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

DOI: 10.22144/ctu.jen.2016.101

A RESPONSE OF FEED UTILIZATION, NUTRIENT DIGESTIBILITY, GROWTH AND CARCASS VALUE OF CALIFORNIAN RABBITS TO DIETARY METABOLIZABLE ENERGY

Truong Thanh Trung, Nguyen Thi Kim Dong and Nguyen Van Thu
College of Agriculture and Applied Biology, Can Tho University, Vietnam

ARTICLE INFO

Received date: 03/09/2015
Accepted date: 08/08/2016

KEYWORDS

Californian rabbit, metabolizable energy, growth rate, digestible nutrient

ABSTRACT

This study was conducted to evaluate the effects of different dietary metabolizable energy (ME) levels on growth performance and nutrient digestibility of growing Californian rabbits (Oryctolagus cuniculus). Sixty Californian rabbits at 45 days of age (500±12.9 g) were arranged in a completely randomized design with 5 treatments and 3 replications. Four rabbits including 2 males and 2 females were in one experimental unit. Five treatments were ME levels of 10.0; 10.5; 11.0; 11.5 và 12.0 MJ/kgDM, respectively. The apparent nutrient digestibility and nitrogen retention were evaluated on the rabbits at 12 weeks of age in 7 days. The results showed that dry matter (DM) intakes were not significantly different (P>0.05) among treatments ranging from 69.4 to 74.5 g/rabbit/day. The digestible DM and crude protein (CP) were not significantly different (P>0.05) among treatments being 38.3-44.0 and 8.45-9.95 g/day, respectively. The daily weight gain was significantly different (P<0.05) among treatments. They were 20.5, 22.4, 22.9, 24.5 and 23.9 g for the ME10.0, ME10.5, ME11.0, ME11.5 and ME12.0, respectively. The carcass, lean meat and thigh meat weights were significantly different (P<0.05) among treatments with the highest values at the ME11.5 treatment (1.374, 1.049 and 412 g, respectively). It could be concluded that the dietary ME of 11.5 MJ/kgDM should be used to feed Californian rabbits for improving growth, carcass quality and economic return

Cited as: Trung, T.T., Dong, N.T.K. and Thu, N.V, 2016. A response of feed utilization, nutrient digestibility, growth and carcass value of californian rabbits to die-tary metabolizable energy. Can Tho University Journal of Science. Vol 3: 25-31.

1 INTRODUCTION

In Mekong delta of Vietnam, rabbit production and meat have been become popularly in recent years due to the increasing of human demands. There are good natural conditions for developing feed sources for rabbit production such as suitable ambient temperature, fertile soil and available fresh water through out a year. Metabolizable energy (ME) was used by growing rabbits for productive functions as maintenance and growth. Several factors would affect the ME requirement in rabbits including body size, age, gender and breed, vital and productive functions, and feeding environment (De Blas and Wiseman, 2010). Many studies had been conducted to find the optimal dietary ME levels for growing rabbits. In Europe, INRA (1984) suggested at 11.6 MJ/kgDM and Lebas (1997) being 11.0 MJ/kgDM in diet for European growing rabbits. In China, Wang (2012) found that the diet containing 11.0 MJ/kgDM inducing better daily weight gain and albumin/globulin ratio of New

Zealand White rabbit. Maize is a major staple food grain throughout the world and a major feedstuff in developed countries. The maize grain is a major feed grain and a standard component of livestock diets where it is used as a source of energy (Heuze, 2015). In Vietnam, maize is the second most important food crop after rice. Maize is also the primary source of feed for Vietnam's livestock. Mekong Delta had 403.000 ha for maize cultivation (General Statistics Office of Vietnam, 2014). These oversea studies used pellets while farmer in Mekong Delta of Vietnam used separately feedstuffs for feeding rabbits. The studies on ME level requirement in Californian rabbits in Mekong Delta of Vietnam have been limited. This study aimed to determine the optimum level of ME level in the diets of growing Californian rabbits for growth rate, carcass performance and economic return under feeding conditions in Mekong Delta of Vietnam.

2 MATERIALS AND METHODS

2.1 Location and time

The experiment was carried out at the experimental farm which is 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 September 2014.

2.2 Experimental design

Sixty Californian rabbits at 45 days of age (500±12.9 g) were arranged in a completely randomized design with 5 treatments. The treatments were different metabolizable energy concentration in diets including 10.0; 10.5; 11.0; 11.5 and 12.0 MJ/kgDM corresponding to ME10.0; ME10.5; ME11.0; ME11.5 and ME12.0 treatments, respectively. The dietary crude protein, lysine, methionine and threonine were formulated at the level of 19.0% CP, 0.95% Lys, 0.67% Met and 0.75% Thr for all experimental units. Four rabbits including 2 males and 2 females were used in an experimental unit. Three replications were applied for all treatments and the experiment lasted 12 weeks. After finishing, all animals were slaughtered for evaluating carcasses and meat quality. Ingredient formulations and chemical composition of diets in the experiment were presented in table 1.

Table 1: Feed ingredients and chemical composition of the experimental diets (%DM)

Ingredients, %DM	Treatments				
	ME10.0	ME10.5	ME11.0	ME11.5	ME12.0
Sweet potato vines	47.0	40.0	38.0	31.0	24.0
Para grass	38.0	35.0	29.0	24.0	20.0
Soybean extraction meal	10.0	13.0	14.0	17.0	20.0
Maize	5.00	12.0	19.0	28.0	36.0
Chemical composition of diets, % DM					
DM	14.0	15.6	17.0	19.9	23.6
OM	89.1	89.9	90.7	91.8	92.8
CP	19.0	19.0	19.0	19.0	19.0
EE	5.60	5.34	5.27	5.01	4.74
CF	20.2	18.5	16.5	14.2	12.1
NDF	47.2	43.9	40.4	36.1	32.3
ADF	29.8	27.2	24.7	21.4	18.5
Ash	10.9	10.1	9.29	8.21	7.24
ME, MJ/kgDM	10.0	10.5	11.0	11.5	12.0

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

2.3 Animal and housing

Californian rabbits were produced at experimental farm. 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 used bio-Quini-coc and Ivermectin 0.25% for prevention coccidiosis and parasites at the beginning time of experiment. The rabbits at 60 days of age were vaccinated to prevent rabbit hemorrhagic disease.

2.4 Feeds and feeding

Para grass, sweet potato vines, soybean extraction meal and maize were used in the experiment. Para grass was collected surrounding the farm daily. The animals were fed three times a day at 7:00h, 12:00h and 17:00h. Fresh water was available for all rabbits almost all day and night time. The refusals were weighed daily in the morning to calculate the feed intake. All feeds were analyzed chemical composition and calculated ME for the treatments.

2.5 Measurements

The feeds and refusals were taken for analysis of DM, OM, CP, EE, NDF, ADF, and ash following procedures of AOAC (1990), Van Soest *et al.* (1991) and Robertson and Van Soest (1981). The metabolizable energy (ME) values of feeds were calculated according to the formula proposed by Maertens *et al*. (2002) and Cheeke (1987).

Rabbits were weighed individually every week. Daily feed intakes, growth rate, and feed conversion ratios were measured and calculated. After finishing, the experimental rabbits were slaughtered for evaluating carcass quality. The economic analysis was also done among the treatments.

Apparent of nutrient digestibility and nitrogen retention were determined by collecting and analyzing offered and refused feeds, feces, and urine daily. The animals had one week for getting samples according to McDonald *et al*. (2002). Feeds and refusals were daily measured. Urine was also collected for nitrogen analysis to calculate the nitrogen retention. DM, CP, EE, NDF and ADF digestibility were employed according Mc Donald *et al.* (2002).

Carcass and meat quality were determined by slaughtering all rabbits at the end of the experiment. Slaughtering procedure was implemented according to the standard described by QCVN 01-75: 2011/BNNPTNT (2001). Thigh and lean meat was sampled to analyze 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. software (Minitab, 2010). To compare difference between mean values of treatments, Tukey's test was used (Minitab, 2010).

3 RESULTS AND DISCUSSIONS

3.1 Chemical composition and ME values of feeds in the experiment

Nutrient composition and ME values of feeds used in the experiment was presented in Table 2.

Table 2: Nutrient composition of feeds in the experiment (%DM)

Feeds	DM	OM	CP	EE	CF	NDF	ADF	Ash	ME, MJ/kgDM
Sweet potato vines	10.5	88.2	20.1	7.50	16.5	42.5	28.2	11.8	10.4
Para grass	15.2	88.0	12.6	4.12	31.2	65.4	40.3	12.0	8.54
Soybean extraction meal	90.2	92.3	43.2	3.02	4.85	15.5	10.3	7.70	12.4
Maize	88.4	98.7	8.40	4.21	2.67	16.4	4.38	1.30	14.8

ME10.0, ME10.5, ME11.0, ME11.5 and ME12.0 were the treatments contained different metabolizable energy levels of 10.0; 10.5; 11.0; 11.5 and 12.0 MJ/kgDM, respectively; DM: dry matter, OM: organic matter, CP: crude protein, EE: ether extract, CF: crude fiber, NDF: neutral detergent fiber, ADF: acid detergent fiber, ME: metabolizable energy.

Table 2 showed that CP content of para grass (12.6%) was lower than that of sweet potato vine (20.1%). The CP and ME content of soybean extraction meal were 43.2% and 12.4 MJ/kgDM, respectively. The CP concentration of maize was 8.40% and ME content was 14.8 MJ/kgDM. The NDF values of para grass and sweet potato vines were 65.4% and 42.5%, respectively. Maize was a main feed supplying energy in the diets.

3.2 Feed and nutrient intakes

The feed and nutrient intakes of rabbits fed diets containing different ME levels were presented in Table 3.

The DM intakes of sweet potato and para grass considerably decreased ($P<0.05$) while DM intakes of maize and soybean extraction meal increased ($P<0.05$) corresponding with increasing levels of ME in diets. The DM intake was not significantly different among treatments being from 69.4-74.5 gDM/rabbit/day. It was similar to the results of using different levels of sweet potato tuber and soybean extraction meal in the crossbred rabbit diets reported by Giang (2010) being 57.4-85.1 gDM/rabbit/day. The DM intake value in this experiment also consisted with the results of Butcher et al. (1981) being from 40.1-90.7 gDM/rabbit/day by using different ME concentration in Californian and New Zealand White rabbit diets. The CP intake was similar ($P>0.05$) among treatments. They were 13.2, 13.8, 14.2, 14.0 and 14.1 g/rabbit/day for the ME10.0, ME10.5, ME11.0, ME11.5 and ME12.0 treatments, respectively. The CP intake values in this experiment were higher than the findings of Giang (2010) being 12.7-13.2 gDM/rabbit/day. The NDF, ADF and CF intakes decreased ($P<0.05$) while the ME intake increased ($P<0.05$) by increasing of maize and soybean extraction meal in the diets. It could be explained that maize and soybean extraction meal contained high ME and low fiber components. De Blas and Wiseman (2010) stated that increasing ME levels in the diets usually decreased crude fiber and fiber fraction concentration. The ME intake values were proportionally increased (P<0.05) from 0.70 to 0.88 MJ/rabbit/day for the ME10.0 to ME12.0 treatments. It was similar to findings of Hoang (2009) being from 0.89 and 0.91 MJ/rabbit/day for Crossbred (Local x New Zealand White) and New Zealand White rabbits, respectively.

Table 3: The feed and nutrient intakes of rabbits in the experiment

	Treatments					SEM/P
	ME10.0	ME10.5	ME11.0	ME11.5	ME12.0	
Feed, gDM/rabbit/day						
SPV	32.6a	29.2a	29.0a	22.3b	17.9b	1.23/0.001
Para grass	26.5a	24.8a	20.9ab	18.5bc	14.0c	1.21/0.001
Maize	3.47e	8.64d	14.2c	20.7b	26.4a	0.84/0.001
SEM	6.94d	9.36cd	10.4bc	12.6ab	15.0a	0.54/0.001
Total intake, g/rabbit/day						
DM	69.4	72.0	74.5	74.1	73.3	3.55/0.853
OM	61.8	64.7	67.6	68.0	68.0	3.23/0.607
CP	13.2	13.8	14.2	14.0	14.1	0.66/0.836
EE	3.89	3.86	3.95	3.69	3.49	0.18/0.420
CF	14.1a	13.2ab	12.2ab	10.6bc	8.76c	0.59/0.001
NDF	32.8a	31.5a	29.9ab	26.9ab	23.4b	1.44/0.006
ADF	20.7a	19.6ab	18.3ab	15.9bc	13.4c	0.87/0.001
Ash	7.60a	7.25ab	6.92ab	6.08bc	5.30c	0.32/0.003
ME, MJ/day	0.70d	0.76c	0.82b	0.85ab	0.88a	0.04/0.001

The numbers with different superscript letters in the same row were significantly different (P < 0.05). SPV: sweet potato vines, SEM: soybean extraction meal

3.3 Growth performance and economic returns

Growth rate and economic returns of the rabbits fed diets containing different ME levels were shown in Table 4.

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

Items	Treatments					SEM/P
	ME10.0	ME10.5	ME11.0	ME11.5	ME12.0	
Initial weight, g/rabbit	511	510	508	507	508	1.26/0.174
Final weight, g/rabbit	2,233[b]	2,391[ab]	2,433[a]	2,566[a]	2,517[a]	37.2/0.002
Daily weight gain, g/rabbit	20.5[b]	22.4[ab]	22.9[a]	24.5[a]	23.9[a]	0.43/0.002
Feed conversion ratio	3.39	3.22	3.25	3.03	3.08	0.19/0.685
Feed cost, VND/rabbit	40,513	45,511	50,598	53,464	56,183	
Total cost, VND/rabbit	125,513	130,511	135,598	138,464	141,183	
Income, VND/rabbit	178,632	191,247	194,616	205,244	201,396	
Profit, VND/rabbit	53,119	60,736	59,019	66,780	60,213	

ME10.0, ME10.5, ME11.0, ME11.5 and ME12.0 were the treatments contained different metabolizable energy levels of 10.0; 10.5; 11.0; 11.5 and 12.0 MJ/kgDM, 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 (P<0.05) among treatments. They were 20.5, 22.4, 22.9, 24.5 and 23.9 g/rabbit/day for the ME10.0, ME10.5, ME11.0, ME11.5 and ME12.0 treatments, respectively. These results leaded to the final weight of rabbits increased when increasing ME concentration in the diets from 10.0 to 11.5 MJ/kgDM then decreased slightly at 12.0 MJ/kgDM. The daily weight gain of rabbits in our experiment was similar to results of the New Zealand White rabbits reported by Wang *et al*. (2012) and El-Tahan *et al.* (2012) from 21.5 to 28.1 g/rabbit/day and from 23.8 to 29.0 g/rabbit/day, respectively. There was a linear relationship (R^2= 0.77) between ME concentration in diets and daily weight gain of experimental rabbits (Figure 1). De Blas and Wiseman (2010) stated that an increase of the level of dietary energy intake also affected body weight gain and partition of energy retained as protein and fat. The body weight gain was not linearly relationship with digestible energy intake

(DEI), because some constituents (as fat) tended to increase more than proportionally. They found a regression equation for the relationship between DEI and daily gain (DG) ($DG = -10.69DEI^2 + 33.59DEI - 6.52$, $r = 0.96$). The economic analysis showed that benefits got from the ME11.5 diet were higher than the other diets due to the better final live weight. The relationship between ME concentration in diets and daily weight gain of experimental rabbits was showed in Figure 1.

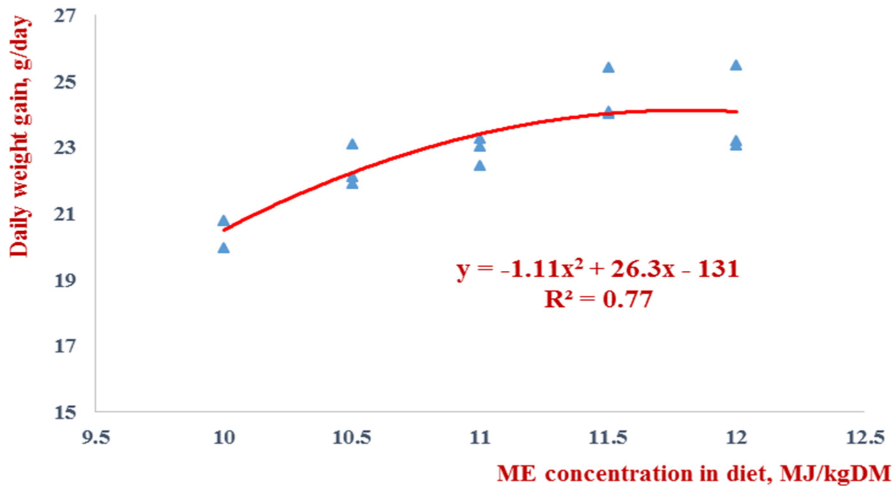

Fig. 1: Effect of ME concentration in diets on daily weight gain of rabbits in the experiment

3.4 Carcass values and meat nutrients

The carcass values and meat quality of rabbits fed diets containing the different ME levels were presented in Table 5.

Table 5: Carcass values, internal organs and meat quality of rabbits in the experiment

Items	Treatments					
	ME10.0	ME10.5	ME11.0	ME11.5	ME12.0	SEM/P
Live weight, g (LW)	2,258^b	2,413^{ab}	2,449^a	2,589^a	2,548^a	37.8/0.002
Carcass weight, g	1,179^b	1,271^{ab}	1,295^{ab}	1,374^a	1,350^a	27.5/0.008
Carcass percentage, %LW	52.3	52.6	52.9	53.0	53.0	0.43/0.695
Lean meat weight, g	893^b	977^{ab}	988^{ab}	1,049^a	1,035^a	19.6/0.004
Lean meat percentage, %	75.7	76.9	76.3	76.4	76.7	0.39/0.331
Thigh meat weight, g	325^b	360^{ab}	368^{ab}	412^a	391^a	9.38/0.002
Thigh meat percentage, % carcass	27.6	28.3	28.4	30.0	28.9	0.48/0.062
Body fat, g	15.7^c	16.3^c	24.0^b	28.0^b	33.7^a	1.08/0.001
Heart, g	4.33	5.00	4.67	4.33	4.67	0.28/0.461
Kidney, g	13.3	16.7	15.0	14.3	14.3	1.16/0.410
Liver, g	51.0	59.3	54.0	58.7	57.0	3.08/0.359
Lung, g	14.3	14.3	15.7	13.0	16.7	1.40/0.461
Stomach, g	31.3	33.3	34.0	33.3	37.0	2.65/0.674
Small intestine, cm	274	284	287	299	293	12.2/0.683
Large intestine, cm	136	137	118	126	121	6.22/0.191
Caecum length, cm	61.0	61.3	58.7	62.7	55.3	3.79/0.691
Nutrient composition of meat, % in fresh						
Dry matter	26.9	27.0	26.1	26.3	26.6	0.45/0.591
Organic matter	98.3	97.3	97.8	97.7	97.4	0.48/0.289
Crude protein	21.5	20.7	21.0	20.5	21.7	0.41/0.331
Ether extract	4.57	4.61	4.83	4.94	4.95	0.24/0.709
Ash	1.73	2.67	2.20	2.33	2.60	0.48/0.676

ME10.0, ME10.5, ME11.0, ME11.5 and ME12.0 were the treatments contained different metabolizable energy levels of 10.0; 10.5; 11.0; 11.5 and 12.0 MJ/kgDM, respectively. The numbers with different superscript letters in the same row were significantly different ($P < 0.05$)

The carcass, lean meat and thigh meat weight were significantly different (P<0.05) among treatments with the highest values at the ME11.5 treatments being 1,374; 1,049 and 412g, respectively. However, carcass percentage was similar (P>0.05) among treatments and it was 52.3, 52.6, 52.9, 53.0 and 53.0 for the ME10.0, ME10.5, ME11.0, ME11.5 and ME12.0 treatments, respectively. It was similar to results of Gidenne *et al.* (1998) being from 54.6 to 56.8% for growing crossbred rabbit (New Zealand and Californian) fed different ratio of lignin and cellulose in the diets (0.2-0.8). The body fat was significantly increased (P<0.05) corresponding to increasing of ME concentration in the diets with the lowest value at ME10.0 treatment (15.7 g) and the highest value at the ME12.0 treatment (33.7 g). De Blas and Wiseman (2010) stated that increase energy in diets would enhance the fat retainability. The weight of internal organs of experimental rabbits including heart, kidney, liver, lung and stomach were similar (P>0.05) among the treatments. The dietary ME concentrations did not affect (P>0.05) on the nutrient composition of rabbit meat. Crude protein content of rabbit meat in the present experiment was from 20.5 to 21.7%, while this value was from 18.7 to 19.5% reported by Thu and Dong (2008) for local rabbits. Dietary ME levels did not appear to affect rabbits meat quality, however, improving FCR (De Blas and Wiseman, 2010). Carraro *et al.* (2007) did not observe any differences in rabbit meat quality after raising the starch levels from 120 to 180 g/kg in the diets.

3.5 Nutrient digestion and nitrogen retention

Nutrient intakes, digestible nutrients and nitrogen retention of experimental rabbits fed diets with different ME levels are presented in Table 6

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

Item	Treatments					SEM/P
	ME10.0	ME10.5	ME11.0	ME11.5	ME12.0	
Intake, g/rabbit/day						
DM	55.7	58.3	61.1	59.5	58.6	2.79/0.733
OM	49.7	52.5	55.5	54.6	54.3	2.53/0.543
CP	10.5	11.1	11.6	11.2	11.2	0.52/0.689
EE	2.95	2.96	3.07	2.81	2.65	0.13/0.308
CF	10.9a	10.4ab	9.71ab	8.24bc	6.74c	0.46/0.001
NDF	26.3a	25.5a	24.6a	21.6ab	18.7b	1.15/0.005
ADF	17.1a	16.4ab	15.6ab	13.4bc	11.3c	0.73/0.001
Ash	5.98a	5.80a	5.66a	4.93ab	4.32b	0.26/0.006
ME, MJ	0.56b	0.61ab	0.67ab	0.68ab	0.70a	0.03/0.044
Digestible nutrient, g/rabbit/day						
DM	39.9	42.8	45.4	44.6	43.6	2.09/0.437
OM	35.8	38.6	41.3	41.0	40.5	1.89/0.283
CP	7.65	8.47	9.06	8.91	8.92	0.42/0.195
EE	2.41	2.43	2.59	2.38	2.21	0.10/0.187
CF	3.46a	3.50a	3.37ab	3.07b	2.27c	0.07/0.001
NDF	14.5a	14.5a	14.2a	12.7ab	10.4b	0.76/0.016
ADF	7.45a	7.53a	7.46a	6.58ab	5.27b	0.42/0.016
Nitrogen balance						
NI, g/rabbit/day	1.68	1.77	1.85	1.80	1.80	0.08/0.689
NR g/rabbit/day	1.04	1.17	1.26	1.23	1.24	0.08/0.326
NI, g/kgW0.75	1.21	1.24	1.27	1.16	1.19	0.05/0.483
NR, g/kgW0.75	0.86b	0.94ab	0.99ab	1.06a	1.04ab	0.04/0.040
NR/NI, %	61.5	65.7	68.1	68.6	68.7	2.39/0.243

NI: nitrogen intake, NR: nitrogen retention, ME10.0, ME10.5, ME11.0, ME11.5 and ME12.0 were the treatments contained different metabolizable energy levels of 10.0; 10.5; 11.0; 11.5 and 12.0 MJ/kgDM, respectively. 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 were similar pattern of the whole experiment. The digestible DM, OM and CP were not significantly different (P>0.05) among treatments being 39.9-45.4, 35.8-41.3 and 7.65-9.06 g/rabbit/day, respectively. The digestible CF, NDF and ADF were significantly different (P<0.05) with the highest values at the ME10.5 treatment being 3.50, 14.5 and 7.53 g/rabbit/day, respectively, and the lowest values at the ME12.0 treatment being 2.27, 10.4 and 5.27 g/rabbit/day, respectively. The results of digestible CP in the present trial were lower than the values reported by Abedo (2012) from 10.9-11.6 g/rabbit/day. The nitrogen retention (g/kgW$^{0.75}$) were significantly different ($P<0.05$) among the treatments with the significant higher value of the ME11.5 treatments. It resulted in the rabbits of ME11.5 treatments giving higher results of daily weight gain, final live weight, carcass quality and economic returns.

4 CONCLUSION

It could be concluded that Californian rabbits fed the diet contained ME level at 11.5 MJ/kgDM gave the better results of growth rate, meat production and economic returns. Maize could be used to supply energy in Californian rabbit diets.

REFERENCES

Abedo, A.A., Ali, F.A.F., Omer, H.A.A., Ibrahim, S.A., 2012. Response of growing rabbits to diets containing different levels of protein and radish (Raphanus sativus L) seeds. Journal of Agricultural Science. 4(3): 281.

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

Butcher, C., Bryant, M.J., Machin, D.H., Owen, E., Owen, J.E., 1981. The effect of metabolizable energy concentration on performance and digestibility in growing rabbits. Trop Anim Prod. 6:2.

Carraro, L., Trocino, A., Fragkiadakis, M., Xiccato,g. and Radaelli, G., 2007. Digestible fiber to ADF ratio and starch level in the diets for growing rabbits. Italian Journal of Animal Science. 6: 752-754.

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

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

El-Tahan, H.M., Amber, K., 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, 501-505.

Gindenne, T., Carabana, R., Garcia, J., De Blas, C., 1998. Fiber Digestions, In: De Blas C & Wiseman J (ed.) The nutrition of the Rabbit, CABI Publishing, London, (5), 69.

Hueze, V., Tran, G., 2015. Maize grain. Feedipedia, a programme by INRA, CIRAD, AFZ and FAO. http://www.feedipedia.org/node/556 last updated on May 11, 2015, 14-34.

INRA, 1984. Tables de composition et de valeur nutritive des matières premières destinées aux animaux d'élevage. Sauvant, D., Perez, J.M. and Tran, G. (eds). INRA Editions, Paris, France

Lebas, F., Coudert, P., de Rochambeau, H., Thebault, R.G., 1997. Rabbit Husbandry, Health and Production, FAO Animal Production and Health Series No. 21.

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

General Statistics Office of Vietnam, 2014. http://www.gso.gov.vn/default.aspx?tabid=717

McDonald, P., Edwards, R.A., Greenhalgh, J.F.D., 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.

Giang, N.T., 2010. Effects of different supplementation levels of sweet potato tube and molasses in the diets on growth rate and nutrient digestibility of crossbred rabbit in Mekong Delta of Viet Nam. Graduate Master Thesis, Faculty of Agriculture and Applied Biology, Can Tho University.

Thu, N.V., 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.

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., Van Soest, P.J., 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., Robertson, J.B., 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. Journal of Dairy Science. 74: 3583-3597.

Wang, X., Ma, M., Sun, L., Wang, C., Zhu, Y., Li, F., 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.