Can Tho University Journal of Science
website: sj.ctu.edu.vn

EFFECTS OF DIETARY CRUDE PROTEIN LEVELS ON GROWTH RATE, MEAT PRODUCTION, DIGESTIBLE NUTRIENTS AND ECONOMIC RETURN OF CALIFORNIAN RABBITS (*Oryctolagus cuniculus*) IN MEKONG DELTA OF VIETNAM

Truong Thanh Trung and Nguyen Thi Kim Dong

College of Agriculture and Applied Biology, Can Tho University, Vietnam

ARTICLE INFO

Received date: 15/08/2015
Accepted date: 19/02/2016

KEYWORDS

Rodents, nitrogen, carcass quality, nutrient digestibility, income

ABSTRACT

A study was conducted at the experimental farm of Can Tho University in Vietnam. The aim of this study was to evaluate the effects of different dietary crude protein levels on growth performance and nutrient digestibility of growing Californian rabbits. Sixty Californian rabbits at 42 days of age were arranged in a complete randomized design with 5 treatments and 3 replications. Four rabbits including 2 males and 2 females were in one experimental unit. Five treatments were different protein levels of 15, 17, 19, 21 and 23%, respectively. The apparent nutrient digestibility and nitrogen retention of the rabbits was measured at 12 weeks of age for 7 days. This experimental period was 12 weeks. The results of study showed that dry matter (DM) and metabolizable energy (ME) intakes were not significantly different ($P>0.05$), however crude protein (CP) intake was significantly different ($P<0.05$) among the treatments with the higher values for the CP21 and CP23 treatments ($P<0.05$). The daily weight gain were 18.0, 20.2, 22.4, 23.3 and 23.2 g/rabbit/day for the CP15, CP17, CP19, CP21 and CP23 treatments, respectively, and were significantly different ($P<0.05$) among the treatments. The carcass weight, thigh meat and lean meat were significantly higher ($P<0.05$) for those animals fed with 21 and 23% CP, while the highest profit was obtained for the CP21 treatment. It could be concluded that the diet contained 21% CP should be used to feed Californian rabbits for improving growth, carcass quality and economic return.

Cited as: Trung, T.T. and Dong, N.T.K., 2016. Effects of dietary crude protein levels on growth rate, meat production, digestible nutrients and economic re-turn of californian rabbits (*Oryctolagus cuniculus*) in Mekong Delta of Vietnam. Can Tho University Journal of Science. Vol 2: 13-19.

1 INTRODUCTION

In recent years, rabbit production has increased considerably in Vietnam because of increasing human consumption. Local rabbits are popularly raised in the Mekong delta due to a good adaptation to the local climate and feeds, however, productivity is very low. Californian rabbits have been imported to upgrade rabbit production. In the Mekong delta of Vietnam, rabbit production fed locally available feeds resources including natural grass, wild vegetables and agro-industrial byproducts. Para grass, *Operculina turpethum* vine and sweet potato tuber are used as rabbit feeds commonly in Mekong delta of Vietnam. Soybean extraction meal and soya waste could be used as crude protein supplement feeds for growing and reproductive rabbits (Thu and Dong, 2008). Protein is an important component for life processes, and effect on growth performance and carcass yield of rabbits. Several authors have studied the optimal dietary crude protein levels for growing rabbits (Carabano *et al.*, 2008) but their studies mainly used commercial pellets for feeding rabbits. The studies on nutrient requirements, forage feeding and diet digestibility in Californian rabbits in Mekong Delta in Vietnam are still limited, especially crude protein levels in diets. The combination among available feedstuffs in Mekong Delta in diets for growing Californian rabbits to satisfy crude protein needs has been not yet studied. Therefore, this study aimed to determine the optimum level of crude protein level in the diets of growing Californian rabbits in Mekong delta of Vietnam.

2 MATERIALS AND METHODS

2.1 Study location and time

The experiment was carried out at the experimental farm, located in Long Hoa ward, Binh Thuy district, Can Tho City, Vietnam. The chemical analysis of feed, feces, urine and meat was done at the Laboratory E205 of the Department of Animal Science, College of Agriculture and Applied Biology, Can Tho University. The implementation of this study was from May to October in 2013.

2.2 Experimental design

Sixty Californian rabbits at 42 days of age (470±6.96g) were arranged in a completely randomized design with 5 treatments and 3 replications. Four rabbits including 2 males and 2 females were in an experimental unit. The treatments were dietary crude protein levels of 15, 17, 19, 21 and 23% (DM) corresponding to CP15, CP17, CP19, CP21 and CP23 treatments, respectively, for evaluating growth performances. Nutrient digestibility was also done in 7 days when the rabbits being at 12 weeks of age. After finishing, the experimental rabbits were slaughtered for measuring carcasses and meat quality. Dietary formulations and chemical composition of diets in the experiment were presented in table 1.

Table 1: Dietary feed ingredients of the experiment (%DM)

Feed, %DM	Treatments				
	CP15	CP17	CP19	CP21	CP23
Operculina turpethum vines	21.0	20.0	17.0	14.0	10.0
Para grass	21.0	21.0	22.0	23.0	25.0
Soybean extraction meal soybean meal	12.0	17.0	23.0	29.0	35.0
Soya waste	10.0	10.0	9.00	8.00	7.00
Sweet potato tuber	36.0	32.0	29.0	26.0	23.0
Chemical composition of diets, %DM					
Nutrients					
DM	20.3	20.9	22.2	23.5	25.1
OM	93.2	93.2	93.2	93.2	93.3
CP	15.0	16.9	19.0	21.0	23.0
EE	4.10	4.11	3.99	3.87	3.72
NDF	32.3	32.2	32.0	31.8	31.8
ADF	23.2	23.2	23.0	22.7	22.6
CF	14.2	14.0	13.6	13.2	12.8
ME, MJ/kgDM	11.6	11.6	11.6	11.6	11.6

CP15, CP17, CP19, CP21 and CP23 were the treatments contained different crude protein levels of 15, 17, 19, 21 and 23% in DM, respectively. DM: dry matter, OM: organic matter, CP: crude protein, EE: crude fat, NDF: neutral detergent fiber, ADF: acid detergent fiber, CF: crude fiber, ME: metabolizable energy

2.3 Animal and housing

Californian rabbits were kept in cages made from grid iron and wood with dimension of width (0.5 m), length (0.5 m) and height (0.4 m). Rabbits were prevented the coccidiosis by Bio-Quino-coc and parasites by Ivermectin 0.25% before entering the trial. At 60 days of age, experimental rabbits were vaccinated to prevent rabbit hemorrhagic disease. The cages were regularly disinfected once per 2 weeks by spraying Virkon'S solution.

2.4 Feeds and feeding

Para grass, *Operculina turpethum* vine, soybean extraction meal, soya waste and sweet potato tuber were used for feeding rabbits in the experiment. Para grass and *Operculina turpethum* vine were collected daily in the areas surrounding the experimental farm. All feeds were analyzed chemical composition and calculated ME for the treatments. Feed samples were collected and analyzed weekly. These feeds were offered in fresh form three times a day at 7 AM, 12:00h and 5 PM. Feeds offered and refusals were recorded daily, while fresh water was freely available at all time.

2.5 Measurements

Feed intake was determined daily by weighing the amount of offered feeds and refusals.

Daily weight gain (DWG) was determined by weighing body weight (BW) of individual rabbit weekly from 7:00 to 7:30 am before feeding.

Chemical composition of feeds including dry matter (DM), organic matter (OM), crude protein (CP), crude fat (EE), crude fiber (CF) and ash were analyzed following the methods described by AOAC (1990). NDF analysis was done according to the Van Soest *et al*. (1991) and ADF were analyzed according to Robertson and Van Soest (1981). The metabolizable energy (ME) values of feeds were calculated according to Maertens *et al*. (2002) and Cheeke (1987).

Apparent nutrient digestibility and nitrogen retention were determined by collecting and analyzing offered and refusal feeds, feces, and urine daily. The feces were collected 2 times at 6 AM and 5 PM daily. The digestive measurement was implemented during 7 consecutive days when rabbits were at 12 weeks of age following the method described by McDonald *et al*. (2002). Urine was collected in each morning and brought to the laboratory immediately for analyzing total nitrogen by Kjeldhal methods. All offered and refusal feeds, and feces samples were dried at 55^0C for 24 hours and to finely ground through 1mm sieve before analyzing.

Carcass and meat quality were determined by slaughtering all rabbits at the end of the experiment. Slaughtering procedure was implemented according to the standards of QCVN 01-75: 2011/BNNPTNT (2001). Carcass (after removing blood, head, 4 feet, hair, skin and internal organs), lean meat and thigh meat were weighed for an evaluation. One hundred gram of the loin and thigh meat was sampled and put into a thermos containing ice and immediately brought to the laboratory for analyzing DM, OM, CP, EE and ash (AOAC, 1990) within a day.

2.6 Data analysis

The data were analyzed by analysis of variance using the One-way model in Minitab 16.1.0.0 software (Minitab, 2010). To compare difference between mean values of treatments, Tukey's test was used (Minitab, 2010).

3 RESULTS AND DISCUSSION

3.1 Chemical composition of feeds and diets

Chemical composition of feed ingredients was presented in Table 2.

Table 2: Chemical composition of feeds used for the experiment (%DM)

Feeds	DM	OM	CP	EE	NDF	ADF	CF	ME, MJ/kgDM
O.turpethum vines	15.2	87.9	15.5	6.50	38.8	30.7	23.6	8.80
Para grass	16.7	90.7	12.6	3.70	67.1	43.4	28.6	7.91
Soybean extraction meal	87.9	93.8	45.1	3.05	16.5	13.5	4.25	12.8
Soya waste	12.7	96.0	22.5	9.23	32.4	27.8	15.5	10.6
Sweet potato tuber	26.2	96.9	3.96	1.86	13.5	8.95	3.15	15.3

DM: dry matter, OM: organic matter, CP: crude protein, EE: crude fat, NDF: neutral detergent fiber, ADF: acid detergent fiber, CF: crude fiber, ME: metabolizable energy

Operculina turpethum vines was higher in the CP content (15.5%) and lower NDF content (38.8%) than those of the Para grass. The CP content of Para grass in this experiment was higher than that reported by Dong and Thu (2012) (9.20%). Soybean extraction meal had higher values of crude protein than that of soya waste. Soybean extraction meal was used to adjust the dietary CP levels in the experiment. The sweet potato tuber was the highest in ME content with value of 15.5MJ/kgDM.

3.2 Feed and nutrient intake

The feed and nutrient intakes of rabbits fed different CP levels were stated in Table 3.

Table 3: The feed, nutrient and metabolizable energy (ME) intakes of rabbits

	Treatments					SEM/P
	CP15	CP17	CP19	CP21	CP23	
Feed intakes, g/rabbit/day (DM)						
O.turpethum vine	15.1[a]	14.3[b]	12.1[c]	9.98[d]	7.14[e]	0.06/0.001
Para grass	15.1[a]	15.0[a]	15.7[b]	16.4[c]	17.9[d]	0.08/0.001
Soybean extraction meal	8.63[a]	12.2[b]	16.4[c]	20.7[d]	25.0[e]	0.03/0.001
Soya waste	7.19[a]	7.16[a]	6.41[b]	5.71[c]	5.00[d]	0.03/0.001
Sweet potato tuber	25.9[a]	22.9[b]	20.6[c]	18.5[d]	16.4[e]	0.09/0.001
Nutrient intake, g/rabbit/day						
Dry matter	71.9	71.6	71.2	71.3	71.4	0.29/0.498
Organic matter	67.0	66.7	66.3	66.5	66.6	0.25/0.489
Crude protein	10.8[a]	12.1[b]	13.5[c]	15.0[d]	16.4[e]	0.06/0.001
Ether extract	2.95[a]	2.95[a]	2.84[b]	2.76[c]	2.66[d]	0.01/0.001
Neutral detergent fiber	23.2[a]	23.1[ab]	22.8[b]	22.6[b]	22.7[b]	0.09/0.007
Acid detergent fiber	16.7[a]	16.6[a]	16.3[ab]	16.2[b]	16.2[b]	0.06/0.002
Crude fiber	10.2[a]	10.0[a]	9.67[b]	9.39[c]	9.15[d]	0.04/0.001
ME, MJ/day	0.835	0.827	0.824	0.827	0.829	0.003/0.269
DP/DE ratio	8.71[a]	10.1[b]	11.6[c]	13.3[d]	14.5[e]	0.06/0.001

CP15, CP17, CP19, CP21 and CP23 were the treatments contained different crude protein levels of 15, 17, 19, 21 and 23% in DM, respectively. DP/DE ratio (gDP/MJDE). The numbers with different superscript letters in the same row were significantly different (P < 0.05)

The feed intakes of rabbits were significantly different (P<0.05) among treatments. The DM intakes of soybean extraction meal increased significantly (P<0.05) while sweet potato tuber decreased significantly (P<0.05) with increasing the dietary CP levels. The intakes of DM and OM were not significantly different (P<0.05) among treatments with 71.2-71.9 g/rabbit/day and 66.3-67.0 g/rabbit/day, respectively. The DM intake in this experiment was similar to the findings on growing Californian rabbits fed different soybean extraction meal in the diets of Phan Thanh Luan (2012) from 71.0 to 71.6 g/rabbit/day. However, the DM intake in present experiment was higher than the results of Hoang (2009) by using different diets (9gCP/kg live weight and 12gCP/kg live weight) on the New Zealand White rabbit with 57.5-59.3 g DM/rabbit/day. In our experiment, the values of g CP intake/kg live weight were from 8.86 to 11.3 g/kg, thus rabbits had to more consume of DM to satisfy nutrient requirements. The CP intake increased (P<0.05) while the NDF, ADF and EE intakes decrease (P<0.05) when increasing of soybean extraction meal in the diets. Because the soybean extraction meal contained a high CP and low NDF, ADF and EE. The CP intake values were similar to the results of Hang (2012) by using diets containing 9, 10, 11gCP/kg live weight on Californian, Hyla, New Zealand White and local rabbits were from 13.6 to 15.4 g/rabbit/day.

The value of ME intake was similar (P>0.05) among treatments from 0.824 to 0.835 MJ/rabbit/day. The ME intake results were higher than the findings of Hang (2012) (0.65-0.74 MJ/rabbit/day). The DP/DE ratio was significantly different (P<0.05) among treatments being from 8.71 to 14.5 g/MJ for the CP15 to CP23 treatments, respectively. According to Carabano *et al,* (2008), the optimal level for CP in a diet depends on its digestibility and the DE content. In present experiment, the DP/DE ratio was from 13.3-14.5 for better growth rate, digestible nutrient and nitrogen retention. It was similar to the findings of Amber (2000) being 13.1 for the optimum growth rate, final live weight and nutrient digestibility.

3.3 Daily weight gain and economic returns

Growth and economic returns of rabbits fed different dietary CP levels were shown in Table 4.

Table 4: Daily weight gain, feed conversion ratio and economic returns of experimental rabbits

Items	Treatments					SEM/P
	CP15	CP17	CP19	CP21	CP20	
Initial body weight, g/rabbit	463	469	463	477	475	6.96/0.475
Final body weight, g/rabbit	1,975^{a}	2,168^{b}	2,341^{c}	2,435^{c}	2,421^{c}	27.0/0.001
Daily weight gain, g/rabbit	18.0^{a}	20.2^{b}	22.4^{c}	23.3^{c}	23.2^{c}	0.30/0.001
Feed conversion ratio	3.99^{a}	3.54^{b}	3.19^{c}	3.06^{c}	3.08^{c}	0.04/0.001
Feed cost, VND/rabbit	23,209	24,806	26,601	28,221	30,026	-
Total cost, VND/rabbit	115,946	118,074	120,468	122,628	125,034	-
Income, VND/rabbit	157,973	173,412	187,291	194,802	193,680	-
Profit, VND/rabbit	42,028	55,338	66,823	72,174	68,646	-

CP15, CP17, CP19, CP21 and CP23 were the treatments contained different crude protein levels of 15, 17, 19, 21 and 23% in DM, respectively. The numbers with different superscript letters in the same row were significantly different (P<0.05). 1kg rabbit live weight=80,000VND; 21,000VND=1USD

Daily weight gain was significantly different among the treatments (P<0.05) with the highest value for the CP21 treatment (Fig. 1). It was similar to the results of the New Zealand White rabbits reported by Wang (2012) being from 21.5 to 28.1 g/day. Rabbit fed CP21 diet had the best FCR (3.06) (P<0.05). The obtained values for FCR were acceptable and consistent with the results being from 3.37 to 3.63 indicated by El-Tahan *et al.* (2012). The economic analysis showed that profit got from the CP21 diets were higher than the other diets due to better final body weight. There was a close linear relationship (R^2= 0.95) between CP intake and daily gain of experimental rabbits. Daily gain of rabbit increased when increasing CP intakes from 10.8 to 15.0 g CP/rabbit/day and decreased slightly at 16.4 g CP/rabbit/day. De Blas and Wiseman (2010) stated that if CP intakes and DP/DE ratio increased and they were to higher than the requirements, growth rate was not modified, nitrogen retention remained constant and nitrogen excretion increased.

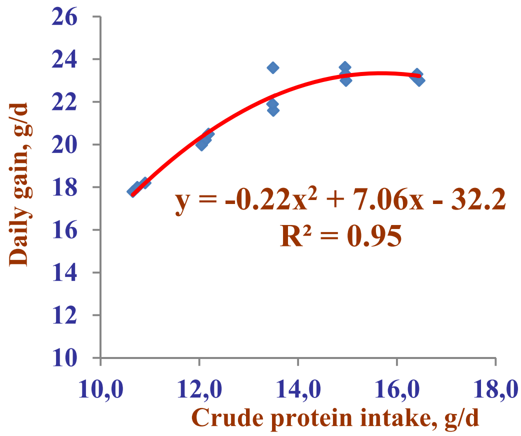

Fig. 1: Effect of CP intake on daily gain of rabbits in the experiment

3.4 Carcass and meat nutrients

The carcass and meat quality of rabbits fed different dietary CP levels were presented in Table 5.

Table 5: Carcass and meat quality of rabbits in the experiment

Items	Treatments					SEM/P
	CP15	CP17	CP19	CP21	CP23	
Live weight, g (LW)	1,990^{a}	2,183^{b}	2,353^{c}	2,466^{c}	2,437^{c}	24.4/0.001
Carcass weight, g	1,047^{a}	1,143^{b}	1,238^{c}	1,289^{c}	1,286^{c}	16.8/0.001
Carcass percentage, %LW	52.6	52.3	52.6	52.3	52.8	0.25/0.621
Lean meat weight, g	789^{a}	863^{ab}	940^{bc}	978^{c}	980^{c}	21.5/0.001
Lean meat percentage, %	75.4	75.5	75.9	75.9	76.2	0.97/0.970
Thigh meat weight, g	272^{a}	310^{b}	346^{c}	383^{d}	372^{d}	4.98/0.001
Thigh meat percentage, % carcass	26.0^{a}	27.1^{ab}	27.9^{bd}	29.8^{c}	28.9^{cd}	0.34/0.001
Caecum length, cm	56.0	54.4	57.9	56.5	56.0	0.84/0.142
Chemical compositions of meat, % in fresh						
Dry matter	26.7	26.1	26.3	26.0	26.1	0.32/0.606
Crude protein	21.0	20.9	20.8	21.0	20.8	0.29/0.956
Ether extract	4.15	4.34	4.45	4.38	4.40	0.07/0.092
Ash	2.49	2.51	1.74	2.48	2.71	0.55/0.767

CP15, CP17, CP19, CP21 and CP23 were the treatments contained different crude protein levels of 15, 17, 19, 21 and 23% in DM, respectively. Means with different letters within the same rows are significantly different at the 5% level

The carcass and thigh meat weights were significantly different (P<0.05) by increasing CP levels in the diets with the highest values at the CP21 diet (1,289 and 383g, respectively). However, carcass percentage was not significantly different (P>0.05) among the treatments and it was 52.6, 52.3, 52.6, 52.3 and 52.8% for the CP15, CP17, CP19, CP21 and CP23, respectively. The carcass percentage in this experiment was lower than that reported by Abedo *et al.*, (2012) from 58.1 to 59.3%. The chemical compositions of meat were not significantly different (P>0.05) among treatments. This indicated that the dietary CP levels did not effect on chemical composition of rabbit meat. De Blas and Wiseman (2010) stated that there was no variation of meat quality when studying dietary protein content on the rabbit meat.

3.5 Nutrient digestibility and nitrogen retention

Nutrient intakes, digestible nutrients and nitrogen retention of experimental rabbits fed different dietary CP levels were presented in Table 6.

Table 6: Nutrient intake, digestible nutrients, and nitrogen retention of experimental rabbits

Items	Treatments					SEM/P
	CP15	CP17	CP19	CP21	CP23	
Nutrient intake (g/rabbit/day) and metabolizable energy (MJ) intake						
Dry matter	53.4	53.3	52.7	52.7	52.6	0.28/0.265
Organic matter	49.7	49.6	49.1	49.2	49.1	0.27/0.290
Crude protein	8.00^{a}	9.02^{b}	9.98^{c}	11.1^{d}	12.1^{e}	0.04/0.001
Ether extract	2.19^{a}	2.19^{a}	2.10^{b}	2.04^{c}	1.96^{d}	0.01/0.001
Neutral detergent fiber	17.2^{a}	17.1^{ab}	16.8^{ab}	16.7^{b}	16.7^{b}	0.09/0.009
Metabolizable energy, MJ	0.620	0.616	0.610	0.611	0.610	0.003/0.237
Digestible nutrient, g/rabbit/day						
Dry matter	37.0^{a}	37.7^{ab}	38.1^{ab}	39.0^{b}	38.5^{b}	0.28/0.008
Organic matter	35.0^{a}	35.5^{ab}	35.9^{ab}	36.7^{b}	36.2^{ab}	0.29/0.027
Crude protein	5.68^{a}	6.57^{b}	7.44^{c}	8.54^{d}	9.33^{e}	0.06/0.001
Ether extract	1.61^{ab}	1.64^{ab}	1.64^{ab}	1.65^{b}	1.57^{a}	0.01/0.018
Neutral detergent fiber	9.29^{a}	9.79^{ab}	10.1^{ab}	10.6^{b}	10.5^{b}	0.17/0.004
Nitrogen balance						
N intake, g/rabbit/day	1.28^{a}	1.44^{b}	1.60^{c}	1.77^{d}	1.94^{e}	0.007/0.001
N retention, g/rabbit/day	0.77^{a}	0.89^{b}	1.02^{c}	1.18^{d}	1.21^{d}	0.01/0.001
N intake, g/kgW$^{0.75}$	1.10^{a}	1.17^{b}	1.24^{c}	1.34^{d}	1.47^{e}	0.01/0.001
N retention, g/kgW$^{0.75}$	0.66^{a}	0.72^{b}	0.79^{c}	0.89^{d}	0.91^{d}	0.01/0.001
N retention/N intake, %	59.8^{a}	61.4^{ab}	63.9^{c}	66.5^{d}	62.3^{bc}	0.41/0.001

CP15, CP17, CP19, CP21 and CP23 were the treatments contained different crude protein levels of 15, 17, 19, 21 and 23% in DM, respectively; N: nitrogen. The numbers with different superscript letters in the same row were significantly different (P<0.05)

Nutrient intakes of growing Californian rabbits at 12 weeks of age had the similar pattern of the whole experiment. The digestible nutrients were significantly different (P<0.05) among treatments. The digestible DM and OM for CP21 and CP23 treatments were significantly higher than others, although DM and OM intakes were similar (P>0.05) among treatments. It could be explained that the apparent digestibility of DM and OM were significantly improved (P<0.05) by increasing soybean extraction meal in the diets being 69.4-73.9% and 70.5-74.7%, respectively. The findings in this experiment consisted with the results of Amber (2000) in which the growth rate and nutrient digestibility increased significantly (P<0.05) when increasing soybean meal levels in the New Zealand White rabbit diets. The digestible CP values (g) was proportionally increased by increasing levels of soybean extraction meal in the diets. It was 5.68, 6.57, 7.44, 8.54 and 9.33 g for the CP15, CP17, CP19, CP21 and CP23 treatments, respectively. The results of digestible CP (g) in the present experiment was consistent with those reported by Dong and Thu (2012) being from 7.96 to 9.40 g/rabbit/day. The nitrogen retention were significantly different (P<0.05) among the treatments with the significant higher values of the CP21 and CP23 treatments. This resulted in the rabbits of CP21 and CP23 treatments having higher values of daily weight gain, final live weight, carcass quality and economic returns. However, the economic analysis showed that profit for the CP21 diets were higher than CP23 diets because of low feed cost and high income.

4 CONCLUSION

Growth performance, nutrient digestibility, nitrogen retention, carcass quality and economic returns are improved for Californian rabbits fed the diet containing 21% CP. The improved CP intake and digestible DM, OM and CP are found by increasing the soybean extraction meal in the diets.

REFERENCES

Abedo A.A et al., 2012. Response of growing rabbits to diets containing different levels of protein and radish (raphanus sativus L) seeds. Journal of Agricultural science, vol. 4, No.3; 2012.

Amber KH., 2000. Effect of replacing Mung Beans (Phaseolus Aureus) for soybean meal in diets for growing rabbits. In: Proceedings 7th World Rabbit Congress, June 4-7, 2000-Valencia-Spain, Volume C, pages 69-75.

AOAC, 1990. Official Methods of Analysis (15th edition). Association of Official Analytical Chemists. Washington, DC. Volume 1: 69-90.

Carabaño R, MJ.Villamide, J.García, N.Nicodemus, A.Llorente, S.Chamorro, D.Menoyo, P.García-Rebollar, A.I. García-Ruiz, J.C.de Blas, 2008. New concepts and objectives for protein-amino acid nutrition in rabbit. In: Proceedings 9th World Rabbit Congress, June 10-13, 2008-Verona-Italy, 477-490.

Cheeke, P.R, 1987. Rabbit feeding and nutrition. Academic Press, San Diego, CA.

De Blas, C. and J. Wiseman, 2010. *Nutrition of the rabbit*, 2nd edition, CAB International.

El-Tahan H.M., Kh.Amber, W.A.Morsy, 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, 501-505.

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

McDonald P, R. A. Edwards, J. F. D. Greenhalgh and C. A. Morgan, 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.

Hang, N.L.T., 2012. Effects of dietary CP levels on growth performance, nutrient digestibility and soft feces of different rabbit breeds. Graduate Thesis, Faculty of Agriculture and Applied Biology, Can Tho University.

Dong, N.T.K. and Thu, N.V., 2012. Effect of mixed or separate feedings and ration of *Centrocema pubescens* and Para grass on feed utilization, nutrient digestibility and growth performance of crossbred rabbits. Proceedings of the international conference "livestock-based farming system, renewable resources and the environment, 6-9 June 2013, Da Lat city, Vietnam.

Thu, N.V. and Dong, N.T.K., 2008. Effect of water spinach and sweet potato vine associated with 2 other natural plants on growth performance, carcass values and economic return of growing crossbred rabbits in the Mekong delta of Vietnam. In: proceedings 9th World Rabbit Congress – June 10-13, 2008 – Verona – Italy, 763-768.

Luan, P.T., 2012. Effects of supplementation of soybean meal in diet on growth rate, feed utilization and nitrogen retention of Californian rabbits. Graduate Thesis, Faculty of Agriculture and Applied Biology, Can Tho University.

Hoang, P.T., 2009. A study on nutrient digestibility, growth performance and economic returns of local crossbred and imported rabbit breeds in Mekong Delta of Vietnam. Graduate Master Thesis, Faculty of Agriculture and Applied Biology, Can Tho University.

QCVN 01-75: 2011/BNNPTNT, 2001. National technical regulation on experiment. Testing breeding rabbits. Ministry of Agriculture and Rural Development, Vietnam. 4p.

Robertson, J. B. and P. J. Van Soest, 1981. The detergent system of analysis and its application to human foods, Chapter 9. The analysis of dietary fiber in foods (W. P. T. James and O. Theander, editors). Marcel Dekker, NY, USA. 123-158 pp.

Van Soest P J, J. B. Robertson and B. A. Lewis, 1991. Symposium: Carbohydrate methodology metabolizable and nutritional implications in dairy cattle: methods for dietary fiber, and non-starch polysaccharides in relation to animal nutrition. Journal of Dairy Science 74: 3583-3597.

Wang. X, M.Mingwen, S.Liangzhan, W.Chunyang, Z.Yanli, L. Fuchang, 2012. Effects of different protein, fiber and energy levels on growth performance and the development of digestive organs in growing meat rabbit. In: Proceedings 10th world rabbit congress – September 3-6, 2012 – Aharm El-Seikh-Egypt, 641-645.