level

The results indicate that there was significant difference in both nitrogen intake and nitrogen retention between two factors (P<0.05); this probable explanation is different CP intakes in dietary treatments caused by graded OT supplementation. The findings of nitrogen intake and nitrogen retention in this experiment are consisted with data of 0.57- 0.74 g/kg $W^{0.75}$ stated by Duong Thi Bich Loan (2010). In the present experiment, there were no significantly different interactions between two factors of SSR length and levels of OT in all criteria of the digestibility trial (P>0.05).

4 CONCLUSIONS

The SSR could be used as a feed for growing rabbits. The rabbits fed the 3 cm long SSR had higher nutrient intakes and gave better growth rate and profit. Supplementing OT at level of 300 g per rabbit per day had better growth performance and higher profit. Apparent NDF digestibility and N retention were improved with increasing levels of OT in diets.

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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). Available from http://www.lrrd.org/lrrd/4/akĩn.htm.

AOAC, Association of Official Analytical Chemists, 1990. Official methods of analysis, 15th Edition. Washington, DC. Volume 1: 69-90.

Bao Moi, 2018. Solutions to develop sugarcane production in Viet Nam (Vietnamese). Available from https://baomoi.com/chu-dong-cac-giai-phap-phat-trien-nganh-mia-duong-viet-nam/c/26031401.epi.

Duong Thi Bich Loan, 2010. Effect of different energy feed source supplementation on growth rate, nutrient digestibility and economic returns of growing Cross-bred rabbits in the Mekong Delta. MSc thesis. College of Agriculture and Applied Biology, Can Tho University (in Vietnamese).

Do Khanh Linh, 2017. Studying usage of Mulato II in diets for growing and reproductive local rabbits in Tien Giang province. MSc thesis, College Faculty of Agriculture and Applied Biology, Can Tho University.

Huynh Thu Thao, 2011. Effect of different coconut meal supplements on feed utilization, growth performance and nutrient digestibility of growing cross-bred rabbits. BSc thesis, College of Agriculture and Applied Biology, Can Tho University (in Vietnamese).

Lebas, F., Coudert, P., de Rochambeau, H. and Thébault, R. G., 1997. Nutrition and feeding. The Rabbit - Husbandry, health and production. FAO corporate document repository. http://www.fao.org/docrep/014/t1690e/t1690e.pdf.

Ly Hoa Nguyet, 2011. Effect of different Tra fish oil supplements in diets on growth performance and nutrient digestibility of crossbred rabbits. BSc thesis, College Faculty of Agriculture and Applied Biology, Can Tho University (in Vietnamese).

Maertens, L., Perez, J. M., Villamide, M., Cervera, C., Gidenne, T. and Xiccato, G., 2002. Nutritive value of raw materials for rabbits: EGRAN tables 2002, World Rabbit Sci. 10, pp. 157-166.

McDonald, P., Edwards, R. A., Greehalgh, J. F. D. and Morgan, C. A., 2002. Digestibility evaluation of foods. In Animal Nutrition. 6th Edition. Longman Scientific and Technical. New York, pp. 245-255.

Minitab, 2010. Minitab reference manual release 16.1.0. Minitab Inc.

Nakkitset, S., 2007. Evaluation of head lettuce (*Lactuca sativa*) residues and *Mimosa pigra* as feed resources for growing rabbits. MSc Thesis. Swedish University of Agricultural Science, Uppsala 2007.

Nguyen Quang Suc, Dinh Van Binh, Le Viet Ly and Preston, T.R ., 1995. Studies on the use of dried pressed sugar cane stalk and fresh peeled sugar cane stalk for rabbits. Livestock Research for Rural Development. 17(2).

Nguyen Thanh Tung, 2012. Effect of different neutral detergent fiber levels on growing performance, nutrient digestibility and soft feces characteristics of different rabbit breeds. BSc Thesis, College of Agriculture and Applied Biology, Can Tho University (in Vietnamese).

Nguyen Truong Giang, 2010. Effect of different supplementation levels of sweet potato vines and molasses on growth performance and nutrient digestibility of growing crossbred rabbits in the Mekong Delta. MSc thesis. College Faculty of Agriculture and Applied Biology, Can Tho University (in Vietnamese).

Nguyen Thi Vinh Chau and Nguyen Van Thu, 2014a. Effect of dietary crude protein levels on growth rate, quality carcass and caecum fluid parameter of crossbred rabbits (New Zealand x local) in the Mekong Delta. Can Tho University Journal of Science. 35(b): 38-47.

Nguyen Thi Vinh Chau and Nguyen Van Thu, 2014b. Effect of dietary metabolizable energy on growth rate, quality carcass and caecum fluid parameter of crossbred rabbits (New Zealand x local) in the Mekong Delta. Can Tho University Journal of Science. 28(b): 36-45 (in Vietnamese).

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, ISSN 1859 – 0802. The National Institute of Animal Sciences (NIAS), Viet Nam. 81: 69-78.

Pham Duc Thang, 2008. Effect of different supplementation levels of *Operculina turpethum* in diets on reproduction of crossbred rabbits. BSc thesis, College of Agriculture and Applied Biology, Can Tho University (in Vietnamese).

Phiny, C. and Kaensombath, L., 2006. Effect on feed intake and growth of depriving rabbits access to caecotropes. MEKARN Proceedings of Workshop on Forages for Pigs and Rabbits. *In*: T. R. Preston and R. B. Ogle (Eds.). Phnom Penh, Cambodia, 22-24 August 2006. Agricultural Publishing house - Hanoi. pp. 183-190.

Preston, T. R. and Leng, R. A., 1987. Matching Ruminant Production Systems with Available Resources in the Tropics and Subtropics PENAMBUL Books Ltd: Armidale NSW, Australia.

Samkol, P., Preston, T. R. and Ly, J. 2006. Digestibility indices and N balance in growing rabbits fed basal diet of water spinach (*Ipomoea aquatica*) supplemented with broken rice. Livestock Research for Rural Development. 18(2): 47-58.

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: 3585-3597.