EFFECT OF DIETARY PROTEIN AND ENERGY LEVELS ON GROWTH AND HEALTH OF EARLY WEANED RABBITS

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ABSTRACT

The present study was carried out to evaluate the effects of protein and energy levels in the diets of early weaned rabbits on the growth performance and general health. Two groups of growing New Zealand White rabbits (18 each) weaned either at 26 or 35 days old, each was subdivided into 3 subgroups, each of 6 kits. Three diets were formulated to contain three levels of crude protein (16 &18 and 19.2 %) with three levels of energy (2522, 2831 and 3008 kcal DE / Kg diet, respectively). Each subgroup of rabbits was assigned randomly to one of the three diets from time of weaning till end of the experiment (84 days age). Body weight of the rabbits and consumed diets were weekly recorded and the feed conversion ratio was calculated as well 3 rabbits from each subgroup were slaughtered at end of the experiment for determination of carcass traits. Blood samples were collected from the ear vein of the rabbits at end of experiment to separate sera for analyzing the total protein, albumin, cholesterol and total lipid.

The results revealed that early weaned rabbits may need to feed diet containing 18% CP and 2831 kcal DE / Kg diet for nearly 24 days after weaning and then after the excess of dietary protein and energy than the recommended levels would be not beneficial in achieving more body development or weight gain. Increasing the dietary protein level or the energy concentration of the diet would formulated for the late weaned (35 days) rabbits than the recommended levels is not advisable, even more, feeding the high protein (19.2 %) high energy (3008 kcal DE /kg) levels resulted in negative effect (low body weight). Niether the age of weaning nor the dietary levels of CP or DE affect the dressed carcass, body organs (liver, kidney & heart) or abdominal fat percentages. Also, proximate chemical composition of liver and leg muscles showed no significant differences due to levels of dietary CP & DE or age of weaning. Results of serum metabolites determination showed no specific trends.

INTRODUCTION

Intensive rearing systems are increasingly used at present in commercial rabbit farms. They are associated with weaning at early ages to reduce parturition interval and to increase numerical productivity of rabbit does.

Early weaning of young rabbits has been proposed as a mean of reducing does energy deficit by decreasing milk energy output and improving the body condition of the doe and its health status **(Pascual, 2001; Gidenne and Fortun-Lamothe, 2002; Xiccato et al., 2004)**. Also, early weaning could reduce the incidence of digestive disorders and reduced pathogen transmission by limiting contacts between litters and does **(Schlolaut, 1988)**. The growth of rabbits could be affected by weaning age. **Trocino et al. (2001)** observed that early weaned kits showed a lower live weight in comparison with rabbits weaned at 32 days of age. Similar results were reported by **Gidenne and Fortun- Lamothe (2001)**. The negative effect of early weaning on live weight was also reported by others **(Ferguson et al., 1997; Gidenne and Fortun-Lamothe, 2001; 2003; 2004; Gallois et al.; 2003, 2004)**. In addition, early weaning at 25 days of age decreased growth rate **(Rodri'guez et al., 1981)** and increased diarrhea incidence **(Lebas, 1993)** when young rabbits were fed commercial fattening diets. Consequently, design of appropriate starter diets seems to be necessary to shorten lactation period and maintain intestinal health and performance of young rabbits. A major constraint in formulating these special diets is level of energy and protein, as younger animals have a less developed digestive system **(Marounek et al., 1995; Scapinello et al., 1999)**. As a consequence, increases the amount of energy or protein reaching the terminal ileum, might increase mortality during the post-weaning period **(Blas and Gidenne, 1998; Lebas et al., 1998)**.

The addition of fat to diets for rabbits could improve feed efficiency **(Santoma et al., 1987)**. However, there is a lack of information on the effects of fat addition to diets on growth performance, body composition and carcass characteristics of growing rabbits. So, the purpose of this research was to investigate the influence of protein and energy levels and fat addition to fibrous diets on growth performance, dressed carcass percentage measurements, body chemical composition of liver & leg muscles and serum levels of some metabolites of early weaned rabbits.

MATERIALS AND METHODS

The experimental rabbits and management :

Thirty six unweaned New Zealand White (NZW) kits were divided into 2 equal main groups of 18 litters each. The first group was weaned at 26 days old and assigned as early weaned rabbits, and the second one of the litters was left with their dams until 35 days of age and assigned as the late weaned rabbits. The growing rabbits in both weaning ages were subdivided into three subgroups (6 kits each). These subgroups were randomly assigned to the respective dietary treatments which differ in protein levels (16, 18 or 19.2% CP) with different energy levels (2522, 2831 and 3008 kcal DE / Kg diet, respectively), to maintain the calorie / protein ratio nearly constant (Table 1). All rabbits were vaccinated against snuffles using Hemorrhagic Septicemia Vaccine and protected against parasites using Ivomec preparation (0.5 ml subcutaneous).

The litters were raised in a flat deck battery system with universal specification. Each doe-cage was supplied with a metal nest-box, metal feeder and nipple drinkers. The kindled litters remained in their nests with their dams

for suckling and eating from birth till time of weaning (either at 26 or 35 days). Does and litters were fed diet containing 17 CP %, 2700 kcal DE/ kg & 11 CF %. The weaned growing rabbits were sexed, weighed and tattooed. Thenafter, the rabbits were removed into the growing batteries (75x 50x35cm / 2 growing rabbits) according to their experimental feeding treatment. The batteries were placed in a windowed, naturally ventilated room. Experimental period extended for 12 weeks from mid of October 2008 to mid of February 2009.

Experimental diets:

Three experimental diets were formulated. First diet (control) was formulated according to NRC (1977) recommendation guides for the nutrient requirements of growing rabbits to provide 16% CP and 2522 Kcal DE/kg. The second diet provided 18% CP and 2831 Kcal DE / kg and third diet provided 19.2% CP and 3008 Kcal DE / Kg. The experimental diets supplemented with a mineral- vitamin premix to cover the required trace elements and vitamins for growing rabbits. The formulated diets were composed, mixed well and pelletized (0.4mm) then kept in plastic bags till using. The ingredients percentage and calculated chemical composition of the experimental diets are presented in table 1. The growing rabbits were fed ad libitum and water was available all the time. Experimental diets were provided 2 times daily (8 AM and 4 PM) in estimated amounts to avoid wasting.

Indices for evaluation of growth performances and serum metabolites :

The rabbits were weighed at the first day after weaning to obtain the average initial body weight then the average body weight and body gain were weekly determined. The average feed consumption and feed conversion ratio per rabbit per week was calculated through out the experimental period.

At the end of experiment, blood samples were collected from 4 rabbits from each experimental subgroup. Sera were obtained by allowing blood samples to coagulate then centrifuged at 3000 rpm for 15 minutes. The separated sera were frozen at - 20°C in deep freezer until used for determination of total protein **(Kaplan et al. 1984)**, albumin **(Doumas et al., 1971)**, cholesterol **(Allain et al., 1974)** and total lipid **(Zollner et al., 1962)**.

Carcass traits:

At the end of experiment (84 days age), three rabbits from each experimental subgroup were randomly taken, weighed and slaughtered to complete bleeding and reweighed again. The rabbits from each treatment were dressed, eviscerated and the dressed carcass % (Carcass weight / live weight x100), abdominal fat, liver, kidneys and heart weights and percent in relation to the live body weight were determined.

Chemical analysis:

Samples from experimental diets were taken for proximate chemical determination of CP, CF, EE and ash. In addition, samples from internal organs (liver and leg muscles) were taken for determination of CP, EE and ash contents according to the conventional methods described by the **A.O.A.C. (1990)**.

Statistical analysis:

Obtained data in the present work were statistically analyzed for analysis of variance

(ANOVA) and least significant difference (LSD) as described by **Snedecor and Cochran (1967).**

RESULTS & DISCUSSION

The data showed that feeding the early weaned rabbits (26 days) the high protein-high energy diets (18 & 19.2% CP and 2831 & 3008 kcal DE/kg, respectively) significantly improved LBW and BG (Tables 2 & 3) compared to the rabbit fed the normal recommended diet containing 16% CP and 2522 kcal DE/kg. The statistically significant increase in BW was continued till the 49 days of age. However, the growing rabbits weaned early at 26 days and fed the diet containing 18% CP had statistically higher live body weight (LBW) than those fed the 19.2% CP-diet starting from the age of 49 days old till end of the experiment at 84 days. The data for the early weaned rabbits fed the higher protein diets (19.2% CP) indicated that the excess in dietary protein percentage (3.2% CP) did not improve BW development or BWG during the period from 49-84 days of age (Tables 2 & 3). The results showed that BWG for the rabbits group fed the high protein diet (19.2%) was lower than that reported for the rabbits group fed the recommended, low protein diet (16% CP) in this period. The present results are in agreement with the findings of **Razzorenova and Morozova (1980)** and others that diet of growing rabbits should contain 16.5 to 18.5% CP. Also, Sanchez et al. (1985) showed that increasing the level of dietary CP to 19 or 20% lowered body weight gain. However, **Raharjo et al. (1986)** reported that feeding diets containing 16 or 21% CP gave comparable (equal) growth performance. On the other hand **Jacob et al. (1992)** fed growing rabbits diets containing 14, 16 & 18% CP and 2600 kcal DE/ kg and concluded that WG increased linearly with increasing CP in diets and protein requirement for maximum growth of rabbits is greater than that recommended by **NRC (1977).** Also, **Gongent et al. (1993)** reported that feeding 18.3% CP diet gave significantly greater body weight than 16.82 & 23.32%. On this concept, **Zanaty and Ahmed (2000)** indicated that live weight of NZW rabbits improved significantly ($p< 0.05$) as dietary CP level increased up to 18.2%.

In the late weaned rabbits (35 days), feeding the high protein-high energy diets (18% and 19.2% CP and 2831 & 3008 kcal DE / kg) did not improved BW or BWG along with the experimental period. Unexpectedly, feeding the late weaned rabbits (35d) the diet containing the normal recommended protein (16%) and energy (2522 kcal/kg) statistically give the same results as those fed the high protein (18% CP) and high energy (2831 kcal DE/kg) diet. **Abdel Malak (2000)** showed that LBWG of NZW growing rabbits increased by increasing dietary CP levels but with no significant differences between groups fed 16 & 18% CP. Therefore, it could be concluded that the early weaned rabbits (at 26 days) may need to fed diet containing 18% CP for nearly 24 days following early weaning (26 days) and the excess of protein in the diet would be not beneficial in achieving more body development or weight gain. Increasing the dietary protein level or the energy concentration of the diet would be formulated for the late weaned (35 d) rabbits than the normal recommended levels is not advisable, even more, feeding the high protein (19.2%) high energy (3008 kcal DE/kg) diet resulted in negative

effect on growth. Similarly, **Feugier et al. (2006)** who fed growing rabbits of 36 days old diets containing 15, 18 or 21% CP and concluded that diet containing CP level less than 18% showed the lowest growth rate as compared with other respective treatments.

Feed intake and feed conversion ratio:-

Generally, the results concerning the weekly amount of feed intake of the rabbit groups weaned at 26 and 35 days of ages and fed the different experimental diets did not show specific trend (Table 4). The fluctuation recorded in the weekly amount of feed intake between the different rabbit groups in some weeks of the experiment can not be explained well, however, it might be a reflection of health status, difference in body weight development of rabbit groups or energy concentration of the experimental diets. In spite of the fact that the amount of cumulative feed intake is statistically the lowest (5750 and 4900 g) in the rabbit groups weaned at 26 or 35 days, respectively and fed the high protein-high energy diets (19.2 % CP). On the other hand, the rabbit groups fed 16% CP and 2522 kcal DE/ kg consumed higher amounts of the diet during the whole experimental period (6190 and 5322 g) for the rabbit groups weaned at 26 and 35 days, respectively.

Feed conversion ratios (FCR) were mostly better and significantly less in the rabbit groups weaned at 26 days and fed the high protein- high energy diets compared to the rabbit groups fed the recommended levels of CP and DE (Table 5). It is of great importance to observe that feeding the late weaned rabbits (35 days) diets containing higher levels of either CP (18 or 19.2 %) did not improve the FCR (Table 5). This finding indicated that increasing the CP and DE levels in diets of the late weaned growing rabbit is not advisable and the recommended levels (16% CP & 2522 kcal DE /kg) are practically sufficient for feeding the NZW rabbits under local conditions. However, increasing the CP and energy content (18% CP and 2831 kcal DE/ kg) in the diet of the early weaned rabbits (26 days) improved the diet utilization represented in the terms of body weight and FCR (2468 g and 2.93).

Protein efficiency ratio (PER)

It is clear that efficiency of protein is markedly effective in the early weeks of growth especially in the kits weaned at 26 days of age. Also, the highest PER is recorded for the early weaned (26 d) rabbits fed the diet containing 18% CP (6.22). The potency of PER of the different diets decreased gradually with increasing of age of the rabbits (Table 6) These findings indicated that growing rabbits need some higher protein content (18%) in their diet during the early weeks of age (26-49 days).

Generally, feeding the 18% CP diet has the best PER value (1.92) in the early (26 d) weaned rabbits. The data also showed that feeding the recommended diet (16% CP & 2522 kcal DE) has the best value of total PER in the late weaned rabbit groups (1.89 vs 1.64 or 1.45 for the 18 or 19.2% CP diet respectively). This finding indicated that late weaned rabbits may do not need further increased in dietary CP or energy than the recommended levels especially in the late growing period (after 42 days of age).

Carcass traits:

The data showed that either of dietary protein and energy levels or age of weaning of the kits had significant impact on dressed carcass%, organs weight or percentage to live weight. On the other hand feeding the growing rabbit the high protein- high energy diets (18 or 19.2 % CP & 2831 or 3008 kcal DE/ kg, respectively) increased the fat percentage of dressed carcass (Table 6). **Trocino et al. (2001) and Tumova et al. (2006)** concluded that age of weaning did not affect dressing percentage in growing rabbits at slaughtering. On the other hand **Ayyat and Maral (1997)** showed that feeding growing rabbits high energy diet increased dresses carcass percentage.

Nether the age of weaning nor the dietary levels of CP or DE affect the dressed carcass, body organs (liver, kidney & heart) or abdominal fat percentages (Table 8). Also, proximate chemical composition of liver and leg muscles showed no significant differences due to levels of dietary CP & DE or age of weaning (Table 9). Results of serum metabolites determination showed no specific trends (Table 7).

Table 1. Ingredients and calculated chemical composition of experimental diets.

	Experimental diets		
	I	II	III
CP level	**16%**	**18%**	**19.2%**
DE (Kcal/Kg)	**2500**	**2812.5**	**3000**
Ingredients			
Corn, yellow	20.75	16.75	13
Soybean meal	21.0	26	31
Barseem hay	19.39	20	17.75
Wheat bran	16.5	20	17
Wheat straw	15.81	8.5	9
Molasses	3.0	2.0	2.0
Cotton seed oil	-	3.5	7
Min. and vit. Premix*	0.25	0.25	0.25
Lime stone	1.1	1.2	1.2
Dicalcium phosphate	1.1	0.8	0.8
Antitoxin	0.1	0.1	0.1
Anticoccidia	0.1	0.1	0.1
Charcoal	0.2	0.2	0.2
Common salt	0.5	0.5	0.5
Methionine	0.2	0.1	0.1
Calculated chemical composition			
CP %	15.98	17.96	19.2
DE %	2522	2831	3008
CF %	13.23	11.20	10.9
Ca %	0.35	0.36	0.36
P %	0.47	0.53	0.53
Lysine %	0.74	0.89	1.1
Methionine, cystine%	0.40	0.46	0.54
Analyzed chemical composition			
CP %	15.86	17.79	19.40
CF %	12.75	11.80	11.12
EE %	3.55	7.14	10.13
Ash %	11.06	10.91	9.50

*The mineral- vitamin premix provide per kg dict: vitamin A, 12,000 IU; vitamin D, 2,500 IU; vitamin E, 12 mg; vitamin K, 2.5 mg; vitamin B1, 1.2 mg; vitamin B2, 6 mg; pantothenic acid, 12 mg; folic acid, 1.2 mg; niacin, 36 mg; pyridoxine, 2 mg; vitamin B12, 0.01 mg; biotin, 0.06 mg; Choline, 100mg; iron, 36 mg; copper, 5 mg; manganese, 72 mg; zinc, 60 mg, iodine, 0.45 mg; selenium, 0.12 mg.

Table 2. Effects of dietary protein and energy levels on body weight development of the growing rabbits weaned at 26 and 35 days of age.

	Weaning age, day					
	26			35		
Dietary CP %	16	18	19.2	16	18	19.2
Age/ day						
26	408 ±10.28	412 ±12.34	408 ± 9.87	-	-	-
30	546^{b} ±11.21	600^{a}±10.15	605^{a} ± 7.27	-	-	-
35	706^{c} ± 30 97	810^{b} ± 32.53	820^{b} ±21.50	886^{a} ± 15.15	880^{a} ±10.00	890^{a} ± 14.08
42	916^{c} ± 44.35	1053^{b} ± 42.48	1044^{b} ± 35.57	1162^{a} ± 31.28	1113^{a} ± 38.88	1126^{a} ± 34.44
49	1177^{d} ± 73.77	1299^{bc} ± 53.75	1241^{cd} ±53.55	1346^{ab} ± 51.14	1410^{a} ± 29.06	1367^{ab} ± 66.79
56	1418^{c} ± 82.53	1546^{ab} ± 62.30	1453^{bc} ±89.32	1630^{a} ± 63.25	1622^{a} ± 38.42	1576^{a} ± 67.35
63	1650^{b} ± 79.27	1766^{a} ± 65.44	1658^{b} ± 60.2	1845^{a} ± 71.56	1835^{a} ± 48.89	1762^{a} ± 37.44
70	1841^{c} ±89.3	1978^{ab} ± 80.86	1845^{bc} ± 68.9	2087^{a} ± 86.3	2050^{a} ± 47.9	1940^{b} ± 42.43
77	2064^{a} ± 93.6	2214^{ab} ± 50.6	2017^{c} ± 59.2	2282^{a} ± 75	2264^{a} ± 66.9	2118^{bc} ± 27.7
84	2218^{b} ± 86.7	2468^{a} ± 45.6	2158^{b} ± 48.9	2477^{a} ± 87 5	2487^{a} ± 73.2	2291^{b} ± 68.4

^{a,b,c} Means with different superscripts within the same row are significantly different ($P< 0.05$).

Table 3. Effects of dietary protein and energy levels on body weight gain of the growing rabbits weaned at 26 and 35 days ages.

	Weaning age, day					
	26			35		
Dietary CP %	16	18	19.2	16	18	19.2
Age/ day						
26 -30	$138^{b} \pm 26.19$	$188^{a} \pm 26$	$197^{a} \pm 21.36$	-	-	-
30 -35	$160^{b} \pm 18.25$	$210^{a} \pm 10.51$	$215^{a} \pm 20.33$	-	-	-
35-42	$210^{c} \pm 20.20$	$243^{b} \pm 15.20$	$224^{bc} \pm 25.77$	$276^{A} \pm 29.81$	$233^{bc} \pm 14.91$	$236^{bc} \pm 19.83$
42-49	$261^{b} \pm 19.14$	$246^{b} \pm 17.3$	$197^{c} \pm 21.38$	$184^{c} \pm 21.10$	$297^{a} \pm 15.92$	$241^{b} \pm 42.08$
49-56	$241^{b} \pm 31.38$	$247^{b} \pm 23.49$	$212^{bc} \pm 29.67$	$284^{a} \pm 25.18$	$212^{bc} \pm 17.33$	$209^{c} \pm 21.09$
56-63	$232^{a} \pm 22.34$	$220^{a} \pm 20.79$	$205^{ab} \pm 18.14$	$215^{ab} \pm 18.30$	$213^{ab} \pm 16.70$	$186^{b} \pm 10.87$
63-70	$191^{b} \pm 29.90$	$212^{ab} \pm 25.7$	$187^{bc} \pm 21.2$	$242^{a} \pm 32.31$	$215^{ab} \pm 22.82$	$178^{c} \pm 21.90$
70-77	$223^{ab} \pm 18.81$	$236^{a} \pm 22.4$	$172^{c} \pm 12.2$	$195^{bc} \pm 23.9$	$214^{ab} \pm 21.32$	$178^{c} \pm 12.05$
77-84	$154^{d} \pm 20.92$	$254^{a} \pm 30.7$	$141^{d} \pm 16.67$	$195^{bc} \pm 27.52$	$223^{ab} \pm 12.70$	$173^{cd} \pm 20.53$
Total gain						
1- 26- 84 d	**$1810^{c} \pm 78.12$**	**$2056^{a} \pm 30.7$**	**$1985^{a} \pm 16.67$**	-	-	-
2- 35- 84 d	**$1512^{b} \pm 61.30$**	**$1658^{a} \pm 25.4$**	**$1338^{c} \pm 18.53$**	**$1591^{ab} \pm 27.52$**	**$1607^{a} \pm 12.70$**	**$1401^{c} \pm 20.53$**

^{a,b,c,d} Means with different superscripts within the same row are significantly different ($P < 0.05$).

Table 4. Effects of dietary protein and energy levels on feed intake (g) of the growing rabbits weaned at 26 and 35 days ages.

	Weaning age, day					
	26			35		
Dietary CP %	16	18	19.2	16	18	19.2
Age/ day						
26 -30	165 ± 7.87	170 ± 9.05	186 ± 15.13	-	-	-
30 -35	228^{b} ± 9.26	241^{ab} ± 11.21	266^{a} ± 22.14	-	-	-
35-42	344^{c} ± 4.53	408^{ab} ± 9.76	401^{ab} ± 11.50	442^{a} ± 14.70	382^{bc} ± 12.7	390^{b} ± 29.5
42-49	535^{b} ± 2.30	571^{a} ± 12.1	508^{b} ± 11.90	463^{c} ± 17.81	463^{c} ± 10.4	433^{c} ± 9.59
49-56	824^{a} ± 1.05	625^{b} ± 13.2	543^{c} ± 15.35	664^{b} ± 15.31	683^{b} ± 6.9	527^{c} ± 18.5
56-63	1080^{a} ± 13.65	800^{c} ± 10.7	744^{cd} ± 23.46	690^{cd} ± 14.77	929^{b} ± 23.25	654^{d} ± 21.65
63-70	1033^{a} ± 28.2	918^{b} ± 9.19	1035^{a} ± 23.35	862^{b} ± 8.43	832^{b} ± 5.80	815^{b} ± 21.44
70-77	1039 ± 18.27	1064 ± 18.82	1021 ± 56.21	1110 ± 23.6	1092 ± 42.6	1007 ± 32.6
77-84	942^{e} ± 25.25	1234^{a} ± 31.4	1046^{cd} ±55.50	1193^{ab} ± 67.1	1121^{bc} ± 87.3	1080^{c} ± 47.9
Total feed intake						
1- 26- 84 d	**6190^{a} ± 85.25**	**6031^{a} ± 91.4**	**5750^{b} ± 55.50**	-	-	-
2- 35- 84 d	**5797^{a} ± 88.12**	**5620^{a} ±72.4**	**5298^{b} ± 71.32**	**5322^{b} ± 98.6**	**5502^{b} ± 95.9**	**4906^{c} ± 77.1**

^{a,b,c,d} Means with different superscripts within the same row are significantly different (P< 0.05).

Table 5. Effects of dietary protein and energy levels on feed conversion ratios of the growing rabbits weaned at 26 and 35 days of ages.

	Weaning age, day					
	26			35		
Dietary CP %	16	18	19.2	16	18	19.2
Age/ day						
26 - 30	1.20^{a} ± 0.19	0.90^{b} ± 0.16	0.94^{b} ± 0.12	--	--	--
30 - 35	1.43^{a} ± 0.24	1.15^{b} ± 0.22	1.24^{ab} ± 0.17	--	--	--
35 - 42	1.64^{a} ± 0.12	1.68^{a} ± 0.14	1.79^{a} ± 0.04	1.40^{b} ± 0.21	1.64^{a} ± 0.4	1.65^{a} ± 0.14
42 - 49	2.05^{c} ± 0.20	2.32^{ab} ± 0.22	2.58^{a} ± 0.21	2.25^{bc} ± 0.28	1.56^{d} ± 0.33	1.79^{d} ± 0.21
49 - 56	3.42^{a} ± 0.18	2.53^{b} ± 0.10	2.56^{b} ± 0.16	2.33^{b} ± 0.15	3.22^{a} ± 0.41	2.52^{b} ± 0.17
56 - 63	4.66^{a} ± 0.38	3.64^{b} ± 0.3	3.63^{b} ± 0.25	3.21^{c} ± 0.25	3.46^{bc} ± 0.53	3.52^{bc} ± 0.26
63 - 70	5.41^{a} ± 0.23	4.33^{b} ± 0.61	5.53^{a} ± 0.51	3.56^{c} ± 0.42	3.87^{c} ± 0.33	4.58^{b} ± 0.18
70 - 77	4.66^{bc} ± 0.41	4.51^{c} ± 0.11	5.94^{a} ± 0.26	5.69^{a} ± 0.23	5.10^{a} ± 1.01	5.66^{a} ± 0.41
77 - 84	6.12^{a} ± 0.41	4.86^{b} ± 0.44	6.42^{a} ± 0.72	6.12^{a} ± 0.33	5.03^{b} ± 0.41	6.24^{a} ± 0.41
Allover FCR						
1- 26- 84 d	**3.41^{a} ± 0.31**	**2.93^{b} ± 0.27**	**2.90^{b} ± 0.43**	-	-	-
2- 35- 84 d	**3.83^{a} ± 0.43**	**3.38^{b} ± 0.29**	**3.95^{a} ± 0.35**	**3.40^{b} ± 0.23**	**3.42^{b} ± 0.25**	**3.50^{b} ± 0.30**

^{a,b,c,d} Means with different superscripts within the same row are significantly different ($P< 0.05$).

Table 6. Effects of protein and energy levels on protein efficiency ratio of the growing rabbits weaned at 26 and 35 days of ages.

Dietary protein %	Weaning age, day					
	26			35		
	16	18	19.2	16	18	19.2
26-30	$5.27^{b} \pm 0.82$	$6.22^{a} \pm 0.71$	$5.38^{b} \pm 0.60$	-	-	-
30-35	$4.42^{ab} \pm 0.16$	$4.90^{a} \pm 0.43$	$4.10^{b} \pm 0.45$	-	-	-
35-42	$3.85^{a} \pm 0.31$	$3.35^{b} \pm 0.23$	$2.84^{c} \pm 0.32$	$3.94^{a} \pm 0.43$	$3.43^{b} \pm 0.40$	$3.07^{c} \pm 0.31$
42-49	$3.08^{b} \pm 0.26$	$2.42^{c} \pm 0.40$	$1.97^{d} \pm 0.16$	$2.51^{c} \pm 0.21$	$3.61^{a} \pm 0.26$	$2.83^{b} \pm 0.20$
49-56	$1.84^{c} \pm 0.15$	$2.22^{b} \pm 0.42$	$1.98^{bc} \pm 0.15$	$2.70^{a} \pm 0.18$	$1.74^{c} \pm 0.20$	$2.01^{bc} \pm 0.16$
56-63	$1.35^{b} \pm 0.18$	$1.55^{b} \pm 0.21$	$1.40^{b} \pm 0.16$	$1.97^{a} \pm 0.20$	$1.29^{b} \pm 0.13$	$1.44^{b} \pm 0.15$
63-70	$1.17^{c} \pm 0.16$	$1.30^{bc} \pm 0.11$	$0.92^{d} \pm 0.11$	$1.77^{a} \pm 0.28$	$1.45^{b} \pm 0.15$	$1.11^{cd} \pm 0.12$
70-77	$1.35^{b} \pm 0.20$	$1.25^{bc} \pm 0.15$	$0.86^{d} \pm 0.10$	$1.11^{c} \pm 0.12$	$1.10^{c} \pm 0.06$	$1.64^{a} \pm 0.15$
77-84	$1.03^{ab} \pm 0.18$	$1.16^{a} \pm 0.14$	$0.68^{c} \pm 0.08$	$1.03^{ab} \pm 0.10$	$1.12^{a} \pm 0.12$	$0.90^{bc} \pm 0.08$
Total PER	$\mathbf{1.84^{ab} \pm 0.30}$	$\mathbf{1.92^{a} \pm 0.22}$	$\mathbf{1.55^{b} \pm 0.13}$	$\mathbf{1.89^{a} \pm 0.32}$	$\mathbf{1.64^{b} \pm 0.29}$	$\mathbf{1.45^{b} \pm 0.31}$

^{a,b,c,d} Means with different superscripts within the same row are significantly different ($P<0.05$).

Table 7. Levels of serum total protein, albumin, total lipids and cholesterol of the growing rabbits weaned at different ages and fed different levels of CP& DE.

	Weaning age, day					
	26			35		
Dietary protein %	16 %	18 %	19.2 %	16 %	18 %	19.2 %
Serum metabolites						
Total protein, g/ dl	5.60^{b} ± 0.56	6.74^{a} ± 0.55	6.97^{a} ± 0.62	5.83^{b} ± 0.49	5.50^{b} ± 0.65	5.77^{b} ± 0.70
Albumin, g/ dl	2.23^{b} ± 0.19	2.38^{b} ± 0.92	3.17^{a} ± 0.43	2.17^{b} ± 0.24	2.08^{b} ± 0.23	2.30^{b} ± 0.10
Cholesterol, mg/ dl	36.52^{b} ± 4.62	37.75^{b} ± 5.85	41.10^{a} ± 7.90	45.0^{a} ± 2.03	44.43^{a} ± 0.25	35.70^{b} ± 19.90
Total lipid mg/ dl	175.4 ± 23	178.9 ± 51.6	189.2 ± 37.3	192.1 ± 23.80	195.9 ± 28.55	182.1 ± 43.65

^{a,b} Means with different superscripts within the same row are significantly different (P< 0.05).

Table 8. Effects of dietary protein and energy levels on carcass quality of the growing rabbits weaned at 26 and 35 days of ages.

	Weaning age, day					
	26			35		
Dietary protein %	16	18	20	16	18	20
Live weight (g)	2123 ^{b} ± 82.5	2440 ^{a} ± 80.2	2145 ^{b} ± 40.7	2525 ^{a} ± 115	2530 ^{a} ± 40	2417.5 ^{b} ± 17
Liver weight (g)	71.53 ± .00	77.5 ± 2.5	73.6 ± 10	97.5 ± 7.5	92.5 ± 8.13	80 ± 5.10
Liver %	3.37 ± 0.12	3.20 ± 0.34	3.43 ± 0.29	3.83 ± 0.14	3.65± 0.15	3.33 ± 0.17
kidney weight (g)	15 ± 0.50	16.6 ± 0.83	15 ± 1.90	17.68 ± 2.11	17.46 ± 2.01	16.2 ± 0.01
Kidney %	0.71 ± 0.03	0.68 ± 0.04	0.70± 0.05	0.70 ± 0.04	0.69± 0.01	0.67 ± 0.03
Fat weight (g)	25 ± 3.26	32.5 ± 4.53	35.6 ± 4.40	32.5 ± 17.5	32.5 ± 3.13	45 ± 3.51
Fat %	1.19 ± 0.29	1.39 ± 0.82	1.66 ± 0.02	1.23 ± 0.64	1.28 ± 0.37	1.86 ± 0.38
Heart weight (g)	7.5 ± 1.10	7.5 ± 1.2	7 ± 0.91	8 ± 0.78	7.5 ± 1.12	7.5 ± 0 64
Heart %	0.36 ± 0.13	0.32 ± 0.13	0.33 ± 0.02	0.33 ± 0.02	.30 ± 0.11	0.30 ± 0.09
Dressed carcass (g)	1225 ^{b} ± 25	1420 ^{a} ± 95	1242.5 ^{b} ± 83	1442 ^{a} ± 53	1482.5 ^{a} ± 23	1422.5 ^{a} ± 43
Dressed carcass %	57.74 ± 1.06	58.01 ± 2.11	57.86 ± 5.01	57.15 ± 5.12	58.58 ± 4.22	58.90 ± 4.11

^{a,b} Means with different superscripts within the same row are significantly different (P< 0.05).

Table 9. Effects of dietary protein and energy levels on proximate chemical composition of liver & leg muscles of the growing rabbits weaned at 26 and 35 days of ages.

	Weaning age, day					
	26			35		
Dietary protein %	16 %	18 %	19.2 %	16 %	18 %	19.2 %
Liver						
Protein %	18.60 ± 3.27	18.85 ± 3.46	18.29 ± 2.79	18.57 ± 2.14	19.1 ± 3.46	18.12 ± 2.41
Fat %	8.75 ± 1.34	8.40 ± 1.48	8.12 ± 1.52	7.56 ± 1.61	8.31 ± 1.34	7.80 ± 1.03
Ash %	1.45 ± 0.32	1.35 ± 0.27	1.39 ± 0.38	1.80 ± 0.28	1.65 ± 0.22	1.73 ± 0.27
Moisture %	70.2 ± 6.21	70.8 ± 5.46	71.8 ± 6.47	71.40 ± 6.25	70.3 ± 6.68	71.9 ± 5.95
Muscles						
Protein %	17.88 ± 3.46	17.75 ± 2.36	17.17 ± 3.18	17.28 ± 2.12	17.22 ± 3.18	17.91 ± 3.27
Fat %	3.6 ± 0.38	4.60 ± 0.67	4.30 ± 0.53	3.99 ± 0.24	4.37 ± 0.51	4.54 ± 0.41
Ash %	4.16 ± 0.32	3.28 ± 0.33	4.02 ± 0.38	4.38 ± 0.29	4.18 ± 0.24	3.92 ± 0.37
Moisture %	74 ± 6.47	73.7 ± 4.29	73.6 ± 7.89	73.8 ± 6.47	73.7 ± 5.44	73.1 ± 3.46

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الملخص العربى

تأثير مستوى البروتين والطاقة فى علائق الأرانب المفطومة مبكراً على معدلات النمو والصحة

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أجرى هذا البحث لدراسة تأثير تغذية مستويات مختلفة من البروتينات (١٦ - ١٨ - ١٩٫٢٪) والطاقة (٢٥٢٢ - ٢٨٣١ - ٣٠٠٨ كيلو كالورى من الطاقة المهضومة لكل كجم) مع ثبات نسبة الألياف (١٠ - ١٢٪) فى العليقة على مستوى معدل النمو فى الأرانب مبكرة الفطام (٢٦ يومياً)، (وزن الجسم والزيادة فى الوزن كذلك كفاءة التحويل الغذائى - صفات الذبيحة - نسبة الدهن فى الجسم) وكذلك الفطام المبكر (٢٦ يوم) كماتم دراسة تأثير زيادة مستويات البروتين والطاقة على صحة الكلى والكبد والصحة العامة للأرانب (بعض مكونات مصل الدم)، أجريت التجربة على ٣٦ أرنب نيوزيلاندى أبيض تم فطامها عند عمر ٢٦ أو ٣٥ يوماً حيث تم تغذيتهم على العلائق التجريبية حتى عمر ٨٤ يوماً وقسمت إلى مجموعات تجريبية حسب عمر الفطام (٢٦ أو ٣٥ يوم) وتم وزن الأرانب عند نهاية كل إسبوع من العمر لمتابعة النمو مع تسجيل العلف المستهلك، وتم جمع عينات من الدم من كل مجموعة قبل الذبح عند نهاية التجربة لفصل مصل الدم وقياس بعض مكوناته (البروتينات الكلية - الكوليسترول - الألبيومين والدهون الكلية)، كما ذبح ٣ أرانب من كل مجموعة لقياس صفات الذبيحة.

وقد خلصت نتائج الدراسة إلى :

- فى الأرانب المفطومة مبكراً التغذية على عليقة تحتوى على ١٨٪ بروتين و٢٨٣١ كيلو كالورى طاقة هضم لمدة ٢٤ يوم من عمر الفطام أدى إلى زيادة الوزن وبعد ذلك وجد أن زيادة البروتين فى العليقة لم يصاحبها زيادة مطردة مع وزن الجسم بالمقارنة بالمجموعات الأخرى.
- زيادة البروتين والطاقة فى علائق الأرانب المفطومة مؤخراً (٣٥ يوماً) عن النسب الموصى بها (١٦٪ بروتين - ٢٥٠٠ كيلو كالورى طاقة) لم تؤدى إلى زيادة فى الوزن ولاينصح بها - زيادة نسبة البروتين إلى ١٨٪ أو ١٩٫٢٪ فى علائق الأرانب مؤخرة الفطام أدى إلى تأثير سلبى فى وزن الجسم بالمقارنة مع المجموعة الضابطة.
- لم يحدث تغيير ملحوظ فى أى من مكونات مصل الدم.
- لم تؤثر نسبة البروتين والطاقة العالية على نسبة وزن الذبيحة أو نسبة وزن الأعضاء الداخلية.
- زيادة البروتين والطاقة رفع نسبة الدهن فى الذبيحة فى حالة الفطام المتأخر.
- ينصح بزيادة مستوى البروتين فى العليقة إلى ١٨٪ و٢٨٠٠ كيلو كالورى من طاقة الهضم فى حالة تغذية الأرانب النامية مبكرة الفطام (٢٦ يوم) ولمدة ٤ أسابيع فقط بعد الفطام.