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RESPONSE OF APRI GROWING RABBITS TO DIETS CONTAINING DIFFERENT LEVELS OF DIGESTIBLE ENERGY AND CRUDE PROTEIN

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ABSTRACT

A total number of 90 APRI rabbits at 5 weeks of age were divided into nine treatments, 10 rabbits each, to investigate the effect of different dietary digestible energy (DE) and crude protein (CP) levels in a 3x3 factorial design on rabbits growth performance, carcass traits, blood plasma constituents and nutrients digestibility during the fattening period (5-13 weeks of age). Rabbits were fed different three levels of DE 2500, 2600, and 2700 kcal DE/kg diet each with 14, 16 and 18 % CP level. The results showed that the highest body weight, daily weight gain and growth performance were obtained with 2600 Kcal DE/Kg diet followed by those fed diet containing 2500 Kcal DE. Increasing dietary protein to 16% CP significantly increased live body weight, daily weight gain, growth performance and performance index and improved feed conversion ratio. There were no significant effect due to DE or protein levels on digestibility coefficient of DM, OM, EE and NFE, while fiber digestibility coefficient decreased with increasing DE. Crude protein digestibility coefficient increased by increasing protein level. There were no significant effect on plasma constituents due to energy levels except in case of triglycerides and cholesterol. CP levels affected significantly on total protein, albumin, globulin and creatinine. Increasing CP increased total edible parts, while no significant differences could be detected due to DE levels. Meat content of DM, CP and EE were increased by increasing DE and protein level. In conclusion the optimal protein and energy levels for APRI rabbits in the present study are 16% CP with 2500 kcal DE/kg diet to maximize the productive performance and economic efficiency.
Keywords: Rabbit performance, digestible energy, crude protein.

INTRODUCTION

Egypt is a country that produce rabbit meat in family farms, tries to develop industrialized rabbit production and has a very important research structure related to rabbit science and technology. Crossbreeding experiments have a main purpose that is to produce superior crosses for growth traits which are influenced by various genetic and non-genetic factors. Performance comparisons among breeds and their crosses are justified because genetic differences among breeds or strains are large relative to genetic variation within breeds (Dickerson, 1992).

In 2003, a co-operative crossbreeding rabbit project was established between Egypt and Spain to develop new line of meat rabbits suitable for hot climate. The V-line rabbits used in this project were crossed with an Egyptian Baladi Red to get a new synthetic line named APRI (Youssef *et al.,* 2008). A deep knowledge involving crossbreeding parameters for performance traits is lacking in hot climates (Khalil *et al.,* 2004 and 2005; Al-Saef *et al.,* 2007).

Nutrition and feeding strategies play a key role in rabbit breeding to optimize production itself such as meat, milk and fur (Gidenne *et al.,* 2010).

Proteins are essential organic constituents of living organism. All living cells synthesize proteins for part or whole of their life. Lower dietary protein is likely to reduce the productive and reproductive performance whereas excess dietary protein would increase the production cost (Sanchez *et al.,* 1985). Animals in good health normally consume sufficient feed to meet their energy requirements. As the quantity of energy ingested daily in terms of DE tends to be constant, the feed intake of rabbits can be predicted from the energy concentration of the diet (Xiccato and Trocino, 2010).

The main objective of the current study was to determine allowances of energy and protein for the new synthetic maternal line APRI to find out the optimum growth performance and economic efficiency. Plasma constituents of APRI rabbits, measured in the present study, were estimated to show metabolic status of rabbits and their health as affected by feeding varying DE and CP levels in the diet.

MATERIALS AND METHODS

The growth trail was carried out at the Rabbits Farm of Sakha Station, Animal Production Research Institute (APRI), Agricultural Research Center, Ministry of Agriculture, Egypt.

A total number of 90 APRI line weanling rabbits at 5 weeks of age were divided randomly into 9 groups (10 rabbit each). All weanling rabbits were nearly equal in live body weight at the beginning of the experiment.

Three dietary levels of crude protein, *i.e*. 14%, 16% and 18% representing -12.5%, 0 and +12.5% differences than the recommended crude protein in NRC (1977) and three levels of digestible energy, i.e. 2500, 2600 and 2700 kcal/kg diet (0, +4 and +8% differences than NRC, 1977) recommended level, were used in 3 X 3 factorial design for eight weeks. Essential amino acids, lysine and sulfur amino acids, in addition to, the minerals and vitamins were adjusted in all diets to cover the requirements according to NRC (1977). Ingredients and chemical analysis of the experimental diets are presented in Table 1.

Rabbits were housed in individual cages and kept under the same managerial conditions. Feed and water were offered *ad libitum* throughout the experimental period (5 to 13 weeks of age). Live body weight, feed intake and number of dead rabbits were recorded. Daily weight gain and feed conversion ratio were calculated. Performance index was calculated according to North (1981) and economic efficiency was calculated according to Raya *et al*. (1991).

At the end of growing period, three rabbits were taken randomly from each treatment, fasted for 12 hrs, weighed and slaughtered to estimate some of carcass traits according to Blasco *et al.* (1993). Carcass parts were presented as a percent of live body weight. Blood plasma samples were taken from 3 rabbits of each treatment to determine some blood constituents. Also samples of meat from (fore-Limb, Lumber region, Hind Limb) were taken and dried at 60^{o}C for 2 days, freed from any bones, and ground for analysis.
A digestibility trail was performed on twenty seven male rabbits, 13 weeks old with nearly similar body weights, to determine the apparent nutrient

digestibility of the experimental diets (3 males for each treatment). Animals were housed in metabolic cages that allowed separation of feces and urine. Feces produced daily were collected in polyethylene bags for five days and stored at -20^{o}c (Perez *et al.*, 1995) till analyzed according to the European reference method for rabbit digestion trials.

Chemical analysis was carried out for diets according to AOAC (1995) for ash, DM, CP, CF and EE. Gross energy was determined in an adiabatic bomb calorimeter. Digestibility coefficients and nutritive values of nutrients in terms of total digestible nutrient (TDN), digestible crude protein (DCP) and digestible energy (DE) were calculated as described by Perez *et al*. (1995).

Data were statistically analyzed using the General linear Model Program of SAS (2004). Duncan's multiple range test was performed (Duncan, 1955) to detect significant differences between means.

Table 1: Composition and chemical analysis of the experimental diets.

Ingredients	2500 kcal DE/kg			2600 kcal DE/kg			2700 kcal DE/kg		
	CP			CP			CP		
	14%	16%	18%	14%	16%	18%	14%	16%	18%
Wheat bran	44.5	48.7	44.0	34.7	35.1	39.3	12.5	16.0	20.0
Clover hay	35.0	31.0	34.0	35.0	35.0	33.0	43.2	40.4	38.5
Yellow corn	6.1	0.7	-	11.1	4.0	-	15.4	9.7	4.5
Barley grains	4.5	4.0	-	7.7	9.0	5.4	15.0	14.3	12.1
Soybean meal 44%	2.4	8.4	15.2	4.0	10.0	15.6	6.4	12.3	18.0
Molasses	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Dicalcium-phosphate	1.0	1.0	1.0	1.5	0.7	0.6	2.0	2.0	1.5
Limestone	0.9	1.0	0.8	0.6	1.0	1.1	-	0.1	0.4
Vit.&Min.	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
NaCl	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
L. Lysine	0.4	0.1	-	0.3	0.1	-	0.3	0.1	-
DL. Methionine	0.4	0.3	0.2	0.3	0.3	0.2	0.4	0.3	0.2
Anticoccidia	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
****Calculated analysis**									
DE kcal/kg	2509	2519	2540	2601	2603	2601	2700	2701	2700
Crude protein%	14.03	16.01	17.98	14.02	16.07	18.00	14.07	16.03	18.05
Crude fiber%	14.38	14.12	14.32	13.71	14.11	14.18	14.04	13.98	14.11
Crude fat%	2.51	2.37	2.26	2.47	2.28	2.19	2.31	2.16	2.05
Calcium%	1.12	1.13	1.11	1.12	1.1	1.11	1.1	1.12	1.11
Phosphorus%	0.8	0.8	0.8	0.8	0.8	0.80	0.8	0.8	0.8
Lysine%	0.65	0.65	0.7	0.65	0.65	0.72	0.65	0.65	0.73
Methionine + Cys.	0.6	0.6	0.6	0.6	0.6	0.60	0.6	0.6	0.6

***Each 3 kg of vit. and min in premix contain: 6000000 IU Vit. A, 900000 IU Vit.. D3, 40000 mg Vit.. E, 2000 mg Vit.. K, 2000 mg Vit. B1, 4000 mg Vit. B2, 2000 mg Vit. B6, 10 mg Vit.. B12, 50000 mg Niacin, 10000 mg Pantothenie acid, 50 mg Biotin, 3000 mg Folic acid, 250000 mg Choline, 50000 mg Zn, 8500 mg Mn, 50000 mg Fe, 50000 mg Cu, 200 mg I, 100 mg Se and 100 mg Co.**
****According to NRC, 1977.**

RESULTS AND DISCUSSION

1-Growth performance

Results in Table 2 show a significant effect among APRI rabbits fed on diets containing varying levels of digestable energy (DE) on their final body weight, daily weight gain, feed conversion ratio, growth performance and performance index during the growing period (5-13 weeks). The highest values of final body weight , daily weight gain and growth performance ratio were recorded with rabbits fed 2600 kcal DE /kg diet followed by those fed diet containing 2500 kcal with no significant differences. This is similar to the study which reported by Maertens (1992) who recommended lower energy requirements (2550 kcal DE /kg diet) for weanling rabbits to avoid the digestive disorders, however, Ayyat *et al.* (1992) showed no significant effects due to feeding different dietary energy levels 2707, 2436 and 2276 kcal DE /kg diet on live body weight, weight gain and feed conversion ratio.

Increasing dietary crude protein (CP) content in diet from 14 to 16% significantly increased final live body weight, daily weight gain, growth performance and performance index and significantly improved feed conversion ratio during experimental period. Feed consumption was not significantly influenced by varying levels of either dietary DE or CP levels. Similarly Bassuny *et al.* (1997) indicated that New Zealand White rabbits fed 16% CP recorded the highest final body weight, daily weight gain and the best feed conversion ratio compared to rabbits fed 14% CP. In addition to Rohilla *et al.* (2002) found that when Soviet chinchilla rabbits kits were fed diet containing 12, 14, 16 and 18% CP, the final body weight at 91 days and average daily weight gain were significantly higher in treatment fed diet containing 16% CP than the other treatments. They added that 16% CP in ration is appropriate for better production responses in commercial rabbit production.

In conformity the NRC (1977) recommended 16% CP, in addition Spreadubury (1978) indicated that 16% CP was the optimal level for rabbits in the temperate climate. On the contrary the growing Rex rabbit gained rapidly with increasing dietary protein level when rabbits fed diets containing different protein levels of 14.5, 16 and 17.5% (Gu *et al*., 2004).

Remarkably the results of this study showed that the interaction between DE and CP levels in the diets had significant effects between treatments. The highest final body weight and daily weight gain resulted by using diet containing 2500 kcal DE /kg diet with 16% CP. Whereas the daily feed consumption was significantly different among treatments, the highest feed consumption was observed by feeding rabbits on diet containing 2600 kcal DE /kg diet and 16% CP. It was clearly noted that feeding rabbits on diets contains 2500 kcal DE /kg diet with 16% CP lead to improve feed conversion ratio compared to the other treatment followed by 2600 kcal with 14% CP. According to the previous results, growth performance ratio and performance index were significantly increased by using the same treatments (2500 kcal with 16% CP and 2600 kcal with 14% CP) without significant differences between the two treatments. These results can be due to that the APRI line have been got from crossing between local breed (Baladi red) and V- line.

2

Local breeds doesn’t need a high level of protein or energy because it's genetically controlled and their body weight, daily gain and feed conversion ratio are lower than for native (Giza white) and for exotic breeds raised in Egypt (eg., New Zealand, Californian, Chinchilla, Bouscat, etc.) as cited by Khalil (1980) , Afifi and Emara (1990), Tag El Din *et al.* (1992), Youssef (1992) and Afifi *et al.* (1993). As it is known, rabbit lies in the mid way between broiler and ruminant, so that, low levels of protein and energy will meet their requirements. Also high levels of protein or energy have been shown to cause many healthy problems which definitely reflects on the growth rate (Maertens 1992).

In these context Raimondi *et al.* (1973) indicated that, feeding rabbits on diets containing different dietary energy and protein levels, 1600 or 1800 kcal net energy with 20% or 17% CP, resulted in a significant increase in weight gain with the low concentration of protein when the energy supply was low, however the proportional of protein had no effect when the high energy was given. On the other hand, Alla *et al.* (2002) found that, live body weight did not significantly affected when mature bucks and does of Bouscat breed were fed different levels of energy 2800, 2650 DE kcal /kg diet with 18 and 15% CP levels.

2- Digestibility coefficients of nutrients

Digestibility coefficients of nutrients and nutritive values of the experimental diets during the experimental period are represented in Table 3. As for DE levels there were no significant differences in digestibility coefficient of dry matter (DM), organic matter (OM), crude protein (CP), Ether extract (EE) and nitrogen free extract (NFE) with increasing DE, while digestibility coefficient of crude fiber was significantly decreased. A significant increase could be observed in total digestible nutrients (TDN), digestible crude protein (DCP) and digestible energy with increasing dietary energy level. These findings were in agreement with those reported by Alla *et al.* (2002) who found that there were no significant differences in digestibility coefficient of DM, EE and NFE however TDN value was significantly increased in rabbits fed diet containing high energy levels (2800 kcal DE /kg diet) compared with low energy diet which contain 2650 kcal DE/kg diet. As for protein levels the digestibility coefficients of DM, OM, EE, CF, NFE, GE, TDN and DE were not significantly influenced by changing dietary protein level, however, CP digestibility and DCP were significantly increased by increasing protein level in the diet. In these respect, Abou Zeid *et al.* (1999), El Hady (2001) and Rohilla *et al.* (2002) indicated that crude protein digestibility significantly increased as crude protein levels increased in the ration.

Regarding to the energy and protein interaction, the analysis of variance showed no significant differences for digestibility coefficients of DM, OM, EE, CF, NFE and TDN could be observed. There were significant differences between treatments in CP, GE, DE and DCP due to the interaction between energy and protein.

3- Blood plasma constituents

Results presented in Table 4 show significant differences between treatments only on plasma triglycerides and cholesterol. However, other studied plasma constituents were not significantly affected by DE levels. Whereas varying CP levels affected significantly on total protein, albumin, globulin and creatinine and highest levels were observed with the treatment fed 18% CP.

3

4

These observations are in agreement with those obtained by Nehad *et al.* (2009) who indicated that, plasma triglycerides and cholesterol were significantly increased with increasing energy level, however there were no significant differences between treatments in liver function enzymes (AST and ALT) or kidney function (urea and creatinine) when rabbits were fed different three levels of DE energy 2500, 2800, 3000kcal /kg diet. In addition Abou-Zeid et al. (1999) found a significant increase in serum total protein and albumin due to increasing protein level from 14 to 18%. Abdel-Malak (2000) and Ismail (1999) indicated that blood urea increased by increasing protein level, however there were no significant differences between treatments in plasma cholesterol due to differences in protein levels 15, 17 and 19%.

The interaction between varying levels of DE and CP did not significantly affect plasma total lipids, cholesterol, albumin, liver enzyme (ALT, AST) and urea , however plasma triglycerides, total protein and creatinine were significantly affected by the interaction between DE and CP. The lowest triglycerides level was recorded with 2500 DE kcal diet with 18% CP, whereas the highest total protein and creatinine were recorded with the treatment which fed diet containing 2700 kcal with 18% CP. These results are in coincide with that obtained by Nehad *et al.* (2009) who observed that the interaction between different levels of protein 16, 18, 19 and 20 % and DE 2500, 2800, 3000 kcal significantly affected blood constituents. The highest values of plasma triglycerides and cholesterol were recorded with rabbits fed 20% CP and 3000 kcal, however, 18% CP with 3000 kcal gave the best value of plasma total protein and liver function (AST and ALT enzyme). In addition Ayyat *et al.* (2002) indicated that serum total protein significantly increased by increasing energy and protein levels.

4- Carcass traits

No significant differences between treatments were observed in total edible parts (TEP), fore parts, trunk, hind part, liver, kidney and heart due to DE levels Table 5, however, abdominal fat and gastrointestinal tract (GIT) were significantly differed among treatments. The highest abdominal fat % was recorded with 2700 kcal DE/kg, the proportional increment was 47.8% comparable to those fed diet containing 2500 kcal DE/kg diet.

Respecting to the effect of CP, a significant increase in TEP, trunk and abdominal fat was detected by increasing dietary CP levels, however the proportional weight of fore parts, hind parts, liver, kidney and heart were not significantly affected by different levels of protein in diets. In contrast gastrointestinal tract was significantly decreased by increasing dietary CP levels.

Inspection of the effect of interaction between energy and protein levels (Table 5) showed a significant difference between treatments in TEP, fore parts, trunk, abdominal fat and GIT relative weight. The highest TEP and trunk were observed in treatment which fed 2600 kcal DE and 18% CP. However, there were no significant effect between treatments in the percentages of hind parts, liver, kidney, and heart. In this respect Jacob *et al.* (1992) reported that, carcass yield, relative weight of liver and kidney of rabbits fed diets containing 14, 16 and 18 % CP did not differ significantly among the treatments.

5

In addition, Obinn and Mmereole (2010) reported that when this crossing rabbits were produced rabbits from crosses between New Zealand White and Californian breeds and fed diet containing 14, 16 and 18% CP with 6.7, 8.7 and 10.8 MJ kg (DE) there were no significant effects on carcass yield, weight of heart and abdominal fat.

5- Chemical composition of meat.

Data on meat composition are shown in Table 6, and revealed that meat content of dry matter (DM), crude protein (CP) and ether extract (EE) were significantly increased by increasing DE in diets, while ash % significantly decreased. This increment in EE in the meat may be due to the increasing of energy and protein levels.

As for protein level, meat content of DM and CP significantly increased by increasing protein level in diets, while no significant differences could be observed in ash or EE.

Table 6: Effect of digestible energy and crude protein levels and their interaction on meat chemical composition of growing APRI rabbits.

Item		Dry matter (DM)	Ash	Crude protein (CP)	Ether extract (EE)
Digestible energy level: Kcal/kg diet					
2500		$31.32^{c}\pm0.4$	$4.06^{a}\pm0.1$	$20.58^{c}\pm0.3$	$6.67^{b}\pm0.1$
2600		$33.20^{b}\pm0.3$	$3.59^{b}\pm0.1$	$22.43^{b}\pm0.2$	$7.18^{a}\pm0.1$
2700		$34.14^{a}\pm0.2$	$3.36^{b}\pm0.1$	$23.23^{a}\pm0.2$	$7.55^{a}\pm0.2$
Protein level %:					
14		$32.38^{b}\pm0.5$	3.71±0.2	$21.66^{b}\pm0.5$	7.01±0.1
16		$32.82^{ab}\pm0.5$	3.71±0.1	$22.03^{ab}\pm0.5$	7.08±0.2
18		$33.46^{a}\pm0.4$	3.60±0.1	$22.55^{a}\pm0.3$	7.32±0.2
Interaction:					
2500	14	$30.80^{d}\pm0.9$	$4.12^{a}\pm0.2$	$20.07^{d}\pm0.7$	$6.61^{c}\pm0.2$
	16	$30.91^{d}\pm0.2$	$4.05^{ab}\pm0.1$	$20.27^{d}\pm0.4$	$6.59^{c}\pm0.2$
	18	$32.25^{cd}\pm0.6$	$4.02^{ab}\pm0.1$	$21.41^{cd}\pm0.3$	$6.82^{c}\pm0.2$
2600	14	$32.78^{c}\pm0.9$	$3.59^{bc}\pm0.2$	$22.10^{c}\pm0.4$	$7.09^{bc}\pm0.2$
	16	$33.24^{bc}\pm0.5$	$3.69^{bc}\pm0.2$	$22.40^{bc}\pm0.5$	$7.15^{ab}\pm0.2$
	18	$33.58^{ab}\pm0.3$	$3.51^{c}\pm0.1$	$22.77^{ab}\pm0.3$	$7.31^{ab}\pm0.1$
2700	14	$33.56^{ab}\pm0.1$	$3.41^{c}\pm0.2$	$22.81^{ab}\pm0.2$	$7.34^{ab}\pm0.1$
	16	$34.31^{ab}\pm0.1$	$3.40^{c}\pm0.2$	$23.40^{a}\pm0.3$	$7.50^{a}\pm0.1$
	18	$34.55^{a}\pm0.3$	$3.25^{c}\pm0.1$	$23.48^{a}\pm0.3$	$7.82^{a}\pm0.4$

[a-d] Values having different superscripts in the same column are significantly different (*P<0.05*).

As for, energy and protein interactions, obtained data (Table 6) revealed that the highest meat content of DM, CP and EE were recorded for rabbits fed 18% CP and 2700 kcal DE/kg diet, while the lowest meat content of ash was recorded for rabbits fed the same diet.

6-Economic efficiency

From the economical point of view, the highest economic efficiency was recorded with rabbits fed diet containing 2500 kcal DE /kg diet with 16% CP followed by that fed 2500 kcal with 14% CP. This increment may be due to the improvement of weight gain or due to decreasing the price of the kilogram diet, while the worst value was observed for those fed 14% CP and 2700 kcal DE/ kg diet Table 7.

Table 7: Input-output analysis and economic efficiency of different treatments.

Energy Level (Kcal/ kg)	Protein Level (%)	Total Feed Intake (kg /head)	Price /kg Diet (L.E.)	Total Feed Cost (L.E.)	Average Weight Gain (kg/head)	Selling Price (L.E.) (1)	Net Revenue (L.E.) (2)	Economic Efficiency(3)
2500	**14**	5.492	2.00	10.985	1.484	26.704	15.720	1.43
	16	5.563	1.97	10.959	1.543	27.776	16.817	1.54
	18	5.435	1.98	10.761	1.423	25.605	14.844	1.38
2600	**14**	5.615	2.08	11.679	1.539	27.710	16.031	1.37
	16	5.880	2.11	12.407	1.455	26.190	13.783	1.11
	18	5.707	2.07	11.813	1.491	26.840	15.027	1.27
2700	**14**	5.776	2.32	13.400	1.356	24.408	11.009	0.82
	16	5.768	2.30	13.266	1.486	26.753	13.486	1.02
	18	5.498	2.27	12.480	1.436	25.848	13.368	1.07

- Other conditions like mortaility (%) and mangement are fixed.
- Ingredients price (L.E. per ton) at 2012 were: 3000 barley; 2500 yellow corn; 1500 berseem hay; 1500 wheat bran ; 3500 soybean meal (44%) ; 25 limestone ; 9000 premix ; 40000 DL-methionine ; 21000 DL-lysine; 1000 dicalcuim phosphate ; 10000 anti-coccidia; 25 salt ; 1000 cane molasses.
- Adding 100 L.E. /ton for pelliting.
(1) Price of kg live body weight was 18 L.E.
(2) Net revenue= Selling price – total feed cost.
(3) Economic efficiency= Net revenue/ total feed cost

Conclusion

From the practical and economical point of view, it can be concluded that optimal protein and energy levels for growing APRI rabbits are 16% CP and 2500 kcl DE/kg diet to maximize the productive performance and economic efficiency.

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إستجابة أرانب الAPRI للعلائق المحتوية على مستويات مختلفة من الطاقة المهضومة والبروتين الخام

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تم إستخدام عدد 90 أرنب APRI عمر 5 أسابيع قسمت الى تسع مجموعات بكل معاملة 10 أرانب في تحليل عامل التباين (3x3) لدراسة تاثير مستوى الطاقة (2500 و2600 و 2700 كيلو كالورى طاقة مهضومة / كجم عليقة) والبروتين 14 و 16 و18 % بروتين خام على اداء الأرانب النامية وصفات الذبيحة ومكونات الدم والكفاءة الاقتصادية خلال فترة التسمين(5-13 اسبوع). اوضحت النتائج ان اعلى وزن للجسم و زيادة يومية مكتسبة واداء النمو سجلت عند مستوى طاقة 2600 يليها التى غذيت على 2500 كيلو كالوري.كما ان زيادة مستوى البروتين الى 16% ادى الى زيادة معنوية فى وزن الجسم و الزيادة اليومية المكتسبة واداء النمو وكذلك معدل التحويل الغذائى.كما لم يكن هناك تأثير لمستوى الطاقة و مستوى البروتين على معاملات هضم المادة الجافة او العضوية او مستخلص الاثير بينما انخفض معامل هضم الالياف بزيادة الطاقة المهضومة وازداد معامل هضم البروتين بزيادة مستوى البروتين ولم يكن هناك تاثيرا معنويا على مكونات الدم نتيجة مستوى الطاقة فيما عدا الجلسريدات الثلاثية والكوليسترول كما اثر مستوى البروتين معنويا على البروتين الكلى والالبيومين والجلوبيولين والكرياتينين كما ان زيادة مستوى البروتين ادى لزيادة الاجزاء الكلية الماكولة بينما لم يكن هناك تاثيرا معنويا يرجع لمستوى الطاقة. ارتفع محتوى اللحم من المادة الجافة والبروتين الخام ومستخلص الاثير بزيادة مستوى الطاقة والبروتين.

لذا يمكن القول ان المستوى الامثل من البروتين الخام والطاقة المهضومة لارانب الـAPRI هو 16% بروتين خام مع 2500 كيلو كالورى طاقة مهضومة / كجم عليقة وذلك لزيادة الاداء الانتاجى والكفاءة الاقتصادية.

قام بتحكيم البحث

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Table 2: Effect of digestible energy, crude protein levels and their interaction on growth performance of growing APRI rabbits.

Item		Initial body weight (g)	Final body Weight (g)	Daily Weight gain (g/d)	Daily Feed consumption (g/d)	Feed conversion ratio	Growth Performance	Performance Index	Mortality %
Digestible energy level: Kcal/kg diet									
2500		701±1.2	2179^{a}±13	26.4^{a} ±0.2	98.1 ±0.4	3.72^{c} ±0.1	102.6^{a} ±0.5	58.72^{a} ±0.9	3.33
2600		703±2.1	2198^{a}±12	26.7^{a} ±0.2	102.3 ±0.4	3.83^{b} ±0.1	103.2^{a} ±0.6	57.61^{a} ±1.0	3.33
2700		701±1.3	2123^{b}±12	25.4^{b} ±0.2	101.3 ±0.6	3.99^{a} ±0.1	100.6^{b} ±0.4	53.34^{b} ±0.8	3.33
Protein level %:									
14		700±1.4	2153^{b} ±18	25.9^{b} ±0.3	100.8 ±0.4	3.90^{b}±0.06	101.8^{b} ±0.7	55.75^{b}±1.3	3.33
16		702±1.7	2196^{a} ±11	26.7^{a} ±0.2	102.5 ±0.7	3.84^{a}±0.5	103.1^{a} ±0.5	57.38^{a}±0.9	3.33
18		703±1.7	2151^{b} ±10	25.7^{b} ±0.1	99.1 ±0.5	3.82^{a}±0.02	101.5^{b} ±0.4	56.30^{a}±0.6	3.33
Interaction									
2500	14	700±2.1	2182^{cd} ±20	26.5^{bc} ±0.3	98.0^{de} ±0.2	3.70^{de} ±0.05	103.0^{ab} ±0.6	59.0^{bc} ±1.4	10.0
	16	702±2.0	2245^{a} ±19	27.6^{a} ±0.3	99.3^{d} ±0.8	3.60^{e} ±0.03	104.7^{a} ±0.5	62.3^{a} ±1.1	0.0
	18	703±2.4	2125^{e} ±11	25.4^{d} ±0.2	97.0^{e} ±0.6	3.82^{cd}±0.03	100.6^{c} ±0.5	55.7^{cd} ±0.7	0.0
2600	14	701±3.7	2239^{ab} ±18	27.5^{a} ±0.3	100.3^{cd} ±0.1	3.65^{e} ±0.04	104.7^{a} ±0.8	61.5^{ab} ±1.3	0.0
	16	702±4.2	2156^{cd} ±15	25.9^{bc}±0.3	105.0^{a} ±0.4	4.04^{b} ±0.06	101.8^{bc} ±0.9	53.4^{d} ±1.2	10.0
	18	704±3.6	2196^{bc} ±23	26.6^{b} ±0.4	101.9^{bc} ±0.8	3.83^{cd}±0.08	102.8^{ab} ±0.9	57.5^{c} ±1.8	0.0
2700	14	701±1.6	2057^{f} ±14	24.2^{e} ±0.2	103.1^{ab}±0.6	4.26^{a} ±0.05	98.31^{d} ±0.5	48.3^{e} ±0.9	0.0
	16	700±2.5	2187^{cd} ±13	26.5^{bc} ±0.2	103.0^{ab}±1.2	3.88^{c} ±0.05	102.9^{ab} ±0.5	56.4^{cd} ±0.9	10.0
	18	701±2.9	2137de ±6	25.6^{cd} ±0.1	98.1^{de}±0.7	3.82^{cd}±0.02	101.2^{bc} ±0.4	55.5^{cd} ±0.5	0.0

$^{a…f}$ **Values having different superscripts in the same column are significantly different (*P<0.05*).**

Table 3: Effect of digestible energy, crude protein levels and their interactions on digestion coefficient of nutrients.

Item		Digestibility Coefficients (%)							Nutritive values		
		Dry matter (DM)	Organic matter (OM)	Crude protein (CP)	Ether extract (EE)	Crude fiber (CF)	Nitrogen free extract (NFE)	Gross Energy (GE)	Total digestible nutrient (%) (TDN)	Digestible crude protein (%) (DCP)	Digestible energy (kcal/g) (DE)
Digestible energy level: Kcal/kg diet											
2500		67.9 ±0.6	66.1 ±0.7	76.1 ±0.5	78.0±1.0	31.8^{a} ±1.2	51.8±0.9	61.1^{b} ±1.0	48.9^{b} ±0.5	12.4^{c} ±0.3	2.8^{c} ±0.1
2600		69.0 ±0.5	68.4 ±0.7	77.9 ±0.4	79.5±0.9	30.2^{ab} ±0.9	52.9±1.0	64.5^{a} ±0.7	50.1^{ab} ±0.6	12.7^{b} ±0.4	3.0^{b} ±0.1
2700		70.1 ±0.5	68.5 ±0.8	79.9 ±0.5	80.9±1.3	27.5^{b} ±1.0	54.4±0.9	67.1^{a} ±1.0	51.0^{a} ±0.6	13.1^{a} ±0.4	3.2^{a} ±0.1
Protein level %:											
14		68.7±0.5	67.7±0.8	77.1^{b} ±0.6	79.4±1.1	30.2±1.2	54.6±0.9	64.1±1.2	50.2±0.6	11.3^{c} ±0.1	2.9±0.1
16		68.9±0.7	67.4±0.7	77.8^{ab} ±0.6	79.4±1.1	29.7±1.3	52.8±0.9	64.6±1.0	49.6±0.7	12.5^{b} ±0.1	3.0±0.1
18		69.3±0.6	67.9±0.9	79.2^{a} ±0.6	79.6±1.3	29.6±0.9	51.7±1.1	63.9±1.3	50.3±0.7	14.3^{a} ±0.1	2.9±0.1
Interaction											
2500	14	67.8±0.7	65.8±1.2	75.7^{d} ±1.2	77.8±2.0	32.1±2.9	53.5±1.4	60.1^{b} ±1.5	49.2±0.7	11.2^{e} ±0.2	2.7^{c} ±0.1
	16	67.7±1.3	65.9±1.3	75.9^{d} ±1.2	78.3±2.1	31.5±2.4	51.5±1.1	61.7^{ab} ±0.9	48.7±0.9	12.2^{d} ±0.2	2.8^{bc} ±0.1
	18	68.1±1.4	66.6±1.6	76.8^{cd} ±0.6	77.9±1.7	31.9±0.8	50.4±2.4	61.4^{ab} ±2.8	48.9±1.3	13.8^{b} ±0.1	2.8^{bc} ±0.1
2600	14	68.5±0.9	69.2±1.5	75.8^{cd} ±0.6	79.5±1.7	30.6±2.0	54.4±2.1	65.1^{ab} ±1.4	50.7±1.4	11.3^{e} ±0.1	2.9^{ab} ±0.1
	16	68.8±1.1	68.0±0.8	77.6^{cd} ±0.6	79.3±1.5	30.3±1.9	52.8±1.6	65.0^{ab} ±1.7	49.4±1.0	12.4^{d} ±0.1	2.9^{ab} ±0.1
	18	69.8±0.9	68.1±1.6	79.4^{bc} ±0.4	79.7±2.2	29.6±1.5	51.6±1.8	63.6^{ab} ±0.7	50.0±1.1	14.5^{a} ±0.1	2.9^{c} ±0.1
2700	14	69.7±0.8	68.2±1.3	78.5^{bc} ±0.9	80.9±2.1	27.9±1.1	55.9±1.4	67.2^{a} ±1.9	50.6±0.8	11.5^{e} ±0.1	3.2^{a} ±0.1
	16	70.4±0.9	68.2±1.4	79.9^{ab} ±0.8	80.7±2.2	27.3±2.5	54.0±2.2	67.1^{a} ±1.8	50.6±1.4	12.9^{c} ±0.1	3.2^{a} ±0.1
	18	70.2±0.8	69.0±1.5	80.8^{a} ±0.7	81.3±2.8	27.2±1.9	53.1±1.3	66.9^{a} ±2.2	51.9±0.9	14.8^{a} ±0.1	3.2^{a} ±0.1

[a-d] Values having different superscripts in the same column are significantly different (*P<0.05*).

Table 4: Effect of digestible energy, crude protein levels and their interactions on some blood plasma constituents of growing APRI rabbits.

Item		Total lipids mg/dl	Triglycerides mg/dl	Cholesterol mg/dl	Total protein g/dl	Albumin g/dl	Globulin g/dl	AST U/L	ALT U/L	Urea mg/dl	Creatinine mg/dl
Digestible energy level: Kcal/kg diet											
2500		328.26±1.9	96.24 ^{b}±2.3	73.6 ^{b}±1.3	5.75 ±0.1	3.01±0.1	2.74±0.1	22.8±0.4	15.2±0.6	15.3±0.3	0.94±0.01
2600		337.89±3.6	104.35^{a}±2.2	75.4 ^{b}±1.3	5.71 ±0.1	3.10±0.1	2.71±0.1	22.9±0.4	15.2±0.4	15.4±0.3	0.96±0.01
2700		337.11±4.9	105.44^{a}±1.8	78.8 ^{a}±1.6	5.77 ±0.1	3.02±0.1	2.75±0.2	23.3±0.5	15.8±0.5	15.3±0.3	0.97±0.01
Protein level%:											
14		331.28±5.3	106.09±2.6	75.1±1.4	5.34^{b}±0.2	2.97^{b}±0.1	2.36^{c}±0.2	22.9±0.4	15.2±0.4	15.1±0.2	0.93 ^{b}±0.01
16		332.57±5.8	100.83±2.7	76.2±1.6	5.83^{a}±0.2	3.16^{a}±0.1	2.75^{b}±0.1	23.0±0.5	15.5±0.5	15.6±0.2	0.96 ^{a}±0.01
18		339.41±6.1	99.10±2.6	76.6±1.7	6.07^{a}±0.2	3.00^{ab}±0.2	3.09^{a}±0.2	23.1±0.4	15.5±0.6	16.0±0.3	0.97 ^{a}±0.01
Interaction:											
2500	14	323.11±3.2	101.96 ^{b}±4.6	73.3±2.3	5.58^{b}±0.2	3.01±0.1	2.57^{bc}±0.2	22.7±0.2	14.7±0.9	14.8±0.3	0.90 ^{b}±0.01
	16	330.00±4.7	95.91^{c}±4.3	73.7±2.8	5.81^{a}±0.3	3.12±0.1	2.69^{b}±0.9	22.9±0.9	15.6±1.2	15.3±0.3	0.95 ^{ab}±0.02
	18	331.67±2.7	90.87^{d}±4.2	73.9±2.8	5..88^{a}±0.1	2.90±0.1	2.98^{a}±0.9	22.9±0.9	15.3±1.1	15.8±0.6	0.96 ^{a}±0.01
2600	14	331.75±5.9	108.00^{a}±4.4	74.9±2.6	5.11^{c}±0.1	3.11 ±0.1	2.00^{c}±0.8	22.8±0.8	15.3±0.6	14.9±0.4	0.93 ^{ab}±0.02
	16	339.93±5.2	101.60^{b}±2.7	75.6±2.1	5.89^{a}±0.1	3.24±0.2	2.88^{a}±0.9	23.0±0.9	15.3±0.6	15.2±0.5	0.96 ^{a}±0.02
	18	342.00±8.6	103.45^{a}±5.3	75.9±2.8	6.12^{a}±0.1	2.95±0.1	3.27^{a}±0.7	22.9±0.7	15.0±0.9	15.9±0.6	0.98 ^{a}±0.01
2700	14	339.00±7.8	108.33^{a}±1.5	77.3±3.0	5.33^{b}±0.3	2.80±0.1	2.53^{b}±0.9	23.2±0.9	15.6±0.9	14.7±0.1	0.95 ^{ab}±0.02
	16	327.79±6.1	105.0 ^{a}±5.2	79.2±3.2	5.79^{ab}±0.1	3.11±0.2	2.68^{a}±1.0	23.1±1.0	15.6±0.7	15.3±0.2	0.98 ^{a}±0.02
	18	344.55±8.1	103.0 ^{a}±2.5	80.1±3.0	6.21^{a}±0.1	3.15±0.4	3.04^{a}±0.4	23.6±0.9	16.3±1.2	15.9±0.6	0.98 ^{a}±0.01

$^{a-.d}$ **Values having different superscripts in the same column are significantly different (*P<0.05*).**

Table 5: Effect of digestible energy, crude protein levels and their interaction on some carcass traits percentages of growing APRI rabbits .

Traits		Total edible parts (TEP)%	Fore parts%	Trunk%	Hind parts%	Liver%	Kidney%	Heart%	Abdominal fat%	Gastro intestinal tract (GIT)%
Digestible energy level: Kcal/kg diet										
2500		53.1±0.9	11.5 ±0.3	18.4±0.3	18.9±0.4	3.3±0.2	0.68±0.04	0.33±0.02	$2.1^{c}\pm0.3$	$22.0^{a}\pm0.4$
2600		53.6±0.7	11.2 ±0.3	18.4±0.5	19.0±0.2	3.0±0.2	0.70±0.03	0.33±0.03	$1.85^{b}\pm0.4$	$19.7^{b}\pm0.4$
2700		52.5±0.6	11.9±0.2	18.0±0.3	18.3±0.3	3.2±0.2	0.69±0.05	0.33±0.04	$3.1^{a}\pm0.6$	$17.6^{c}\pm0.4$
Protein level %:										
14		$51.9^{b}\pm0.7$	11.8±0.2	$17.5^{b}\pm0.4$	18.4±0.5	3.1±0.1	0.66±0.03	0.34±0.05	$2.5^{b}\pm0.1$	$20.7^{a}\pm0.7$
16		$53.8^{a}\pm0.7$	11.9±0.3	$18.8^{a}\pm0.5$	19.1±0.3	2.9±0.3	0.71±0.04	0.33±0.04	$2.1^{ab}\pm0.1$	$19.6^{b}\pm0.7$
18		$53.4^{ab}\pm0.8$	11.8±0.3	$18.4^{a}\pm0.3$	18.8±0.4	3.3±0.2	0.71±0.03	0.33±0.04	$3.1^{a}\pm0.1$	$19.1^{b}\pm0.8$
Interaction										
2500	14	$52.8^{bc}\pm0.9$	$11.8^{ab}\pm0.3$	$17.8^{ab}\pm0.3$	18.9±0.5	3.4±0.2	0.68±0.05	0.34±0.03	$1.7^{e}\pm0.8$	$22.5^{a}\pm1.0$
	16	$55.2^{ab}\pm1.5$	$11.9^{b}\pm0.4$	$19.7^{a}\pm0.4$	19.9±0.3	3.1±0.4	0.63±0.04	0.33±0.04	$2.3^{e}\pm0.6$	$21.9^{a}\pm0.8$
	18	$51.2^{c}\pm1.0$	$10.8^{b}\pm0.3$	$17.9^{ab}\pm0.3$	17.9±0.4	3.4±0.3	0.74±0.06	0.32±0.04	$2.2^{e}\pm0.6$	$21.6^{a}\pm0.5$
2600	14	$51.9^{bc}\pm1.0$	$11.9^{ab}\pm0.5$	$18.5^{b}\pm0.5$	18.5±0.6	3.3±0.4	0.63±0.07	0.34±0.05	$2.1^{d}\pm0.3$	$20.8^{ab}\pm0.9$
	16	$53.4^{bc}\pm0.5$	$12.0^{ab}\pm0.4$	$18.9^{ab}\pm0.3$	18.9±0.5	3.1±0.2	0.80±0.05	0.32±0.06	$2.2^{c}\pm1.5$	$19.2^{bc}\pm0.4$
	18	$55.5^{a}\pm1.2$	$12.6^{a}\pm0.3$	$19.7^{a}\pm0.4$	19.7±0.4	2.6±0.3	0.68±0.04	0.34±0.04	$2.3^{c}\pm0.6$	$19.2^{bc}\pm0.5$
2700	14	$51.0^{c}\pm0.6$	$11.9^{ab}\pm0.3$	$17.6^{b}\pm0.4$	17.6±0.3	3.2±0.5	0.66±0.07	0.34±0.03	$2.6^{bc}\pm0.7$	$18.8^{bc}\pm0.8$
	16	$52.9^{bc}\pm1.2$	$11,8^{ab}\pm0.4$	$18.8^{ab}\pm0.5$	18.6±0.4	2.8±0.3	0.70±0.06	0.34±0.05	$2.1^{ab}\pm0.6$	$17.5^{cd}\pm0.1$
	18	$53.5^{bc}\pm0.8$	$12,0^{ab}\pm0.4$	$18.0^{ab}\pm0.4$	18.7±0.5	3.7±0.2	0.71±0.05	0.33±0.07	$2.8^{a}\pm0.6$	$16.4^{d}\pm0.3$

[a-e] Values having different superscripts in the same column are significantly different (*P<0.05*).