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EFFECT OF DIFFERENT PROTEIN SOURCES IN THE DIETS ON FEED INTAKE, NUTRIENT DIGESTIBILITY, GROWTH AND CARCASS VALUE OF CALIFORNIAN RABBITS (*Oryctolagus cuniculus*) IN THE MEKONG DELTA OF VIETNAM

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

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ABSTRACT

Sixty Californian rabbits (Oryctolagus cuniculus) at 45 days of age (470±7.93 g) were arranged in a completely randomized design with five treatments and three replications. Four rabbits (2 males and 2 females) were in one experimental unit. Five treatments were protein sources including the meals of soybean extraction, water spinach leaves, fish, feather and blood corresponding to Soybean Extraction Meal; Water spinach Leaves Meal; Fish Meal; Feather Meal and Blood Meal treatments, respectively. Para grass (Brachiaria mutica) and Centrocema pubescens were a basic diet for rabbits. The dietary crude protein (CP) and metabolizable energy (ME) were formulated at the level of 19.0% and 11.6 MJ/kgDM in the different treatments. The apparent nutrient digestibility and nitrogen retention were observed when rabbits being at 12 weeks of age. The results showed that dry matter and CP intakes were significantly higher (P<0.05) for the SEM and WLM treatments than other treatments. The daily weight gain was significantly different (P<0.05) among treatments with the highest value for the SEM treatment (22.8g/day) and the lowest value for the FEM treatment (14.9g/day). The carcass weight and percentage of SEM and WLM were significantly (P<0.05) higher than the FEM and BM, while the higher profit was for the WLM and SEM (3.07 and 2.63 USD/rabbit), respectively. The nutrient digestibility and nitrogen retention were improved for the SEM and WLM treatments. It could be concluded that crude protein sources from soybean extraction and water spinach leaf meal could be used to feed growing Californian rabbits for improving feed and nutrient utilization, growth rate and economic returns.

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1 INTRODUCTION

Rabbit meat production has been more developed recently in Vietnam due to suitable production conditions such as low investment, labor saving, good income and low risks. Californian rabbits have been imported to Vietnam since 2000s to upgrade local rabbit production because of their high productivity. Consequently, they could need higher protein requirements than the native rabbits. In the Mekong delta of Vietnam, crossbred rabbits (New Zealand

and local) are fed locally available feed resources including natural grasses, wild vegetables and agro-industrial byproducts. The diets for rabbits usually contain high proportion of fiber and low protein content. Protein is needed for growth, reproduction and health of rabbits and can be obtained from both plant and animal sources. The nutritive value of a protein feed source is determined not only by its amino acid composition, but also by its digestibility of ingested protein. The main factors involved in protein digestibility of rabbits are chemical structure, properties, and accessibility to enzyme activity (McDonald *et al*, 2010). Rabbits could also utilize more protein resources from microbial activity in caecum by the coprophagy.

Protein sources such as soybean extraction, fish, feather and blood meals have been studied and supplemented in rabbit diets (Biobaku *et al.*, 2003; Ojebiyi *et al*., 2008; Trigo *et al*., 2012; Trung and Dong., 2012; Duwa *et al.*, 2014;). In Vietnam, water spinach (*Ipomoea aquatica*) stems are made and used as pickles for human consumption, while the leaves with high crude protein content (around 30%) are usually thrown away as wastes (Thu, 2013). Dong *et al.* (2008) reported that supplying water spinach leaves as a protein supplementation source improved performance for growing rabbits. The above protein sources are available for feeding animals in the Mekong delta of Vietnam. However, the studies on them for feeding growing rabbits in this region have been limited. Therefore, the objectives of this study were to determine the suitable protein sources in the diets with better uses, growth and benefits of growing Californian rabbits and to recommend farmers for practices.

2 MATERIALS AND METHODS

2.1 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 September 2013 to January 2014.

2.2 Experimental design

Sixty Californian rabbits at 42 days of age (470±7.93 g) were arranged in a completely randomized design with five treatments and three replications. Four rabbits including two males and two females were in an experimental unit. The treatments were different protein sources in diets including the meals of soybean extraction, water spinach leaves, fish, feather and blood corresponding to SEM; WLM; FM; FEM and BM treatments, respectively. The dietary crude protein (CP) and metabolizable energy (ME, MJ/kgDM) were formulated at the level of 19.0% and 11.6 in the different treatments, respectively. Nutrient digestibility and nitrogen retention was observed for when the rabbits being at 12 weeks of age. The experiment lasted 12 weeks. After finishing, the rabbits were slaughtered for evaluating carcasses and meat quality.

Chemical compositions of feeds, dietary formulas and their chemical compositions were presented in Table 1 and 2.

Table 1: Chemical composition (%DM) of feeds used in the experiment

Items	CenP	PG	SoyaW	BR	SEM	WLM	FM	FEM	BM
DM	19.0	16.8	11.0	89.5	87.9	90.3	83.0	84.9	90.7
OM	88.6	90.7	96.6	94.1	91.8	87.3	78.1	77.6	96.6
CP	18.5	12.4	21.0	8.60	43.4	30.6	63.2	79.9	83.9
EE	5.57	5.82	9.49	3.97	3.94	8.87	8.76	6.01	0.61
CF	22.6	26.2	17.1	2.26	4.75	18.3	1.03	3.89	1.54
NDF	49.1	67.1	37.2	17.5	19.3	45.3	10.9	27.0	15.0
ADF	38.6	40.4	28.3	8.90	12.2	30.2	4.05	22.2	11.4
ME, MJ/kgDM	8.90	8.46	9.82	14.2	12.3	9.56	11.5	10.8	11.4

CenP: Centrocema pubescens; PG: para grass; SoyaW: soya waste; BR: broken rice; SEM: soybean extraction meal; WLM: water spinach leaves meal; FM: fish meal; FEM: feather meal; BM: blood meal. 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

Table 2: Dietary formulas of treatments of the experiment (%DM)

	Treatments				
	SEM	WLM	FM	FEM	BM
Feed, %DM					
Centrocema pubescens	19.5	18.0	23.4	24.3	24.4
Para grass	17.3	13.1	12.9	13.4	13.5
Soya waste	5.30	3.91	6.40	6.60	6.60
Broken rice	37.3	27.6	44.8	46.4	46.7
Soybean extraction meal	20.6	-	-	-	-
Water spinach leaves	-	37.4	-	-	-
Fish meal	-	-	12.5	-	-
Feather meal	-	-	-	9.30	-
Blood meal	-	-	-	-	8.80
Sum	100	100	100	100	100
Chemical composition of diets, %DM					
Dry matter	31.4	35.6	30.9	30.3	30.2
Organic matter	92.1	90.2	90.5	90.9	92.7
Crude protein	19.0	19.0	19.0	19.0	19.0
Ether extract	4.89	6.55	5.53	5.16	4.68
Crude fiber	11.7	15.6	10.9	11.5	11.4
Neutral detergent fiber	33.6	40.9	31.7	34.0	33.0
Acid detergent fiber	21.8	27.1	20.6	22.8	21.9
ME, MJ/kgDM	11.6	11.6	11.6	11.6	11.6
%CP_protein source/ total CP	47.0	57.2	41.5	39.3	39.0

SEM, WLM, FM, FEM and BM were the treatments containing crude protein supplementation feeds from meals of soybean extraction, water spinach leaves, fish, feather and blood, respectively

2.3 Animals and housing

Four Californian rabbits were kept in cages made in grid iron and wood (0.5 x 0.5 x 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 disinfected every two weeks by spraying Virkon'S solution.

2.4 Feeds and feeding

Para grass (*Brachiaria mutica*), *Centrocema pubescens*, soya waste, broken rice, soybean extraction meal, water spinach leaves, fish meal, feather meal and blood meal were used in the experiment. *Centrocema pubescens* and para grass was daily collected surrounding the farm for feeding rabbits. The water spinach leaves were sun-dried and then grind using an electric motor grinder. Fish, feather and blood meal were bought one time for the whole experiment. The supplements were mixed up soya waste for feeding. The animals were fed three times a day at 7:00, 12:00 and 17:00. Fresh water was available for 24 hours per day.

2.5 Measurements

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

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 and feces 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 two times at 6 am and 5 pm daily. The digestive measurement was implemented 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 Kjeldal methods.

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 grams of the loin and thigh meat were 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 Statistical analysis

The data were analyzed by analysis of variance using the General Linear 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 DISCUSSION

3.1 Feed and nutrient intakes

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

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

	Treatments					SE/P
	SEM	WLM	FM	FEM	BM	
Feed intakes, g/rabbit/day (DM)						
Centrocema pubescens	16.3^{a}	10.4^{b}	15.4^{a}	14.5^{a}	15.1^{a}	0.68/0.001
Para grass	18.7^{a}	6.27^{b}	17.2^{a}	16.8^{a}	17.6^{a}	0.58/0.001
Soya waste	4.38	4.41	4.31	4.18	4.09	0.14/0.496
Broken rice	31.5	31.5	31.4	31.1	31.3	0.34/0.915
Soybean extraction meal	16.5	-	-	-	-	0.06/0.001
Water spinach leaves	-	33.4	-	-	-	0.23/0.001
Fish meal	-		9.51	-	-	0.11/0.001
Feather meal	-	-	-	5.04	-	0.25/0.001
Blood meal	-	-	-	-	5.91	0.13/0.001
Nutrient intake, g/rabbit/day						
Dry matter	87.4^{a}	86.0^{a}	77.9^{b}	71.7^{c}	74.0^{c}	0.78/0.001
Organic matter	80.5^{a}	78.0^{a}	70.4^{b}	65.4^{c}	68.5^{bc}	0.71/0.001
Crude protein	16.1^{a}	16.6^{a}	14.6^{b}	12.4^{d}	13.5^{c}	0.21/0.001
Ether extract	4.32^{b}	5.57^{a}	4.35^{b}	3.72^{c}	3.53^{c}	0.05/0.001
Neutral detergent fiber	30.9^{a}	31.6^{a}	27.2^{b}	26.8^{b}	27.1^{b}	0.43/0.001
Acid detergent fiber	19.9^{a}	20.7^{a}	17.3^{b}	17.5^{b}	17.6^{b}	0.29/0.001
ME, MJ/day	0.99^{a}	0.96^{b}	0.88^{c}	0.81^{d}	0.84^{d}	0.01/0.001
CP from protein source	7.18^{b}	10.2^{a}	6.01^{c}	4.03^{d}	4.96^{cd}	0.25/0.001
%CP_protein source/total CP	44.5^{b}	61.7^{a}	41.1^{bc}	32.5^{d}	36.8^{cd}	1.46/0.001

SEM, WLM, FM, FEM and BM were the treatments containing crude protein supplementation feeds from meals of soybean extraction, water spinach leaves, fish, feather and blood, respectively. The numbers with different superscript letters in the same row were significantly different (P < 0.05)

Table 3 showed that DM, OM, CP, EE, NDF, ADF and ME intakes of the SEM and WLM treatments were significantly higher (P<0.05) than the other treatments. The DM intake of experimental rabbits were similar to the results of using different protein sources in the New Zealand rabbit diets reported by Biobaku *et al*. (2003) being 90.4, 84.4 and 86.4 gDM/rabbit/day for groundnut cake and fish meal; groundnut cake; and fish meal treatments, respectively. The DM intake value in this experiment was also consistent with the results of Duwa *et al*. (2014) being from 58.7 to 68.3 gDM/rabbit/day by using fish meal replacing maggot meal in the crossbred rabbit (Dutch x New Zealand White rabbit) diets. The lowest value of CP was found for the FEM treatment (12.4 g/rabbit/day). The CP intake values in this experiment were higher than the findings of Duwa *et al*. (2014) being from 7.13 to 10.5 g/rabbit/day. Based on our observations, we found that rabbits of the SEM and WLM treatments consumed more feeds than the rabbits under the FM, FEM and BM treatments. According to Duwa *et al*. (2014) the dry matter intake of rabbit increased gradually by reducing of fish meal ratio in the rabbit diets with 58.7, 59.5, 62.7, 67.9 and 68.3 g/rabbit/day for the fish meal level in the diets at 5; 3.75; 2.50; 1.15 and 0%, respectively. Ayanwale (2006) and Ojebiyi *et al*. (2008) reported that the feed daily intakes of rabbits were reduced when increasing feather meal and blood meal in diets, respectively. The reduction of

DM intakes could be caused by the special smells, which were not suitable for rabbits and high in protein concentration in the meals of fish, feather and blood.

3.2 Growth performance and economic returns

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

Table 4: Final live weight, daily weight gain (DWG) and economic returns of experimental rabbits

	Treatments					SE/P
	SEM	WLM	FM	FEM	BM	
Initial live weight, g/rabbit	467	470	465	473	475	7.93/0.874
Final live weight, g/rabbit	2379[a]	2268[a]	1940[b]	1724[c]	1819[bc]	35.6/0.001
Daily weight gain, g/day	22.8[a]	21.4[a]	17.6[b]	14.9[c]	16.0[bc]	0.38/0.001
Feed conversion ratio	3.84[a]	4.03[ab]	4.43[bc]	4.82[c]	4.63[c]	0.12/0.001
Feed cost, USD/rabbit	2.10	1.27	2.58	1.61	1.80	-
Total cost, USD/rabbit	5.93	5.09	6.40	5.43	5.62	-
Income, USD/rabbit	8.56	8.16	6.98	6.20	6.54	-
Profit, USD/rabbit	2.63	3.07	0.58	0.77	0.92	-

SEM, WLM, FM, FEM and BM were the treatments containing crude protein supplementation feeds from meals of soybean extraction, water spinach leaves, fish, feather and blood, respectively. The numbers with different superscript letters in the same row were significantly different (P<0.05)

The final live weights of rabbits were significantly different (P<0.05) among the treatments and significantly higher for the SEM and WLM treatment. Similarly, the DWG of these treatments (22.8 and 21.4 g/day, respectively) were significantly higher (P<0.05) than that of FM, FEM and BM treatments (17.6, 14.9 and 16.0 g/day, respectively). The daily weight gain of rabbits fed soybean extraction meal and water spinach leaf meal 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) being from 21.5 to 28.1 g/rabbit/day and from 23.8 to 29.0 g/rabbit/day, respectively. Biobaku *et al*. (2003) found that daily weight gain of New Zealand White rabbits fed the diet containing 12.4% fish meal was 9.88 g/day. The crossbred rabbits (Dutch x New Zealand White rabbit) were fed a diet containing 5% fish meal having daily weight gain of 11.3 g/day (Duwa *et al*., 2014). Rabbit fed feather meal in this experiment had the DWG higher than the results stated by Ayanwale (2006) being from 12.3, 12.4, 13.3 and 13.6 g/day for the ratio of feather meal in diets of 0, 5, 10 and 15%, respectively. The DWG values of rabbits supplemented cassava pills/blood meal (3+2 mixture) of 0, 10, 20 and 30% in diets were 8.94, 8.92, 8.53 and 8.40 g/day, respectively (Ojebiyi *et al*., 2008). Feed conversion ratio (FCR) for the SEM and WLM treatments was lower than other treatments and they were 3.84 and 4.03. The FCR of growing rabbits was 3.12 when consuming a diet containing 29.6% soybean (Maidala *et al*., 2016). Dong *et al*. (2008) reported that FCR was 4.71 and 4.03 when using fresh water spinach leaves at 50 and 75% in the crossbred rabbit diets, respectively. The crossbred rabbits (New Zealand x Californian) fed feather meal had FCR at 4.71 (Trigo *et al*., 2012). Ojebiyi *et al*. (2008) fed blood meal at 0, 4, 8 and 12% levels in growing rabbit diets, FCR were 6.16, 7.45, 6.99 and 6.49, respectively. The economic analysis indicated that the profit for the WLM treatment was the highest (3.07 USD/rabbit) due to the low feed cost. The second highest profit was occupied by the SEM treatment (2.63 USD/rabbit), while the other treatments were very low (from 0.58 to 0.92 USD/rabbit).

3.3 Carcass values and meat nutrients

Table 5 showed that the carcass, lean meat and thigh meat weights of the SEM and WLM treatments were significantly higher (P<0.05) than the others. Similarly, the carcass and lean meat percentage were also significantly higher (P<0.05) for the SEM and WLM treatments. Gidenne *et al*. (1998) reported that the carcass percentage was from 54.6 to 56.8% for growing crossbred rabbit (New Zealand and Californian) fed different ratio of lignin and cellulose in the diets (20-80%). Duwa *et al*. (2014) presented that the crossbred rabbit (Dutch x New Zealand White rabbit) fed the diets containing from 0 to 5.0% fish meal had the carcass percentage from 45.75 to 70.0. The weights of internal organs of rabbits in the present study (heart, kidney, liver and stomach) were similar (P>0.05) among the treatments. Duwa *et al*. (2014) found that the heart and kidney weights of the crossbred rabbits were from 2.75 to 4.34 g and from 6.83 to 11.3 g, respectively. In the present study, no significant differences (P>0.05) were found on chemical compositions of rabbit meat among the treatments. In a study on the starch levels from 120 to 180 g/kg in the rabbit diets, Carraro *et al*. (2007) did not find any differences in rabbit meat quality. The meat protein of rabbits in the present study was consistent with the results reported by Schlutz (1974) being from 19.7 to 21.3%.

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

Items	Treatments					
	SEM	WLM	FM	FEM	BM	SE/P
Live weight, g (LW)	2412^{a}	2296^{a}	1966^{b}	1751^{c}	1853^{bc}	36.6/0.001
Carcass weight, g	1261^{a}	1209^{a}	1013^{b}	878^{c}	932^{bc}	22.4/0.001
Carcass percentage, %LW	52.3^{a}	52.6^{a}	51.6^{ab}	50.2^{b}	50.3^{b}	0.37/0.004
Lean meat weight, g	959^{a}	927^{a}	737^{b}	618^{c}	663^{bc}	16.5/0.001
Lean meat percentage, %	76.1^{a}	76.7^{a}	72.7^{b}	70.3^{c}	71.1^{c}	0.21/0.001
Thigh meat (TM) weight, g	350^{a}	344^{a}	282^{b}	241^{c}	255^{bc}	8.36/0.001
TM percentage, %	27.8	28.4	27.9	27.4	27.3	0.36/0.300
Heart, g	4.67	5.00	4.67	3.67	4.00	0.34/0.119
Kidney, g	15.7	17.3	16.7	16.0	16.3	0.99/0.790
Liver, g	52.0	61.3	56.3	61.0	59.3	2.91/0.223
Stomach, g	34.7	36.3	35.3	36.3	40.7	2.89/0.638
Caecum length, cm	63.3	65.0	61.6	67.0	57.7	4.27/0.623
Chemical composition of meat, % in fresh						
Dry matter	26.3	27.1	26.6	26.2	27.1	0.52/0.681
Organic matter	98.7	98.5	98.4	98.4	98.3	0.26/0.898
Crude protein	21.4	21.6	21.0	21.1	21.4	0.20/0.232
Ether extract	4.04	4.18	4.30	4.31	4.39	0.19/0.759
Ash	1.33	1.47	1.57	1.60	1.67	0.26/0.898

SEM, WLM, FM, FEM and BM were the treatments containing crude protein supplementation feeds from meals of soybean extraction, water spinach leaves, fish, feather and blood, respectively. The numbers with different superscript letters in the same row were significantly different (P<0.05)

3.4 Nutrient digestion and nitrogen retention

The nutrient intakes, digestible nutrients and nitrogen balance of the digestibility trial were presented in Table 6.

In the digestibility trial, the nutrient intakes of growing Californian rabbits at 12 weeks of age were similar pattern of the whole experiment; however, there was an improvement of nutrient and ME intakes for the FM treatment. The digestible DM, OM, CP, EE, CF, NDF and ADF were significantly higher (P<0.05) for the SEM and WLM treatments compared to the FEM and BM treatments (Table 6). It was also found that the apparent CP digestibility of the SEM and WLM treatments (82.8 and 82.6%, respectively) in this experiment was significantly higher (P<0.05) compare to that of the FM, FEM and BM treatments (81.1, 76.3 and 77.9%, respectively). Umucalilar *et al.* (2003) concluded that protein degradation fraction was higher for plant sources than for animal by-products. Maertens *et al.* (2002) found that the apparent CP digestibility (CPD) of soybean meals were increasingly 82.0, 83.0 and 84.0% corresponding to soybean meals containing 44.0, 46.0 and 48.0% CP, respectively. Similarly, Thu (2011) reported that the CP digestibility of growing rabbits improved when increasing levels of fresh water spinach leaves in the diets at 71.8, 81.1, 83.1, 86.0 and 85.7% for the 0, 20, 40, 60 and 80% fresh water spinach leaves (%DM) in the diets, respectively. It was also found that the CPD of fish meal was higher than that of feather meal and blood meal (Umucalilar *et al.,* 2003). When feeding fish meal (12.4%) to the exotic white rabbits in Nigeria, Biobaku *et al*. (2003) reported that the CP digestibility was 86.6%. Moritz and Latshaw, (2001) concluded that feather meal and blood meal were generally unpalatable, and a high proportion of the protein in feather meal could not be degraded. Feather meal had a low content of some indispensable amino acids such as Lys, Met, His and Trp (Divakala, 2008) and low nitrogen and amino acids digestibility (Bielorai *et al*., 1982; Knabe *et al*., 1989). Ojebiyi and Saliu (2104) stated that DM and CP digestibilities of growing rabbits were reduced by increasing levels of blood meal in the diets. Similarly, rabbits fed blood meal had the lowest feed intake, live weight gain and feed efficiency compared to other plant protein sources (Fanimo *et al*., 2002). The nitrogen retention was significantly higher (P<0.05) for the SEM and WLM treatments compared to the FEM and BM treatments. These results were similar to the findings of Dong *et al* (2008) that nitrogen retention of crossbred rabbits was 0.76, 0.84, 0.88 and 1.07 g/kg$W^{0.75}$ when using fresh water spinach leaves at 0, 25, 50 and 75% (%DM) in the diets.

Table 6: Nutrient intakes, digestible nutrients and nitrogen retention of rabbit in the nutrients digestibility trial

Item	Treatments					SE/P
	SEM	WLM	FM	FEM	BM	
Intake, g/rabbit/day						
Dry matter	56.5^{a}	55.5^{a}	52.1^{a}	44.3^{b}	46.4^{b}	1.02/0.001
Organic matter	52.0^{a}	50.3^{ab}	47.2^{bc}	40.4^{d}	42.9^{cd}	0.92/0.001
Crude protein	10.4^{a}	10.8^{a}	9.78^{a}	7.64^{b}	8.46^{b}	0.24/0.001
Ether extract	2.79^{b}	3.62^{a}	2.91^{b}	2.30^{c}	2.22^{c}	0.05/0.001
Crude fiber	7.00^{a}	7.55^{a}	6.38^{b}	5.75^{c}	5.97^{bc}	0.13/0.001
Neutral detergent fiber	19.9^{a}	20.6^{a}	18.2^{b}	16.5^{b}	17.0^{b}	0.36/0.001
Acid detergent fiber	12.9^{a}	13.5^{a}	11.6^{b}	10.8^{b}	11.0^{b}	0.23/0.001
ME, MJ/rabbit/day	0.65^{a}	0.62^{a}	0.59^{a}	0.50^{b}	0.52^{b}	0.01/0.001
Digestible nutrient, g/rabbit/day						
Dry matter	41.5^{a}	40.0^{a}	37.1^{ab}	29.0^{c}	31.3^{bc}	1.37/0.001
Organic matter	38.8^{a}	36.5^{a}	33.5^{ab}	26.5^{c}	29.1^{bc}	1.24/0.001
Crude protein	8.64^{ab}	8.90^{a}	7.93^{b}	5.83^{c}	6.58^{c}	0.19/0.001
Ether extract	2.41^{b}	3.09^{a}	2.43^{b}	1.66^{c}	1.78^{c}	0.07/0.001
Neutral detergent fiber	11.4^{a}	11.3^{a}	9.53^{ab}	8.08^{b}	8.79^{b}	0.40/0.001
Acid detergent fiber	5.67^{a}	5.64^{a}	4.70^{ab}	3.77^{b}	4.27^{ab}	0.34/0.009
Nitrogen balance						
N intake, g/rabbit/day	1.67^{a}	1.72^{a}	1.57^{a}	1.22^{b}	1.35^{b}	0.04/0.001
N retention, g/rabbit/day	1.19^{a}	1.24^{a}	1.08^{ab}	0.74^{c}	0.86^{bc}	0.05/0.001
N intake, g/kg$W^{0.75}$	1.28^{ab}	1.36^{a}	1.36^{a}	1.14^{b}	1.22^{ab}	0.03/0.002
N retention, g/kg$W^{0.75}$	0.93^{a}	0.91^{a}	0.79^{ab}	0.65^{b}	0.71^{b}	0.04/0.002

SEM, WLM, FM, FEM and BM were the treatments containing crude protein supplementation feeds from meals of soybean extraction, water spinach leaves, fish, feather and blood, respectively. The numbers with different superscript letters in the same row were significantly different (P<0.05)

4 CONCLUSIONS

The conclusion was that soybean extraction and water spinach leaf meals could feed growing Californian rabbits for improving meat performance and profits. The fishy smell and low palatability and digestibility of the fish, feather and blood meals could limit the dietary nutrient intakes, digestion and growth rate of the experimental rabbits; however, more studies should be done for better utilizations of these protein sources.

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