

## **EFFECT OF DIETARY SUPPLEMENTATION WITH NANO-SELENIUM OR GLUTAMINE ON GROWTH PERFORMANCE AND CARCASS CHARACTERISTICS OF GROWING RABBITS FED DIETS CONTAINING TWO CRUDE PROTEIN LEVELS**

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### **ABSTRACT**

In this experiment, fifty four, 6-week-old weaned New Zealand White rabbits were used to investigate the impact of dietary supplementation with nano-selenium or glutamine on growth performance and carcass characteristics of growing rabbits fed diets containing two crude protein levels. A factorial experiment (2x3), being two levels of dietary crude protein (16 and 14 %) without or with organic nano-Se (0.1 mg/kg feed) and glutamine (10 g/kg feed) were performed. Rabbits were randomly distributed into 6 equal experimental groups; each contained three equal replications. Each replicate group was housed in a separate cage and fed their respective experimental diets from 6 to 15 weeks of age. Feed and water were offered ad libitum throughout the experimental period. Apart from the effect of feed supplements, rabbits fed the normal crude protein level (16%) achieved significantly better growth performance (final live body weight, daily weight gain, daily feed intake and feed conversion ratio) while carcass traits were not affected compared with those of rabbits fed the low crude protein level. But dietary supplements (nano-Se or glutamine) did not significantly affect criteria of growth performance or dressing-out percentage of rabbits. Dietary protein by added supplements interaction did not significantly affect traits, investigated in the present study, the whole experimental period. Based on the present results, it can be concluded that the crude protein level (14%) is inadequate for attaining normal growth of post-weaning New Zealand White rabbits. However, dietary supplementation with nano-selenium or glutamine proved to be ineffective.

**Keywords:** Rabbits, performance, nano - selenium, glutamine, carcass traits.

### **INTRODUCTION**

In all livestock, the current trend is to maximize N retention by adjusting dietary protein level accordingly to a balanced amino acid supply and thus avoiding any N excess in the diet. In rabbits, about two thirds of ingested N is excreted (Xiccato *et al.*, 2006) and therefore a reduction in dietary protein level may help to minimize the N excretion to the environment. Furthermore, this reduction may also help to control the growth of pathogenic bacteria that promote higher mortality in the post-weaning rabbits. Feeding growing rabbits on dietary protein levels less than 16 % may adversely affect their growth performance during the post-weaning period.

Application of nanotechnology in the agri-food sector potentially offers huge benefits for both consumers and manufacturers in a wide range of applications. Many of these benefits result from the ultrafine dimensions of nano-particles, which enable them to reach new locations in the body, and thus can perform their biological functions more efficiently (Kaiser, 2007). According to the recent literature, consumers are more concerned about food produced by the application of nanotechnology (Siegrist *et al.* 2008).

It has been reported that dietary supplementation of Se at 0.1 ppm produced an improvement in fetal and birth weight of offspring in rabbit does but the level of 0.3 ppm was not effective (Struklec *et al.*, 1994). Selenium passes from the blood into the tissues and is mainly concentrated on proteins particularly selenocysteine and glutathione peroxidase in kidneys, liver, pancreas, and spleen and to a small extent in muscles, bones and brain. In addition, selenium plays another vital role in the thyroid, as a part of glutathione peroxidase (Struklec *et al.*, 1994).

Glutamine is the most abundant amino acid in the plasma, where it functions as a non-toxic nitrogen vehicle (Carrascosa *et al.*, 1984) and a respiratory fuel (Moreadith and Lehninger, 1984). Thus, it is not surprising that glutamine behaves as a key nutrient for rapidly dividing cells. Recent studies showed that specific nutrients such as amino acids can promote gastro-intestinal integrity (Clifford, 2006).

The objective of this study was to evaluate the effect of single addition of nano-selenium (0.1 ppm) and glutamine (1.0%) to diets containing two levels of crude protein (16 and 14%) on growth performance and economical efficiency of growing rabbits.

## **MATERIALS AND METHODS**

The experimental work of the present study was carried out at the Poultry Research Unit, Agricultural Research and Experimental Center, Faculty of Agriculture, Mansoura University.

### **Experimental animals and management.**

Fifty four, 6 weeks old weaning New Zealand White (NZW) rabbits were used in this study. Rabbits were randomly distributed into 6 equal experimental groups; each contained three equal replications. Each replicate group was housed in a separate cage with the following dimensions (50x50x45 cm) for length, width and height, respectively. Rabbits were fed their respective experimental diets from 6 to 15 weeks of age. Feed and water were offered *ad libitum* throughout the experimental period. The values of live body weight and feed intake were recorded on a replicate group basis and thus daily weight gain and feed conversion were also calculated.

### **Feed supplements**

In the present study, the organic nano-selenium and glutamine were processed and supplied by the Egyptian National Research Center. The product of organic nano-Se, tested herein, contained 5000 ppm Se of which 2.0 g were added to 100 kg of the basal diet to contain 0.1 mg Se/ kg, while glutamine was added at a level of 10 g/kg feed (equivalent to 1.0% of the

diet).

**Experimental rations and design.**

An experiment (2×3) was conducted with factorial arrangement of treatments, being two levels of dietary crude protein (16 and 14 %) without or with organic nano-Se (0.1 mg/kg feed) and glutamine (10 g/kg feed). Thus, six experimental rations were formulated and used. The experimental groups of rabbits were fed their respective experimental rations in pelleted form. Two basal rations were used in this study; the first containing 16% CP which served as a control (R1) and the second one contained 14% (R4). The composition and calculated analysis of the basal diets are presented in Table 1, according to NRC (1977) recommendations.

**Table 1: Ingredients and chemical composition of the basal diets**

Feed ingredients	Basal diets	
	Normal protein (control)	Low protein
	(16% CP)	( 14% CP)
Yellow corn	14	-
Barley	8.0	25.0
Soybean meal	7.0	-
Wheat bran	26.2	40.0
Alfalfa hay	40.0	30.0
Molasses	2.0	2.0
Dicalcium phosphate	1.2	1.2
Limestone	1.0	1.2
Sodium chloride	0.2	0.2
Vit. Min. Premix	0.4	0.4
Total	100	100
Calculated analysis (as fed, NRC, 1977)		
Digestible energy (Kcal/kg)	2687	2625
Crude Protein (%)	16.20	14.00
Crude Fiber (%)	13.20	12.96
Ether extract (%)	3.00	2.98
Calcium (%)	1.20	1.20
Available phosphorus (%)	0.45	0.52

\*Premix: Each 2 kg of the premix contained Vit A, 10.000000 IU; Vit D<sub>3</sub>, 2000000 IU, Vit E, 10000 mg; Zinc, 3000 mg, Manganese, 2000 mg; Iron, 4000 mg; Copper, 1000 mg; Iodine, 100 mg; Selenium, 10 mg; Cobalt, 10 mg; Sodium, 23000 mg; and Magnesium, 2000 mg; CaCo<sub>3</sub>: added to 2.0 kg .

The control ration was supplemented with organic nano-Se and glutamine and termed R2 and R3, respectively. The low crude protein basal ration was supplemented with organic nano-Se and glutamine and termed R5 and R6, respectively.

**Growth performance parameters:**

Live body weights of the experimental rabbits were individually recorded the start of the experiment and on a weekly basis thereafter, estimated to the nearest five grams in the early morning before receiving any feed or water. Body weight gain and feed conversion ratio were also calculated on a replicate group basis. Mortality of rabbits was also monitored and recorded daily.

#### **Carcass evaluation:**

At the end of the experimental period, three rabbits from each experimental treatment were randomly chosen and slaughtered to study carcass characteristics. Rabbits were fasted for approximately 18 hours before slaughtering, individually weighed and slaughtered according to the rules of Islamic religion. Slaughter data were immediately recorded for the individual rabbits. Skinning was carried out by removing the skin including tail and legs. Carcasses were eviscerated and the different organs (e.g. Liver, heart, kidneys, viscera and lungs) were removed and immediately weighed to the nearest gram. Absolute weights of dressed carcass and organs and dressing-out percentage were estimated.

#### **Statistical analysis:**

Statistical analysis of data was carried out using the General Linear Model Program of SAS (2000). Differences among means of treatments were identified by Duncan's Multiple Range Test (Duncan, 1955). The obtained data for productive traits of different groups of rabbits were subjected to factorial analysis of variance according to the following mathematical model:

$$Y_{ijk} = \mu + T_i + L_j + TL_{ij} + e_{ijk}$$

Where;  $Y_{ijk}$  = Observation of the tested factor,  $\mu$  = Overall mean,  $T_i$  = The effect of CP level,  $L_j$  = The effect of supplements,  $TL_{ij}$  = The interaction between CP level and supplements and  $e_{ijk}$  = experimental random error.

## **RESULTS AND DISCUSSION**

#### **Live body weights and weight gain of growing rabbits:**

The effects of feeding diets containing two levels of crude protein and supplemented with nano-Se or glutamine on live body weights and weight gain of growing rabbits are presented in Tables 2 and 3, and the Figure 1. No deaths of rabbits occurred during the duration of this study.

Apart from the effect of feed supplements, dietary protein level did not significantly ( $P > 0.05$ ) affect live body weights (LBW) of rabbits up to the 10<sup>th</sup> week of age (Table 2). However, rabbits fed the normal dietary protein level (*i.e.* 16% CP) achieved significantly ( $P \leq 0.05$ ) higher LBW compared with those of rabbits fed the low protein level, irrespective of the effect of feed supplements (Table 2). Regardless of the effect of dietary protein level, addition of nano-Se or glutamine had no significant effect ( $P > 0.05$ ) on live body weights of rabbits at different ages of the experimental period, from 6 to 15 weeks of age. Dietary protein by added supplements interaction did not significantly affect live body weight of growing rabbits throughout the whole experimental period from 6 to 15 weeks of age.

As regards the effects of dietary treatments, rabbits fed the diets containing the normal crude protein level (16%) exhibited significantly higher ( $P \leq 0.05$ ) body weight gain during the 8<sup>th</sup>, 11<sup>th</sup>, 15<sup>th</sup> and during the entire experimental period (6-15 weeks of age), regardless of the effect of dietary supplements. Apart from the effect of dietary protein level, addition of nano-Se or glutamine had no significant effect ( $P > 0.05$ ) on body weight gain

(BWG) of rabbits at all age intervals and the whole experimental period, except at period from 10-11 weeks of age in which nano-se caused superior daily weight gain of rabbits compared with their control counterparts. Dietary protein by added supplements interaction did not significantly affect live body weight of growing rabbits throughout the whole experimental period, except at period from 10-11 weeks of age in which nano-se produced better daily weight gain of rabbits compared with the control group.

The lack of significant differences in LBW and BWG of rabbits fed diets supplemented with glutamine is in agreement with the results of Chamorro *et al.* (2010), who reported that dietary supplementation with glutamine did not affect average daily gain of growing rabbits. Also, Dokoupilova *et al.* (2007) noted that added dietary Se did not significantly affect BWG of growing rabbits. The present results are also in harmony with the findings of Cai *et al.* (2012), who observed no effect of added dietary nano-Se up to 2.0 mg/kg on body weight gain of broiler chicks during both starter and grower phases. Independently from the effect of dietary treatments, means of daily weight gain, obtained in the present study, are in harmony with those reported by Schiere (2004), who found that growth rates around 15-20 grams per day are common in rabbits reared at the tropics, even though it is possible to obtain 30-40 grams per day on very good feeds.

**Table 2: Effect of dietary supplementation with Nano-Selenium or glutamine on live body weight of growing rabbits fed diets containing two crude protein levels from 6 to 15 weeks of age**

Dietary treatments	Live body weight (g) at ages (in weeks)									
	6	7	8	9	10	11	12	13	14	15
Crude protein (A):										
16% (A1)	746	830	945	1074	1244	1383 <sup>a</sup>	1590 <sup>a</sup>	1708 <sup>a</sup>	1851 <sup>a</sup>	1984 <sup>a</sup>
14% (A2)	750	835	911	1034	1198	1317 <sup>b</sup>	1491 <sup>b</sup>	1597 <sup>b</sup>	1722 <sup>b</sup>	1816 <sup>b</sup>
SEM	10.4	12.9	18.8	26	19.3	20	20.48	20	23	27
Significance	NS	NS	NS	NS	NS	*	**	**	**	**
Supplements (B):										
0.0 (B1)	746	831	918	1051	1220	1337	1551	1654	1795	1903
0.1 Se (B2)	757	842	942	1056	1234	1374	1573	1688	1829	1945
1.0 glutamine (B3)	742	827	923	1055	1208	1339	1499	1614	1737	1853
SEM	12.7	15.8	23	31.4	24	24	25.1	25	28	33
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
AB Interaction:										
A1B1 = R1	742	815	914	1053	1203	1339	1565	1682	1843	1983
A1B2 = R2	763	842	975	1080	1272	1426	1627	1745	1887	2019
A1B3 = R3	734	835	945	1089	1257	1385	1579	1696	1823	1949
A2B1 = R4	750	847	921	1050	1237	1336	1536	1626	1746	1824
A2B2 = R5	752	841	910	1031	1196	1322	1519	1631	1770	1870
A2B3 = R6	749	818	901	1020	1159	1294	1419	1533	1651	1756
SEM	18.0	22.3	32	44.5	33.4	34	35.5	35	39.1	47
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

a-b: For each of the main effects, means within the same column with different superscripts differ significantly ( $P \leq 0.05$ ). SEM=standard error of means.

**Table 3: Effect of dietary supplementation with Nano-Selenium or glutamine on daily body weight gain of growing rabbits fed diets containing two crude protein levels from 6 to 15 weeks of age**

Dietary Treatments	Daily weight gain (g)									
	6-7 wk	7-8 wk	8-9 wk	9-10 wk	10-11 wk	11-12 wk	12-13 wk	13-14 wk	14-15 wk	6-15 wk
Crude protein (A):										
16% (A1)	12.0	16.32 <sup>a</sup>	18.46	24.35	19.84 <sup>a</sup>	29.60	16.78	20.49	18.94 <sup>a</sup>	19.64 <sup>a</sup>
14% (A2)	12.22	10.75 <sup>b</sup>	17.57	23.40	17.10 <sup>b</sup>	24.84	15.80	17.97	13.43 <sup>b</sup>	16.93 <sup>b</sup>
SEM	1.446	1.207	1.488	1.382	0.535	2.903	0.986	1.823	1.196	0.404
Significance	NS	**	NS	NS	**	NS	NS	NS	**	**
Supplements (B):										
0.0 (B1)	12.12	12.40	19.10	24.12	16.71 <sup>b</sup>	30.48	14.79	20.12	15.50	18.37
0.1 Se (B2)	12.05	14.40	16.19	25.52	19.98 <sup>a</sup>	28.43	16.45	20.02	16.57	18.85
1. 1.0 glutamine (B3)	12.17	13.79	18.76	21.98	18.71 <sup>ab</sup>	22.76	16.52	17.55	16.48	17.64
EM	1.771	1.478	1.823	1.692	0.655	3.555	1.208	2.232	1.465	0.495
Significance	NS	NS	NS	NS	*	NS	NS	NS	NS	NS
AB Interaction:										
A1B1 = R1	10.33	14.24	19.81	21.48	19.33	32.38	16.71	23.00	19.91	19.96
A1B2 = R2	11.29	19.0	15.05	27.48	22.00	28.71	16.86	20.29	18.86	19.95
A1B3 = R3	14.38	15.71	20.52	24.10	19.18	27.71	16.71	18.19	18.05	19.29
A2B1 = R4	13.91	10.57	18.38	26.76	14.10	28.57	12.86	17.24	11.10	17.05
A2B2 = R5	12.81	9.81	17.33	23.57	17.95	28.14	16.05	19.76	14.29	17.75
A2B3 = R6	9.95	11.86	17.00	19.86	19.24	17.81	16.33	16.91	14.91	15.98
SEM	2.504	2.090	2.578	2.393	0.926	5.027	0.505	3.157	2.072	0.699
Significance	NS	NS	NS	NS	*	NS	NS	NS	NS	NS

a-b: For each of the main effects, means within the same column with different superscripts differ significantly ( $P \leq 0.05$ ). SEM=standard error of means.

In disagreement with the present results, Ebeid *et al.* (2012) reported that feeding male California rabbits on diets supplemented with organic Se (0.15 or 0.30 ppm) resulted in an increase in live body weight and daily weight gain compared with their control counterparts. Similarly, Malayoglu *et al.* (2009) fed broiler chicks from day-old to 42 days of age on diets supplemented with organic Se (Se-enriched yeast) at 0.15 or 0.30 mg/kg and found a significant improvement in body weight and body weight gain due to feeding the organic Se at 0.30 mg/kg diet but not at the level of 0.15 mg/kg. Working with growing pullets, Mohapatra *et al.* (2014) found that feeding diets enriched with nano-Se up to 0.30 mg/kg from 9 to 20 weeks of age produced an improvement in live body weight of pullets when the level of added nano-Se reached 0.60 mg/kg body weight of pullets was negatively affected. In addition, Hanafy *et al.* (2009) evaluated the response of Bandarah laying hens to feeding diets fortified with organic Se up to 0.30 mg/kg from 40 to 60 weeks of age and found that live body weight of hens increased significantly compared with the control group.

#### **Feed intake and feed conversion ratio of growing rabbits:**

The effects of feeding diets containing two levels of crude protein and supplemented with nano-Se or glutamine on daily feed intake (DFI) and feed conversion ratio (FCR) of growing rabbits are presented in Tables 4 and 5, respectively. Apart from the effect of feed supplements, dietary protein level exerted a significant effect ( $P \leq 0.05$ ) on DFI of rabbits during the periods of 9-

10, 10-11, 11-12, 12-13, 13-14, 14-15 weeks of age (Table 4). During the entire experimental period (from 6 to 15 weeks of age) DFI of rabbits fed the low crude protein diet was significantly lower ( $P<0.01$ ) than that of the control group, irrespective of the effect of added supplements (Table 4).

With regard to the effect of dietary protein level on FCR, dietary protein level had a significant effect ( $P\leq 0.05$ ) on FCR of growing rabbits during the periods of 7-8 and 10-11 weeks of age and during the whole experimental period (Table 5), irrespective of the effect of dietary supplements. During the entire experimental period, FCR of rabbits fed the normal crude protein level (16%) was significantly better ( $P<0.05$ ) than that of rabbits fed the low crude protein level (14%), regardless of the effect of added supplements (Table 5).

**Table 4: Effect of dietary supplementation with nano-selenium or glutamine on daily feed intake of growing rabbits fed diets containing two crude protein levels from 6 to 15 weeks of age**

Dietary treatments	Daily feed intake (g)									
	6-7 wk	7-8 wk	8-9 wk	9-10 wk	10-11 wk	11-12 wk	12-13 wk	13-14 wk	14-15 wk	6-15 wk
Crude protein (A):										
16% (A1)	45.39	50.48	62.22	71.57 <sup>a</sup>	73.26 <sup>b</sup>	111.44 <sup>a</sup>	103.17 <sup>a</sup>	104.62 <sup>a</sup>	110.77 <sup>a</sup>	81.43 <sup>a</sup>
14% (A2)	45.88	48.60	60.12	68.30 <sup>b</sup>	83.30 <sup>a</sup>	105.67 <sup>b</sup>	92.06 <sup>b</sup>	93.94 <sup>b</sup>	94.36 <sup>b</sup>	76.91 <sup>b</sup>
SEM	0.633	0.702	0.737	0.724	2.733	1.027	2.565	2.580	3.547	0.443
Significance	NS	NS	NS	*	*	**	*	*	**	**
Supplements (B):										
0.0 (B1)	44.5	48.73	59.57	69.37	80.77	109.17	95.78	100.60	102.15	78.96
0.1 Se (B2)	47.08	51.45	61.55	71.50	71.02	109.83	99.77	101.0	104.65	79.76
1.1.0glutamine (B3)	45.32	48.43	62.40	68.93	83.05	106.67	97.28	96.25	100.88	78.80
SEM	0.775	0.860	0.903	0.887	3.347	1.258	3.141	3.160	4.344	0.543
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
AB Interaction:										
A1B1 = R1	44.67	49.27	59.87	70.10	68.93	112.33	102.90	104.83	112.67	80.62
A1B2 = R2	46.53	52.40	62.73	72.73	69.43	110.00	108.33	111.67	114.87	83.19
A1B3 = R3	44.97	49.77	64.07	71.87	81.40	112.00	98.27	97.37	104.77	80.50
A2B1 = R4	44.33	48.20	59.27	68.63	92.60	106.00	88.67	96.37	91.63	77.30
A2B2 = R5	47.63	50.50	60.37	70.27	72.60	109.67	91.20	90.33	94.43	76.33
A2B3 = R6	45.67	47.10	60.73	66.00	84.7	101.33	96.30	95.13	97.00	77.11
SEM	1.096	1.216	1.277	1.254	4.734	1.780	4.442	4.468	6.143	0.768
Significance	NS	NS	NS	NS	NS	*	NS	NS	NS	NS

a-b: For each of the main effects, means within the same column with different superscripts differ significantly ( $P\leq 0.05$ ). SEM=standard error of means.

Regardless of the effect of dietary protein level, addition of nano-Se or glutamine had no significant effect ( $P>0.05$ ) on DFI or FCR of rabbits throughout the experimental period, except during the period of 10-11 weeks of age in which rabbits fed the nano-Se-supplemented diets exhibited significantly better ( $P<0.01$ ) FCR compared with that of the control group. Dietary protein by added supplements interaction did not significantly affect DFI and FCR of growing rabbits throughout the whole experimental period from 6 to 15 weeks of age.

**Table 5: Effect of dietary supplementation with Nano-Selenium or glutamine on feed conversion ratio of growing rabbits fed diets containing two crude protein levels from 6 to 15 weeks of age**

Dietary treatments	Feed conversion ratio (g feed: g gain)									
	6-7 wk	7-8 wk	8-9 wk	9-10 wk	10-11 wk	11-12 wk	12-13 wk	13-14 wk	14-15 wk	6-15 wk
Crude protein (A):										
16% (A1)	4.42	3.27 <sup>b</sup>	3.70	3.07	3.73 <sup>b</sup>	4.13	6.28	5.58	6.03	4.16 <sup>b</sup>
14% (A2)	4.15	4.80 <sup>a</sup>	3.48	2.98	5.06 <sup>a</sup>	5.55	6.29	5.42	7.29	4.57 <sup>a</sup>
SEM	0.651	0.363	0.330	0.206	0.233	1.188	0.398	0.576	0.443	1.05
Significance	NS	*	NS	NS	**	NS	NS	NS	NS	*
Supplements (B):										
0.0 (B1)	3.79	4.29	3.34	3.01	5.15 <sup>a</sup>	3.67	6.57	5.33	7.02	4.32
0.1 Se (B2)	4.15	4.01	4.05	2.89	3.61 <sup>b</sup>	3.99	6.26	5.46	6.79	4.25
1.0 glutamine (B3)	4.90	3.81	3.37	3.19	4.43 <sup>ab</sup>	6.85	6.03	5.70	6.17	4.52
SEM	0.798	0.445	0.405	0.252	0.285	1.455	0.488	0.705	0.542	0.129
Significance	NS	NS	NS	NS	**	NS	NS	NS	NS	NS
AB Interaction:										
A1B1 = R1	4.89	3.73	3.35	3.43	3.58	3.62	6.20	4.99	5.67	4.03
A1B2 = R2	4.46	2.84	4.61	2.78	3.16	4.09	6.59	6.34	6.59	4.17
A1B3 = R3	4.40	3.24	3.14	3.01	4.46	4.68	6.07	5.39	5.82	4.18
A2B1 = R4	3.20	4.84	3.34	2.58	6.71	3.72	6.94	5.65	8.39	4.54
A2B2 = R5	3.84	5.19	3.49	3.00	4.07	3.90	5.94	4.58	6.99	4.31
A2B3 = R6	5.40	4.37	3.61	3.37	4.40	9.01	5.99	6.01	6.51	4.83
SEM	1.128	0.629	0.572	0.356	0.403	2.058	0.690	0.997	0.767	0.182
Significance	NS	NS	NS	NS	**	NS	NS	NS	NS	NS

a-b: For each of the main effects, means within the same column with different superscripts differ significantly ( $P \leq 0.05$ ). SEM=standard error of means.

The interaction between dietary protein level and added supplements on DFI of growing rabbits was insignificant, except during the period of 11-12 weeks of age which was significant ( $P < 0.05$ ). Dietary protein by added supplements interaction did not significantly affect FCR of growing rabbits, except during the period of 10-11 weeks of age which was significant ( $P < 0.01$ ).

The present results are in agreement with the findings reported by Chamorro *et al.* (2007), who found that dietary supplementation with glutamine did not affect average daily feed intake or feed efficiency of growing rabbits during the entire fattening period. Also, Dokoupilova *et al.* (2007) noted that added Se (Se-enriched yeast) did not affect FCR of growing rabbits. The present results also agree with the findings of Cai *et al.* (2012), who observed no effect of added dietary nano-Se up to 2.0 mg/kg on feed intake of broiler chicks during both starter and grower phases. Similar results were obtained by Malayoglu *et al.* (2009), who found that broiler chicks fed diets supplemented with organic Se (Se-enriched yeast) at 0.15 or 0.30 mg/kg achieved comparable means of feed intake and feed conversion ratio to those of the control chicks. With laying hens, Hanafy *et al.* (2009) observed no significant differences in feed intake of Bandarah pullets fed diets fortified with organic Se up to 0.30 mg/kg compared with the control group.



On the other hand, Ebeid *et al.* (2012) reported that feeding male California rabbits on diets supplemented with organic Se (0.15 or 0.30 ppm) led to inferior feed conversion ratios compared with their control counterparts. Working with growing pullets, Mohapatra *et al.* (2014) found that feeding diets enriched with nano-Se up to 0.30 mg/kg from 9 to 20 weeks of age positively affected feed conversion ratio of pullets but when the level of added nano-Se reached 0.60 mg/kg FCR was negatively affected. In general, the inconsistent results among different studies in the scientific literature regarding the responsiveness of growing animals to dietary supplementation with nano-selenium or glutamine could be related to a variety of factors such as species, genotype, age, diet composition (amino acid profile), duration of study, processing of nano-Se and its carrier, and added dose etc.

**Carcass characteristics of growing rabbits:**

The effects of feeding diets containing two levels of crude protein and supplemented with nano-Se or glutamine on carcass characteristics of growing rabbits are presented in Table 6.

Apart from the effect of feed supplements, dietary protein level exerted a significant effect ( $P \leq 0.05$ ) on absolute weights of skin, head, liver and kidneys but other carcass traits were not affected (Table 6). Apart from the effect of feed supplements, feeding the low crude protein level (14%) negatively affected ( $P \leq 0.05$ ) weights of skin, head and kidneys of rabbits compared with those of the control group. Regardless of the effect of dietary protein level, addition of glutamine led to a significant reduction in weights of skin, viscera, head, liver and kidneys but added nano-Se had no effect on all carcass traits measured compared with the control group. Dietary protein by added supplements interaction did not significantly affect all carcass traits examined in of 15-week-old growing rabbits.

The absence of significant differences in dressing-out percentage of the experimental rabbits agrees with the findings of Dokoupilova *et al.* (2007), who noted that added Se (Se-enriched yeast) did not affect dressing-out percentage of growing rabbits. In disagreement with the present results, Ebeid *et al.* (2012) reported that feeding male California rabbits on diets supplemented with organic Se (0.15 or 0.30 ppm) led to an improvement in both hot carcass weight and dressing percentage compared with their control counterparts.



Fig (1)

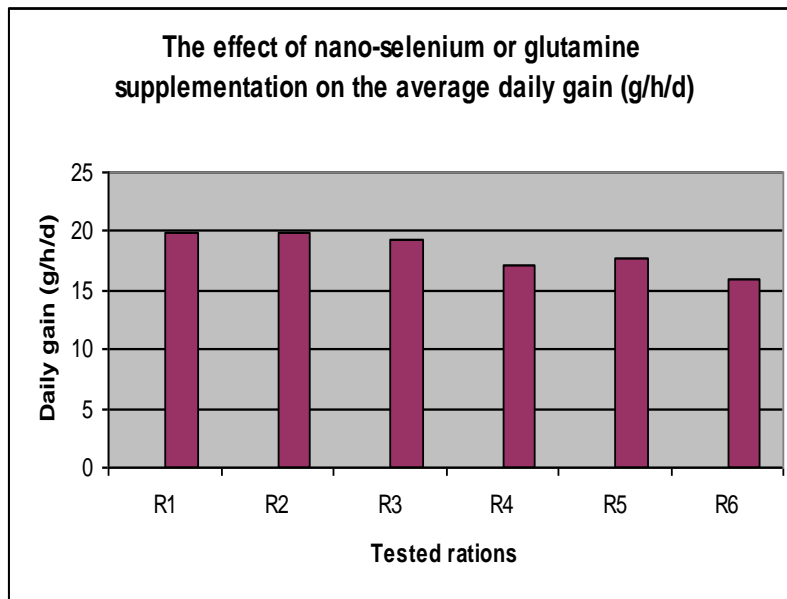
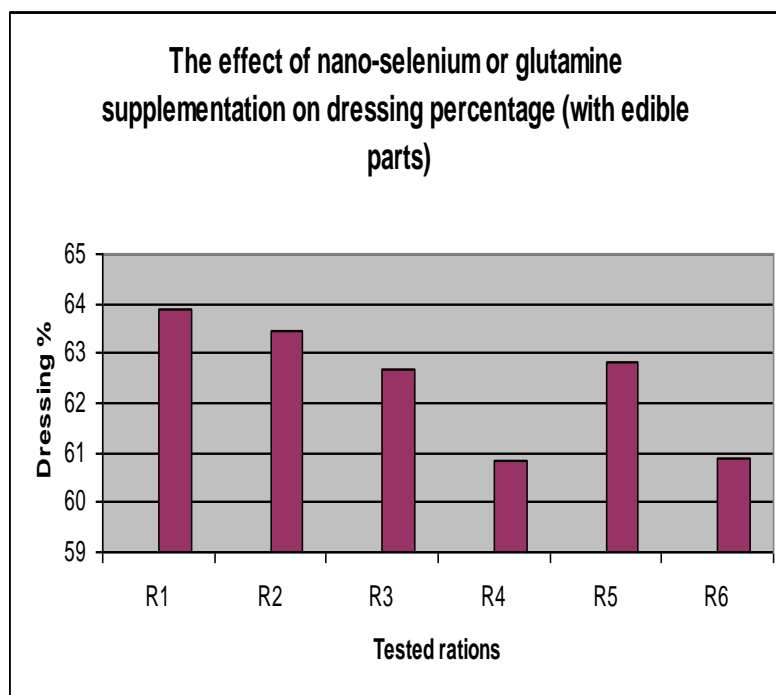


Fig (2)



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تأثير إضافة النانو سيلينيوم أو الجلوتامين على الأداء الانتاجي وخصائص الذبيحة للأرانب النامية المغذاه على علائق محتوية على مستويين من البروتين.  
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استخدم عدد ٥٤ أرنب (نيوزيلندي أبيض) عمر ٦ اسابيع حديثي الفطام في هذه التجربة لدراسة تأثير إضافة نانو سيلينيوم أو الجلوتامين على نمو وخصائص الذبيحة للأرانب النامية و التي تم تغذيتها على علائق تحتوى على مستويين من البروتين.  
أجريت التجربة العاملية (٣×٢) حيث تحتوى على مستويين من البروتين (١٦، ١٤ %) وبدون أو بإضافة نانو سيلينيوم (١، ملجم/ كجم عليقه) و جلوتامين (١٠ جرام/ كيلو جرام عليقة) وزعت الارانب عشوائيا ١ ، ٦ مجاميع تجريبية حيث تحتوى كل منها على ثلاث مكررات بالتساوى فى هذه المجاميع و تم تغذية كل مجموعة على أى من هذه العلائق التجريبية خلال الفترة من ٦ - ١٥ اسبوع من عمر الارانب و كان الغذاء و الماء أمام الارانب بصفة مطلقه خلال فترة التجربة.  
أشارت تأثير الإضافات الى ان الأرانب التي غذيت على عليقة (١٦% بروتين) بدون إضافات أدت الى تحسن معنوى على الأداء الإنتاجي (وزن الجسم النهائى ، الزيادة اليومية ، كمية المأكول اليومي ، معدل التحول الغذائى) بينما صفات الذبيحة لم تتأثر معنويا مقارنة بالتغذية على مستوى منخفض من البروتين و لكن إضافة النانو سيلينيوم أو الجلوتامين لم تؤثر معنويا على الأداء الانتاجى أو النسبة المئوية لصفات الذبيحة بينما التأثير المشترك لمستوى البروتين مع الإضافات العلفية لم تؤثر معنويا على جميع الصفات المدروسة خلال فترة التجربة.  
و يمكن الأستنتاج من هذه الدراسة ان مستوى البروتين ١٤% غير كافي للنمو الطبيعي للأرانب النامية للنيوزلاندى الابيض فى مرحلة ما بعد الفطام بينما أضافة النانو سيلينيوم أو الجلوتامين لم تظهر تأثير معنوى على الأداء الانتاجى تحت ظروف هذه الدراسة.







**Table 6: Effect of dietary supplementation with Nano-Selenium or glutamine on some carcass characteristics of 15-week-old growing rabbits fed diets containing two crude protein levels**

Dietary treatments	LBW (g)	Dressing (%)	Skin wt. (g)	Lungs wt. (g)	Viscera wt. (g)	Head wt. (g)	Liver wt. (g)	Heart wt.(g)	Kidneys wt. (g)	Total dressing (%)
Crude protein (A):										
16% (A1)	2212 <sup>a</sup>	58.31	379 <sup>a</sup>	15.89	333	112.0 <sup>a</sup>	86.1 <sup>a</sup>	8.33	17.6 <sup>a</sup>	61.51
14% (A2)	1970 <sup>b</sup>	57.26	338 <sup>b</sup>	12.89	317	84.4 <sup>b</sup>	65.6 <sup>b</sup>	6.33	12.6 <sup>b</sup>	63.36
SEM	33.2	0.79	8	1.111	11	6.59	5.08	0.97	1.14	0.76
Significance	**	NS	**	NS	NS	*	*	NS	**	NS
Supplements (B):										
0.0 (B1)	2223 <sup>a</sup>	58.00	383 <sup>a</sup>	13.33	354 <sup>a</sup>	97.3 <sup>ab</sup>	75.8 <sup>ab</sup>	6.83	14.7 <sup>ab</sup>	62.37
0.1 Se (B2)	2153 <sup>a</sup>	58.85	372 <sup>a</sup>	16.83	325 <sup>ab</sup>	115 <sup>a</sup>	88.3 <sup>a</sup>	9.33	17.5 <sup>a</sup>	63.13
1. 1.0 glutamine (B3)	1897 <sup>b</sup>	57.50	321 <sup>b</sup>	13.00	295 <sup>b</sup>	82.2 <sup>b</sup>	63.3 <sup>b</sup>	5.83	13.0 <sup>b</sup>	61.80
SEM	41	0.96	9.3	1.36	13	8.07	6.22	1.19	1.39	0.93
Significance	**	NS	**	NS	*	*	*	NS	NS	NS
AB Interaction:										
A1B1 = R1	2318	59.40	398	11.67	345	105.0	83.3	6.66	15.0	63.90
A1B2 = R2	2263	57.50	393	20.0	352	135.0	102	11.7	21.7	63.47
A1B3 = R3	2053	58.3	345	16.0	302	96.0	73.3	6.66	16.0	62.70
A2B1 = R4	2128	56.60	367	15.0	363	89.7	68.3	7.0	14.3	60.83
A2B2 = R5	2042	58.20	350	13.67	298	95.3	75.0	7.0	13.3	62.80
A2B3 = R6	1740	56.97	297	10.00	288	68.3	53.3	5.0	10.0	60.90
SEM	57.5	1.36	13	1.925	18.6	11.42	8.79	1.68	1.97	1.32
Significance	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

a-b: For each of the main effects, means within the same column with different superscripts differ significantly (P<0.05). SEM=standard error of means.

100. \*\*Total dressing percentage= (carcass yield + edible organs/live body weight)\*100 SEM = standard error of means.