Effect of dietary levels of arginine on the growth performance and immunity of growing rabbits

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ABSTRACT

The present Study was conducted at Environmental Studies and Research Institute farm, University of Sadat City and the Regional Center for Food and Feeds to determine the effect of the using different levels of arginine on the performance and immunity of growing rabbits. Forty WNZ growing rabbits of both sexes , aged 5 weeks with an average initial weight of 750 g were used in the experiment . The animals were divided into 5 groups, each group has 4 replicates each. All animals were individually housed in galvanized wire cages with feeder and automatic nipple drinker and kept under the same managerial conditions. *The results obtained were:* The final body weight of rabbit fed T_4 was insignificantly higher than the other groups T_1, T2, T3 andT5 being (2500.0g *vs*. 2280.0; 2487.50; 2446.87 and 2316.43g, respectively.), Also, rabbits group fed dietary arginine by 0.4g/kg diet (T_3) achieved the best total gain value (1758.13g) compared with control(T1) and other experimental groups(T2;T4;T5) being (1548.57 and 1740.63 ; 1715.63 ; 1563.57 , respectively . But there is no significant differences in final body weight gain between control and experimental treatments which supplemented with different levels of dietary arginine. Rabbits group fed dietary arginine by 0.6g/kg diet (T_4) significantly ($p<0.05$) consumed the highest total FI (1081.25 and 451.25 g), meanwhile, rabbits group fed dietary arginine by 0.8 g/kg diet (T_5) significantly ($p<0.05$) achieved the lowest feed intake (333.13g) .Insignificant differences between control and other experimental groups which ranged from 3.25 to 3.64 and no cleared effect for dietary arginine on FCR. *Therefore*, it can be concluded that dietary arginine by 0.4g/kg diet (T_3) achieved better growth performance of growing rabbits.

Key words: Arginine; Body weight; Weight gain; Growing rabbits; Feed conversion ratio

الملخص

أجريت هذه الدراسة بمعهد الدراسات والبحوث البيئية والمركز الاقليمى للاغذية والاعلاف بهدف دراسة تاثير استخدام مستويات مختلفه من الارجنين على اداء النمو والمناعة فى الارانب النامية . تم استخدام ٤٠ ارنب نامى تتراوح اعمارهم بين خمس اسابيع بوزن ابتدائى(٧٥٠) جرام تقريبا وتم تقسيمهم الى خمس مجموعات بكل مجموعة اربع مكررات وكل مكرر به عدد ٢ ارنب تم تربية الارانب فى اقفاص معدنية تحت نفس ظروف التغذية والشرب وكانت أهم النتائج المتحصل عليها :-

حققت المجموعة الرابعة أعلى معدل فى الوزن الكلى النهائى للجسم مقارنة بباقى مجموعات التجربة بينما سجلت المجموعة التى تم تغذيتها على عليقة تحتوى على (٤، جرام /لكل كيلو جرام ارجنين) المجموعة الثالثة احسن معدل زيادة فى الوزن (١٧٥٨,١٣ جرام) مقارنة بباقى المجموعات التجريبية بينما لم يتم رصد اى اختلافات معنوية فى الوزن النهائى بين عليقة المقارنة والمجموعات التجريبية المغذاه على مستويات مختلفه من الارجنين .

وحققت المجموعة المغذاه على عليقة بها (٦، جرام /لكل كيلوجرام ارجنين) - معنويا- أعلى ماكول بينما أظهرت المجموعة الخامسة المغذاه على عليقة تحتوى على (٨، جرام /لكل كيلوجرام أرجنين) أقل غذاء ماكول .

لم يلاحظ اى أختلافات معنوية بين المجموعات التجربية فيما يخص معامل التحويل الغذائى ،

توصى الدراسة بتغذية الارانب على علائق تحتوى على (٤، جرام /لكل كيلو جرام ارجنين) لضمان أداء نمو جيد

INTRODUCTION

The rabbit is considered as a good animal for meat production not only because of its early sexual maturity, sizable number of progeny kindled per doe and rapid growth, but also because the good quality of its meat. In addition; rabbits can utilize forages and agriculture by-products that are rich with fiber and convert it into high quality low fat meat, they are more efficient in feed conversion than other livestock animals (Cheeke *et al.* 1982 and Lebas 1983).

With respect to optimal dietary levels of protein for growth, Many Studies established that the best nutritive unit for energy and protein (crude, digestible or net), and the requirements of these nutrients for growth. These studies considered a wide range of protein and energy levels, different slaughter weights (2.0, 2.25 or 2.5 kg) or weaning age (25 vs 35 d) (de Blas *et al.*, 1981 and 1985).

Several experiments have been performed to evaluate different units and to characterize the protein value of feedstuffs usually included in rabbit diets (Villamide *et al.* 2013).

Rabbit dietary intake is required in young animals to attain a normal growth rate. In addition, even though arginine is not required for maintenance of nitrogen balance in the adult under ordinary circumstances, this amino acid could still become indispensable in disease states, such as renal disease or diabetes, or other circumstances, such as response to trauma. Aside from the diet, arginine can be synthesized from citrulline mainly in the liver and kidney, or it can be released by the muscles (Reyes *et al.* 1994).

The intestinal transformation of arginine into citrulline seems to be of prime importance in the metabolic adaptation to high versus low protein diets. The immune cells possess the ability to synthesize both polyamines and nitric oxide. (Cynober *et al.* 1995).

(1 charmo)Recent studies show that specific nutrients such as AA can promote gastrointestinal integrity (Ziegler et al., 2003; Clifford, 2006). Glutam+ine is a primary energy source of enterocytes and immune cells (Newsholme et al., 1999). Previous information (Adamson and Fisher, 1976) indicated that Arg requirements of young rabbits might be particularly high.

Arginine has important roles in the modulation of the immune response (Evoy *et al.* 1998). Both Gln. and Arg. Considered conditionally essential AA under hypermetabolic states as occur at weaning. Arginine can be partially synthesized from

Gln; however, the rate of synthesis might not be sufficient to meet Arg requirements in young rabbits . (Wu *et al.* 1994).

Supplementation of diets for early weaned pigs with these AA prevented jejunal atrophy and normalized lymphocyte function (Wu et al., 1996; Yoo et al., 1997; Zhan et al., 2008). However, there is no information available on the effects of dietary supplementation
with Gln and Arg on gut barrier function in weaned rabbits. Therefore , The aim of this study is to determine the effect of the using different levels of arginine on the performance and immunity of growing rabbits.

MATERIALS AND METHODS

The present experiment was carried out at farm of Sustainable Development Department, Environmental Studies and Research Institute, University of Sadat City and cooperation with the Regional Center for food and feeds, Agriculture Research Center to determine the effect of feeding dietary of the use of different levels of arginine on growth performance and immunity of growing rabbits .

The study included 40 growing White New Zealand (WNZ) rabbits of both sexes (males and females), aged 4 weeks with an average initial weight of 550 g then divided into 5 groups with 4 replicates each. All animals were individually housed in galvanized wire cages (45 cm x 54 cm x 35 cm) with feeder and automatic nipple drinker and kept under the same managerial conditions during the experimental period (2 months).

Formulated diets of 17% crude protein were formulated, the diet containing 17% CP (commercial or control, T_1)

Table (1). The Experimental groups were arranged as the following:

Group 1:	(T1)	(commercial or control diet)
Group 2:	(T2)	Addition of arginine by 0.2/kg diet
Group 3:	(T3)	Addition of arginine by 0.4/kg diet
Group 4:	(T4)	Addition of arginine by 0.6/kg diet
Group 5:	(T5)	Addition of arginine by 0.8/kg diet

Table (2).Composition of ingredient feed rations for control and treated groups.

Ingredients	Control 17 %CP
Alfalfa	25.00
Wheat bran	26.00
Barley grains ,Ground	20.00
Soybean meal (44% CP)	13.5
Yellow corn, ground	10.00
Wheat straw	1.50
Dl-Methionine	0.35
Premix*	0.50
Na Cl	0.35
Di calcium phosphate	1.90
CaCO3	0.90
Total (kg)	100
Calculated analysis**	
Crude protein %	17.10
ME, kcal/kg diet	2520
Crude fiber %	12.00
Ether extract %	2.59
Calcium %	1.10
Available phosphorus	0.41
Lysine %	0.81
Methionine	0.60
Cost/kg of diet in L.E. ***	2.70

*The premix (Vit. & Min.) was added at a rate of 3 kg per ton of diet and supplied the following per kg of diet (as mg or I.U. per kg of diet): Vit. A 12000 I.U., Vit. D3 2000 I.U., Vit. E 40 mg, Vit. K3 4 mg, Vit. B1 3 mg, Vit. B2 6 mg, Vit. B6 4 mg, Vit. B12 0.03 mg, Niacin 30 mg, Biotin 0.08 mg, Pantothenic acid 12 mg, Folic acid 1.5 mg, Choline chloride 700 mg, Mn 80 mg, Cu 10 mg, Se 0.2 mg, I 40 mg, Fe 40 mg, Zn 70 mg and Co 0.25mg.

According to Feed Composition Tables for animal & poultry feedstuffs used in Egypt (2001).

According to market prices of the year 2018.

Rabbit Growth performance

Rabbits were weighed individually at the end of each week, during the whole experimental period of 8 weeks to the nearest gram. Live performance measurements for each feeding period were measured and / or calculated in terms of live body weight (LBW), body weight gain (BWG) was calculated by subtracting the average body weight from the average final body weight of the rabbit.

Body weight gain = W2 – W1, where

W_1 = body weight at the onset of the period.

W_2 = body weight at the end of the period

Feed intake (FI) Under each treatment, feed intake for each replicate was weekly calculated, on a group basis, by subtracting the residual feed from the offered one. Average daily feed intake per rabbit was then calculated by using the following equations:

$$\text{FI/rabbit/day} = \frac{\text{FI / replicate/week}}{\text{No. of rabbits consumed feed daily during the week period}}$$

Average daily feed intake (FI) per rabbit was calculated at the end of every week as follows:

FI = Total feed intake in gram per day per group / Number of rabbits.

Feed conversion ratio (FCR) Feed conversion ratio (FCR) (using the weight of mortality to correct FI data) weekly and whole experimental period was calculated for each replicate under each treatment and calculated as kg of feed used for producing one kg of body weight gain as follows:
FCR = Average feed intake (kg) per rabbit / body weight gain (kg) per rabbit.

RESULTS AND DISCUSSION

Body weight (g).

Live body weight (g) as effected by supplemented dietary different levels of arginine is presented in Table 3 and fig. 1. Data indicated that increasing dietary arginine insignificant improved among live body weight (g) after 2 weeks of experiment .After 4 weeks of experiment , rabbit group fed dietary arginine by 0.4/kg diet (T_3) recorded significantly ($p<0.05$) the best body weight value (1766.87 g). Meanwhile, the lowest body weight was achieved with T_1 group (control) being 1550.63g.The final body weight of rabbit fed T_4 was insignificantly higher than the other groups T_1, T2, T3 andT_5 being (2500.0g *vs*. 2280.0; 2487.50; 2446.87 and 2316.43g, respectively.), but these differences were not significant.

These results were in agreement with the findings obtained by (Delgado *et al* 2018). who reported that post-weaning rabbits fed dietary treatments did not affect weight gain, feed intake, feed efficiency and final body weight during the whole fattening and were on average 45.5 g/d, 89.4 g/d, 0.511 and 1838 g, respectively.

Items**	Treatments*	

	T1 (Control)	T2 (0.2)	T3 (0.4)	T4 (0.6)	T5 (0.8)	
IW(g)	733.13 ± 30.95	746.88 ± 30.95	741.88 ± 30.95	731.25 ±30.95	745.63 ± 30.95	NS
LBW2	1088.75 ±44.05	1074.37±44.05	1158.12 ± 44.05	1172.50 ±44.05	1145.63 ±44.05	NS
LBW4	1550.63[b]±57.91	1709.38[ab]± 57.91	1766.87[a] ± 57.91	1726.88[ab]± 57.91	1663.13[ab] ±57.91	*
LBW6	2047.14 ±67.57	2203.13 ± 63.21	2231.25 ± 63.21	2170.0 ± 63.21	2070.0 ± 63.21	NS
LBW8	2280.0±77.77	2487.50 ±72.74	2500.0 ±72.74	2446.88 ±72.74	2316.43 ±77.77	NS
TLBW	2280.0±77.77	2487.50±72.74	2500.0±72.74	2446.87±72.74	2316.43±77.77	NS

Table 3. Live body weight (LBW) (g) of growing rabbits as affected by different levels of arginine. (Means ± SE).

*a, b ……. values within a row with different superscripts significantly different ($p<0.05$). NS = not significant SE= standard error

**T_1=Control diet; T_2 = Addition of arginine by 0.2/kg diet; T_3 = Addition of arginine by 0.4/kg diet, T_4 = Addition of arginine by 0.6/kg diet, T_5= Addition of arginine by 0.8/kg diet.

*** IW(g) : Initial weight (g) ; LBW2: Live body weight after 2 weeks of experimental period ; LBW4: Live body weight after 4 weeks of experimental period ; LBW6 : Live body weight after 6 weeks of experimental period ; LBW8: Live body weight after 8 weeks of experimental period ; FLBW: Final live body weight at the end of the experimental period .

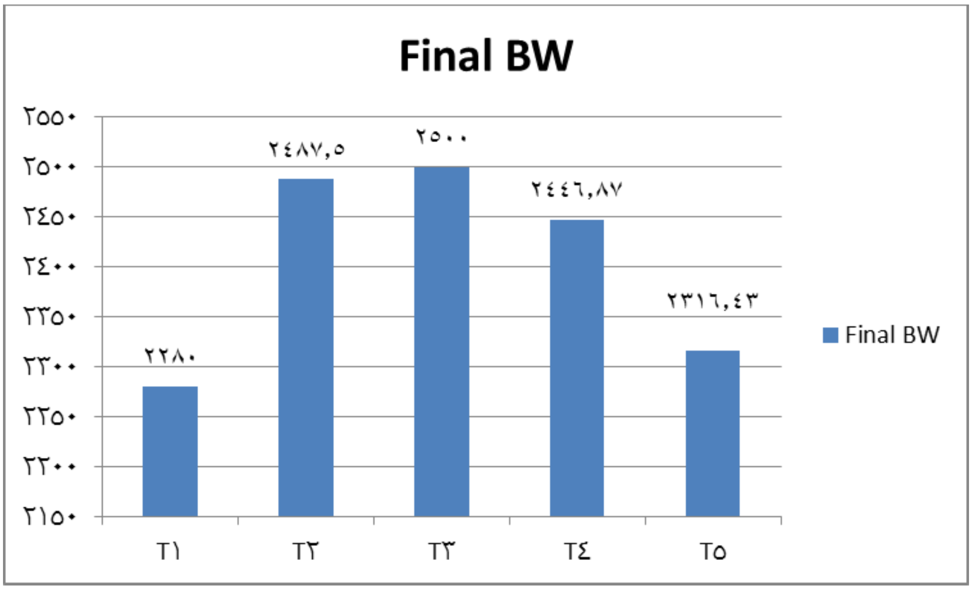

Fig.1 Final Body weight (g) as affected by supplemented dietary different levels

of dietary arginine.

Live body weight gain.

Live body weight gain results as effected by supplemented dietary_different levels of dietary arginine are presented in Table 4, and fig. 2. After 2 weeks of experiment, data indicated that the best gain value (214.38 g) was insignificantly recorded by T_4 group (Addition of dietary arginine by 0.6g/kg diet) compared to control group which detected the worst gain value (176.88 g.). After the fourth week of experiment, It was observed that the total gain of rabbits group T_2 (Addition of dietary arginine by 0.2g/kg diet) was insignificantly higher than control and other experimental groups being (297.50 *vs* 223.75 ; 241.25 and 224.38 , respectively). After 6 weeks of experiment, results in Table 4 indicated that the best gain value (343.13 g) was significantly ($p<0.05$) recorded by T_2 group (Addition of dietary arginine by 0.2g/kg diet) and control group compared to other experimental groups. The same trend was observed among total gain results which cleared that rabbit group fed dietary arginine by 0.4g/kg diet (T_3) achieved the best total gain value (1758.13g) compared with control(T1) and other experimental groups(T2;T4;T5) being (1548.57 and 1740.63 ; 1715.63 ; 1563.57 , respectively . But there is no significant differences in final body weight gain between control and experimental treatments which supplemented with different levels of dietary arginine. These results were in agreement with the findings obtained by (Delgado *et al.* 2018) who indicated that supplementation with Arg., Gln. or Arg. +Gln. did not affect growth performance because the amino acid levels were enough to meet rabbits post-weaning requirements (Colin, 1975). and this is in agreement with previous results (Baylos *et al.,* 2008; Chamorro *et al.,* 2010).

Table 4. Live body weight gain (LBWG) (g) of growing rabbits as affected by different
levels of dietary arginine. (Means ± SE).

Items***	Treatments**					Sig.
	T1 (Control)	T2 (0.2)	T3 (0.4)	T4 (0.6)	T5 (0.8)	
LBWG 2	176.88 ± 22.11	163.75 ± 22.1	211.88 ± 22.11	214.38 ± 22.1	206.88 ± 22.11	NS
LBWG 4	223.75 ± 26.49	297.50 ± 26.49	258.13 ± 26.49	241.25 ± 26.49	224.38 ± 26.49	NS
LBWG 6	312.86^{a} ±13.11	343.13^{a} ±12.26	233.75^{b}±12.26	208.75^{b} ±12.26	200^{b} ± 12.26	*
LBWG 8	72.43 ±17.22	80.63 ±16.11	80.63 ±16.11	86.25 ±16.11	52.86 ±17.22	NS
TG	1548.57	1740.63	1758.13 ±	1715.63	1563.57	N

	±72.1	±67.42	67.41	±67.41	±72.1	S

*a, b, c …….e values within a row with different superscripts significantly different ($p<0.05$). NS = not significant SE= standard error

** T_1=Control; T2 = Addition of arginine by 0.2/kg diet, T3 = Addition of arginine by 0.4/kg diet, T4 = Addition of arginine by 0.6/kg diet, T5= Addition of arginine by 0.8/kg diet.

***LBWG2: Live body weight gain after 2 weeks of experimental period; LBWG4: Live body weight gain after 4 weeks of experimental period; LBWG6: Live body weight gain after 6 weeks of experimental period; LBWG8: Live body weight gain after 8 weeks of experimental period; TG: Total Live body weight gain the experimental period

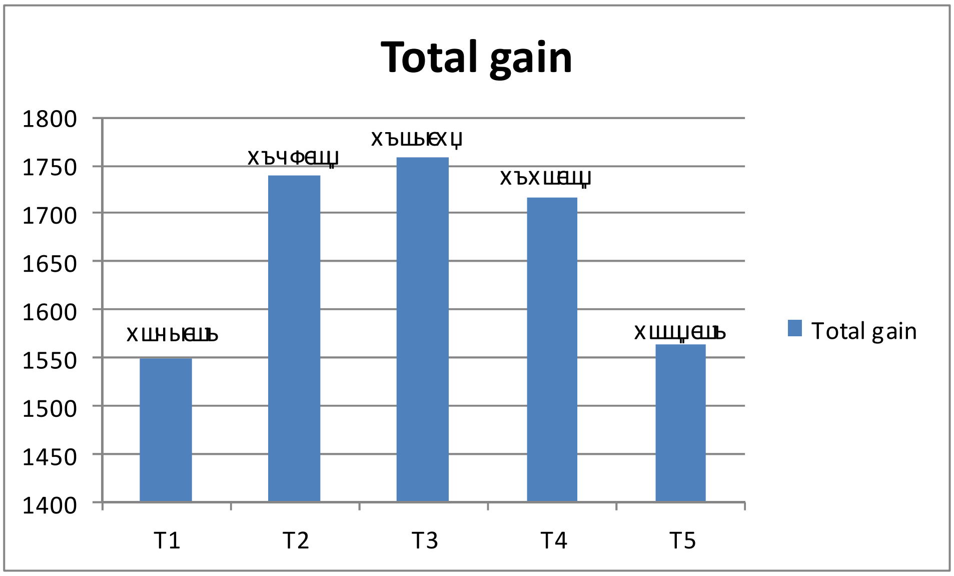

Fig.2. Total live body weight gain as affected by supplemented dietary different levels of dietary arginine

<u>Feed intake (FI)</u>

Feed intake data expressed as FI (g) are presented in (Table 5 and fig.3). Results of feed intake (g) after 2; 4 weeks and total feed intake during the experimental period indicated that groups fed different dietary levels of arginine were significantly ($p<0.05$) increased compared with control rabbit groups (T_1). After 6 and 8 weeks of the experimental period, FI results showed that rabbits group fed dietary arginine by 0.6g/kg diet (T_4) significantly ($p<0.05$) consumed the highest FI (1081.25 and 451.25 g), meanwhile, rabbits group fed dietary arginine by 0.8 g/kg diet (T_5) significantly ($p<0.05$) achieved the lowest feed intake (333.13g) .

In this concern, (Adamson and Fisher. 1976). indicated that Arg requirements of young rabbits might be particularly high. There is an increased requirement for nutrients (approximately 30% of intake) to maintain healthy/functional structure of intestinal mucosa (Burrin *et al.* 2000).

Table 5. Feed intake (FI) (g) of growing rabbits as affected by different levels of arginine. (Means ± SE)

Items ***	Treatments**					Sig.
	T_1 (Control)	T_2 (0.2)	T_3 (0.4)	T_4 (0.6)	T_5 (0.8)	
FI 2	465^{b} ±16.17	558.75^{a} ±16.17	557.5^{a}±16.17	560^{a}±16.17	547.5^{a}±16.17	*
FI 4	665^{b}±54.93	967.5^{a} ±54.93	932.5^{a}±54.93	946.25^{a} ±54.93	830^{a}±54.93	*
FI 6	883.13^{ab} ±21.84	793.75^{b}±82.89	1003.13^{ab} ±82.89	1081.25^{a} ±82.89	994.38^{ab} ±82.89	*
FI 8	345.63^{bc} ± 21.84	418.13^{a} ±21.84	404.38^{b} ±21.84	451.25^{a} ±21.84	333.13^{c} ±21.84	*
TFI	4799.38^{b}±212.84	5808^{a} ±212.84	5967^{a}±212.84	6148.75^{a} ±212.84	5607.50^{a} ±212.84	*

*a, b, values within a row with different superscripts significantly different ($p<0.05$). NS = not significant SE= standard error

**T_1=Control; T2 = Addition of arginine by 0.2/kg diet, T3 = Addition of arginine by 0.4/kg diet, T4 = Addition of arginine by 0.6/kg diet, T5= Addition of arginine by 0.8/kg diet.

***FI2: Feed intake after 2 weeks of experimental period; FI4: Feed intake after 4 weeks of experimental period; FI6: Feed intake after 6 weeks of experimental period; FI8: Feed intake after 8 weeks of experimental period; TFI: Total feed intake

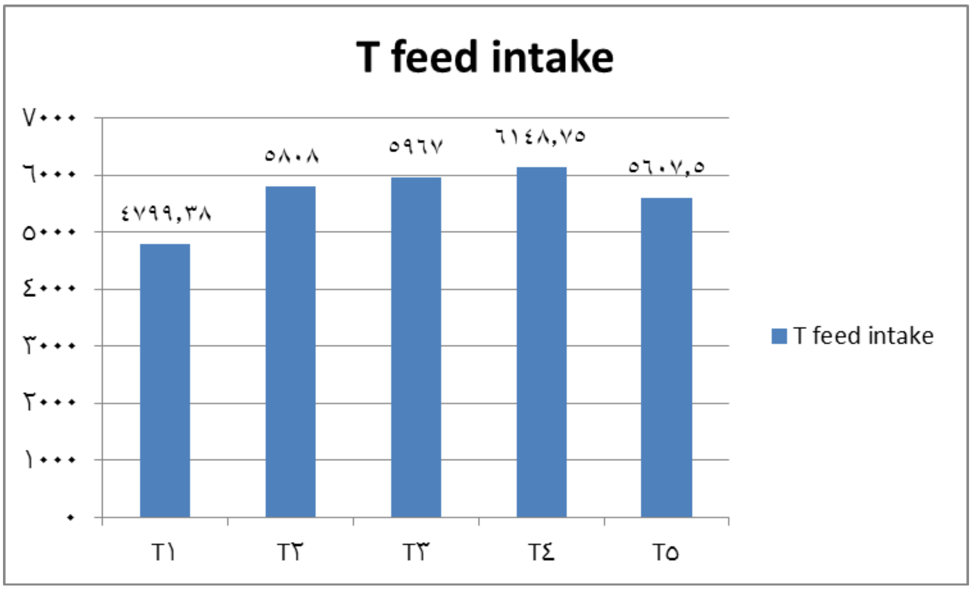

FIG.3.Total feed intake (g)/8wks as affected by supplemented dietary different Levels of dietary arginine

Feed conversion ratio (FCR).

Data in (Table 6 and fig.4) indicated that the best feed conversion (g feed/g gain) after 2 weeks of experiment was observed with T_3(2.72^b) followed by T_4 being 2.72 and 2.77, respectively, while the worst feed conversion was found for T_2 (4.10) followed by those fed T_5 (2.86) and T_1 (3.14). This improvement of FCR for these diets may be due to the higher body weight gain and lower feed intake caused by some improvements in digestive tract environment of experimental rabbits. The same results were observed after 8 weeks of feeding the experimental diets. Among the results of total feed conversion, Data indicated that insignificant differences between control and other experimental groups which ranged from 3.25 to 3.64 and no cleared effect for dietary arginine on FCR. These results were in agreement with those obtained by (Chamorro *et al* . 2010). who concluded that Diets containing a combination of 1% Gln and 0.5% Arg. were of little additional benefit. Also, arginine can be partially synthesized from Gln; however, the rate of synthesis might not be sufficient to meet Arg. requirements in young rabbits. (Wu *et al.,* 1994). On the other hand (Adamson and Fisher 1976). indicated that Arg. requirements of young rabbits might be particularly high.

Table 6. Feed conversion ratio (FCR) (g) of growing rabbits as affected by different levels of arginine. (Means ± SE).

Items* **	Treatments**					Sig.
	Control	T2 (0.2)	T3 (0.4)	T4 (0.6)	T5 (0.8)	
FCR 2	3.14^{ab} ± 0.42	4.10^a ± 0.42	2.72^b ± 0.42	2.77^b±0.42	2.86^{ab} ±0.42	*
FCR 4	3.13 ±0.72	3.30 ±0.72	4.57 ±0.72	4.66 ±0.72	4.03 ±0.72	NS
FCR 6	3.00^b±0.37	2.30^b ± 0.34	4.38^a ±0.34	5.35^a ± 0.34	5.14^a ±0.34	*
FCR 8	18.24 ±4.84	7.04 ± 4.53	7.01 ±4.53	5.90 ±4.53	12.99 ± 4.84	NS
TFC	3.25 ±0.16	3.35 ±0.15	3.45 ±0.15	3.62 ±0.15	3.64 ±0.16	NS

*a, b, values within a row with different superscripts significantly different ($p<0.05$). NS = not significant SE= standard error.

** T_1=Control; T_2 = Addition of arginine by 0.2/kg diet, T_3 = Addition of arginine by 0.4/kg diet, T_4 = Addition of arginine by 0.6/kg diet, T_5= Addition of arginine by 0.8/kg diet.

*** FCR_2: Feed conversion ratio after 2 weeks of experimental period; FCR_4: Feed conversion ratio after 4 weeks of experimental period; FCR_6: Feed conversion ratio after

6 weeks of experimental period; FCR_8: Feed conversion ratio after 8 weeks of experimental period; TFC: Total Feed conversion ratio.

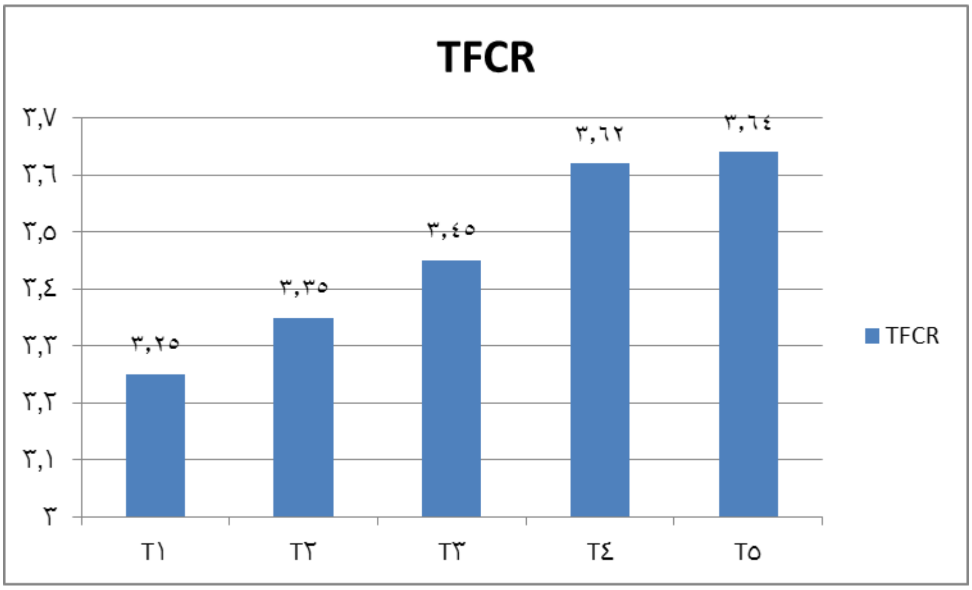

Fig. 4. Average FCR after 8 weeks as affected by supplemented dietary different Levels of dietary arginine.

Conclusion:

Therefore, it can be concluded that dietary arginine by 0.4g/kg diet (T_3) achieved better growth performance of growing rabbits.

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