Effects of Dietary Crude Protein Levels on Growth Performance, Nutrient Digestibility and Nitrogen Retention in Growing Californian Rabbits Fed Available Feedstuffs in Mekong Delta of Vietnam

Truong Thanh Trung, Nguyen Thi Kim Dong

Faculty of Agriculture & Applied Biology, Can Tho University, Vietnam
Corresponding e-mail: tttrung@ctu.edu.vn

ABSTRACT

A study including two experiments was conducted at the Experimental farm of Cantho University in Vietnam. The aim of this study was to evaluate the effects of different dietary crude protein levels in the diets of growing Californian rabbits on growth performance and nutrient digestibility. In experiment 1, feeding trial, sixty Californian rabbits at 42 days of age, was arranged in a completely randomized design with 5 treatments and 3 replications and 4 balanced sex rabbits per experimental unit. The 5 dietary treatments were different protein levels of 15, 17, 19, 21 and 23%, respectively. In the experiment 2, nutrient digestibility trial, had similar design to that of the feeding trial, however, 12-week old rabbits were used. The results of study indicated that crude protein (CP) intakes increased ($P<0.05$) with increasing of crude protein levels in the diets. The average daily gain was the highest and feed conversion ratio was the lowest in the CP21% treatment ($P<0.05$) with 23.3g/rabbit/day and 3.06, respectively. The apparent digestibility coefficients of DM, OM, CP, EE, NDF and nitrogen retention were significantly increased ($P<0.05$) with increasing the levels of CP in the diets. The weight of carcasses, thigh meat and lean meat were significantly higher ($P<0.05$) for animals fed 21% CP (CP21). It could be concluded that growing Californian rabbits fed diet with 21% crude protein had the best growth performance, higher nutrient digestibility and gave better economic returns.

Key Words: Californian Rabbits, Crude Protein, Carcass Yield, Nutrient Digestibility

INTRODUCTION

In recent years, rabbit production based on low cost forages has been increased considerably in Vietnam in order to meet the increasing demand for human food. Local rabbits are popularly raised in the Mekong delta because of a good adaptation to the local climate and feeds but low productivity. In order to upgrade native rabbit production, Californian breeds have been imported. In the Mekong Delta in Vietnam, rabbit production based on locally available feed resources including natural grass, wild vegetables and agro-industrial byproduct. Para grass, *Operculina turpethum* and sweet potato tuber are used as rabbits feed, are widely available in Mekong Delta in Vietnam. Soybean and soya waste can be used as crude protein supplement feeds for growing and reproductive rabbits (Nguyen & Nguyen 2008). The appropriate usages of these feeds for Californian rabbit diets are still limited. Protein is an important component for life processes and effects on growth performance and carcass yield of rabbits. Several authors have studied the optimal dietary levels of protein for growing rabbits (Carabaño et al. 2008) but their studies mainly used commercial diets for 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 level requirement in diet. The combination among available feedstuffs in Mekong Delta in diets for growing Californian rabbits to satisfy crude protein needs has not been implemented, yet. This study aimed to determine the optimum level of crude protein level in the diet of growing Californian rabbits fed available feedstuffs in Mekong delta in Vietnam.

MATERIALS AND METHODS

Experiment 1: Feeding trial

The experiment was conducted at the experimental farm of Cantho University. Sixty

Californian rabbits at 42 days of age (average live weight of 470 g) were arranged in a completely randomized design with 5 treatments and 3 replications. Four rabbits (balanced for sex) in one cage was the experimental unit. The treatments were percentage of crude protein in diets at levels of 15, 17, 19, 21 and 23% (DM basic) (CP15, CP17, CP19, CP21 and CP23), respectively. At the end of feeding trial, the experimental rabbits were slaughtered for carcass and meat quality evaluation.

Experiment 2: Digestibility trial

The experimental design was similar to that of the feeding trial; however, 12-week old rabbits were used. The animals had one week for adaptation and 6 days for recording and taking samples of feces and urine.

Feeds, feeding and management

Para grass, *Operculina turpethum*, soybean, soya waste and sweet potato tuber were used in the experiment. Para grass and *Operculina turpethum* were collected daily in the areas surrounding Cantho city. These feeds were given in fresh form and were offered three times a day at 7:00h, 12:00h and 17:00h. Quantities offered and refusals were recorded daily for each forage. Fresh water was freely available. The rabbits were vaccinated to prevent hemorrhagic and parasite diseases.

Measurements

Feeds and refusals were analysed for dry matter (DM), organic matter (OM), crude protein (CP), crude fiber (CF), ether extract (EE) and ash according to AOAC (1990) procedures. Neutral detergent fiber (NDF) and Acid detergent fiber (ADF) were determined following procedures of van Soest et al. (1991). Dry matter, OM, CP, NDF and EE digestibility were calculated according to Mc Donald et al. (2002). Metabolisable energy (ME) of para grass and *Operculina turpethum* was estimated following formulas of Maertens et al. (2002) and NRC (1998) for soybean, soya waste and sweet potato tuber. Rabbits were weighed weekly.

Statistical analysis

The data from both experiments were analyzed using the General Linear Model option in the ANOVA of Minitab (Minitab 2010).

RESULTS AND DISCUSSION

Experiment 1: feeding trial

Chemical composition of feeds used in Experiment 1 was shown in Table 2. In Table 2, the DM of Para grass was 16.7% and higher than *Operculina turpethum* of 15.2%. The CP content of *Operculina turpethum* was 15.5%, while it was 12.6% in Para grass. Neutral detergent fiber (NDF) and ADF content of Para grass were higher than the *Operculina turpethum, i.e.,* (67.1% vs. 38.8% and 43.4% vs. 30.7%), respectively. Soybean and soya waste had higher levels of crude protein and metabolism energy than the forages.

Table 1. Ingredient composition of the experimental diets (%DM)

Feed	Treatment (level of crude protein)				
	CP15	CP17	CP19	CP21	CP23
Operculina turpethum	21.0	21.0	21.0	25.0	25.0
Soybean	11.0	16.0	21.0	25.0	30.0
Soya waste	10.0	10.0	10.0	11.0	12.0
Sweet potato tuber	32.0	27.0	23.0	17.0	13.0
Para grass	26.0	26.0	25.0	21.0	21.0
% CP in diet	15.0	17.0	19.0	21.0	23.0
% NDF in diet	36.0	36.0	36.0	36.0	36.0
ME, MJ/kg dry matter	11.6	11.6	11.6	11.6	11.6

Table 2. Chemical composition of feeds used in Experiment 1 (% in DM, except for DM which is on fresh basis)

Feed	DM	OM	CP	EE	NDF	ADF	CF	ME, MJ/kgDM
Operculina turpethum	15.2	87.9	15.5	6.50	38.8	30.7	18.6	9.69
Soybean	87.9	93.8	45.1	18.1	23.7	13.5	6.56	14.4
Soya waste	12.7	96.0	22.5	9.23	32.4	27.8	15.5	13.4
Sweet potato tuber	26.2	96.9	3.96	1.86	13.5	8.95	3.15	15.5
Para grass	16.7	90.7	12.6	3.70	67.1	43.4	25.7	6.48

DM: dry matter; OM: organic matter; CP: crude protein; EE: ether extracts; NDF: neutral detergent fiber; ADF: acid detergent fibre; CF: crude fiber; ME: metabolisable energy

Table 3. Effect of level of crude protein in diet on feed and nutrient and metabolizable energy (ME) intakes of growing Californian rabbits

Parameter	Treatment					SEM/Prob
	CP15	CP17	CP19	CP21	CP23	
Feed, g/rabbit/day (in fresh form)						
O. turpetlum	100.000^{ab}	101.000^{a}	99.000^{b}	119.000^{c}	116.000^{d}	0.340/0.001
Soybean	9.100^{a}	12.800^{b}	17.100^{c}	20.300^{d}	24.200^{e}	0.040/0.001
Soya waste	54.600^{a}	56.700^{b}	54.600^{a}	61.000^{c}	65.400^{d}	0.190/0.001
Sweet potato tuber	87.300^{a}	74.500^{b}	63.100^{c}	47.400^{d}	36.000^{e}	0.290/0.001
Para grass	113.000^{a}	110.000^{b}	106.000^{c}	91.400^{d}	88.300^{e}	0.390/0.001
Feed, g/rabbit/day (DM basis)						
O. turpethum	15.200^{a}	15.300^{a}	15.000^{a}	18.000^{b}	17.700^{c}	0.060/0.001
Soybean	7.990^{a}	11.200^{b}	15.000^{c}	17.900^{d}	21.300^{e}	0.030/0.001
Soya waste	6.930^{a}	7.200^{b}	6.930^{a}	7.740^{c}	8.310^{d}	0.020/0.001
Sweet potato tuber	22.900^{a}	19.500^{b}	16.500^{c}	12.400^{d}	9.430^{e}	0.090/0.001
Para grass	18.800^{a}	18.400^{b}	17.700^{c}	15.300^{d}	14.800^{e}	0.080/0.001
Total intake, g/rabbit/day (DM basis)						
Dry matter	71.800	71.600	71.200	71.300	71.400	0.250/0.418
Organic matter	66.700	66.400	66.000	65.900	66.000	0.230/0.091
Crude protein	10.800^{a}	12.100^{b}	13.500^{c}	15.000^{d}	16.400^{e}	0.030/0.001
Ether extract	4.200^{a}	4.730^{b}	5.290^{c}	5.910^{d}	6.490^{e}	0.020/0.001
Neutral detergent fiber	25.800	25.900	25.700	25.700	25.800	0.090/0.600
Acid detergent fiber	17.900	17.900	17.700	17.800	17.800	0.060/0.181
Crude fiber	9.990	10.000	9.920	10.000	10.100	0.030/0.098
ME, MJ/day	0.832	0.828	0.825	0.827	0.831	0.003/0.515

Means with different letters within the same rows are significantly different at the 5% level

Feed and nutrient intakes of growing Californian rabbits were presented in Table 3. The intakes of CP and EE (g/rabbit/day) were higher ($P<0.05$) at the higher level of crude protein in diets. The CP intake proportionally increased in the diets with increasing level of CP and they are significantly different ($P<0.05$) among treatments.

The daily weight gain and feed conversion ratio were showed in Table 4. Daily weight gain was significantly different among the treatments ($P<0.05$). The highest daily gain

was achieved by rabbits fed CP21 diet, while the lowest value was achieved by rabbits fed CP15 diet. The daily weight gain of rabbits in this experiment was similar to results in the New Zealand White rabbits reported by Wang *et al.* (2012) from 21.5 to 28.1 g/d. Rabbit fed CP21 diet had the best FCR (3.06) (P<0.05), while the worst FCR was observed with those fed CP15 diet (3.99). The obtained values for FCR were acceptable levels and consistent with the results being from 3.37 to 3.63 indicated by El-Tahan *et al.* (2012). The economic analysis showed that benefits obtained from the CP21 diets were higher than the other diets due to the better growth rate and feed conversion ratio.

The criteria of carcass weight, lean meat weight and thigh meat weight were significantly affected (P<0.05) by the different CP diets (Table 5). In a study of fresh sweet potato vine and water spinach associated with Mom grass and Cuc in the diets, Nguyen & Nguyen (2008) reported that the carcass and lean meat percentage of growing crossbred rabbit increased from 44.0 to 48.7% and from 78.3 to 80.3%, respectively. Crude protein content of rabbit meat in the present experiment varied between 20.8 to 21.0%, while previously reported that the CP content of rabbit meat was in the range of 18.7 to 19.5% reported by Nguyen & Nguyen (2008).

Table 4. Mean values of daily weight gain and feed conversion in growing Californian rabbits fed different CP levels in diets in Experiment 1

Item	Treatment					SEM/Prob
	CP15	CP17	CP19	CP21	CP23	
Initial weight	463.00	469.00	463.00	477.00	475.00	6.960/0.475
Final weight	1975.00^{a}	2168.00^{b}	2341.00^{c}	2435.00^{c}	2421.00^{c}	27.000/0.001
Daily weight gain	18.00^{a}	20.20^{b}	22.40^{c}	23.30^{c}	23.20^{c}	0.300/0.001
Feed conversion ratio	3.99^{a}	3.54^{b}	3.19^{c}	3.06^{c}	3.08^{c}	0.040/0.001
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	-
Difference (VND/rabbit)	42,028	55,338	66,823	72,174	68,646	-

Means with different letters within the same rows are significantly different at the 5% level. 21,000 VND = 1 USD

Table 5. Carcass and meat quality of Californian rabbits fed different diets

Item	Treatment					SEM/Prob
	CP15	CP17	CP19	CP21	CP23	
Live weight, g (LW)	1990^{a}	2183^{b}	2353^{c}	2466^{c}	2437^{c}	24.4/0.001
Carcass weight, g	1047^{a}	1143^{b}	1238^{c}	1289^{c}	1286^{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 (TM) 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 composition 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

Means with different letters within the same rows are significantly different at the 5% level

Experiment 2: Digestibility and N balance trial

The composition of the feedstuffs offered, feed and nutrient intakes and the effects of different CP levels on nutrient digestibility are shown in Table 6, 7 and 8.

Nutrient intakes of growing Californian rabbits in the experiment 2 were similar pattern of the experiment 1. The apparent digestibility of DM, OM, CP, EE and NDF significantly increased (P<0.05) by increasing the levels of CP in experimental diets (Table 8). Apparent crude protein digestibility of rabbits fed CP21 diet was significantly higher (P<0.05) than CP15 and CP17 treatments with the lowest value for for the CP15 diet. The results of apparent CP digestibility in the present experiment was consistent (74.9-77.9%) with those reported by El-Tahan *et al.* (2012).

Table 8 also shows that the digestible nutrient values of DM, CP, EE and NDF increased with the increase of CP level in diets and they were significantly different (P<0.05) among treatments with the higher values for the CP21 and CP23 treatments. The nitrogen intake and retention were significantly different (P<0.05) among treatments with the significant higher values of the CP21 and CP23 treatments.

Table 6. Chemical composition of feeds used in Experiment 2 (% in DM, except for DM which is on fresh basis)

Feed	DM	OM	CP	EE	NDF	ME, MJ/kgDM
Operculina turpethum	15.00	88.00	15.60	6.50	39.50	9.69
Soybean	87.90	95.40	45.00	18.20	30.60	14.40
Soya waste	12.70	95.80	22.60	9.03	30.90	13.40
Sweet potato tuber	26.10	97.00	3.96	1.90	12.50	15.50
Para grass	16.90	89.80	12.40	3.65	66.50	6.48

DM: dry matter, OM: organic matter, CP: crude protein, EE: ether extracts, NDF: neutral detergent fiber, ME: metabolism energy

Table 7. Feed and nutrient intakes (g/day) of rabbits in the diets of the exp. 2

Item	Treatment					SEM/Prob
	CP15	CP17	CP19	CP21	CP23	
Dry matter	53.40	53.30	52.70	52.70	52.60	0.300/0.274
Organic matter	49.60	49.50	48.90	48.80	48.80	0.270/0.193
Crude protein	8.00[a]	9.02[b]	10.00[c]	11.10[d]	12.10[e]	0.050/0.001
Ether extract	3.11[a]	3.52[b]	3.91[c]	4.37[d]	4.78[e]	0.020/0.001
Neutral detergent fiber	19.20	19.50	19.40	19.50	19.60	0.110/0.294
Metabolisable energy, MJ	0.62	0.62	0.61	0.61	0.61	0.003/0.109

Means with different letters within the same rows are significantly different at the 5% level

Table 8. Nutrient digestibility coefficients (%) and and N balance of rabbits. Experiment 2

Item	Treatment					SEM/Prob
	CP15	CP17	CP19	CP21	CP23	
Apparent digestibility, %						
Dry matter	69.30^{a}	70.90^{ab}	72.30^{bc}	73.90^{c}	73.20^{bc}	0.530/0.001
Organic matter	70.40^{a}	71.40^{ab}	72.90^{abc}	74.50^{c}	73.50^{bc}	0.570/0.003
Crude protein	71.10^{a}	72.80^{ab}	74.50^{bc}	77.30^{c}	77.20^{c}	0.630/0.001
Ether extract	76.80^{a}	79.90^{ab}	81.10^{b}	81.80^{b}	81.50^{b}	0.850/0.011
Neutral detergent fiber	54.40^{a}	58.20^{ab}	61.30^{bc}	65.00^{c}	64.50^{c}	1.030/0.001
Digestible nutrients, g						
Dry matter	37.00^{a}	37.70^{ab}	38.10^{ab}	39.00^{b}	38.50^{ab}	0.350/0.021
Organic matter	34.90	35.30	35.70	36.40	35.80	0.320/0.064
Crude protein	5.69^{a}	6.57^{b}	7.45^{c}	8.56^{d}	9.34^{e}	0.070/0.001
Ether extract	2.39^{a}	2.81^{b}	3.17^{c}	3.58^{d}	3.90^{e}	0.040/0.001
Neutral detergent fiber	10.50^{a}	11.40^{ab}	11.90^{bc}	12.70^{c}	12.70^{c}	0.230/0.001
Nitrogen balance, g/kgW$^{0.75}$						
Intake	1.10^{a}	1.17^{b}	1.24^{c}	1.34^{d}	1.47^{e}	0.010/0.001
Retention	0.66^{a}	0.72^{b}	0.79^{c}	0.89^{d}	0.91^{d}	0.010/0.001

Means with different letters within the same rows are significantly different at the 5% level

CONCLUSION

The conclusion of the study was that local forages and agro-industrial byproducts feedstuffs in Mekong Delta in Vietnam could be used for feeding growing Californian rabbits without negative effects on growth performance, nutrient digestibility and meat composition and the optimum level of dietary crude protein was 21%.

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