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EFFECT OF DIETARY PROTEIN LEVELS AND ZINC SUPPLEMENTATION ON GROWTH PERFORMANCE, DIGESTIBILITY, BLOOD CONSTITUENTS AND CARCASS TRAITS OF GROWING RABBITS

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ABSTRACT: This study was conducted to investigate the influence of the dietary protein level (low; LP or high; HP) and diet supplemented with zinc on growth performance, nutrients digestibility, blood biochemistry, and carcass traits of growing rabbits. A total of 28 New Zealand White (NZW) male rabbits with an initial body weight of 734.6±14.69 g were randomly divided into 4 treatment groups for 8 weeks feeding trial. Two dietary levels of crude protein, *i.e.* 14.76 and 18.53% and two levels of zinc oxide (ZnO) 0 and 100 mg /kg diet were used in 2 × 2 factorial design. The results showed that ZnO supplementation caused a significant ($P<0.01$) increase in final live body weight (FBW), daily body weight gain (DWG), feed conversion ratio (FCR), digestibility coefficients (DM, OM, CP),and nutritive values (DCP, TDN and DE) without significant effects related to its interaction with protein level. However, ZnO supplementation showed insignificant effects in estimated blood parameters dressing percentage and relative weights of liver, kidney, heart, lung and spleen .On the other hand, the final margin was increased with ZnO supplementation in rabbits fed LP and HP diets by 27.17 and 9.23%, respectively. Conclusively, the results revealed that fortification of low or high protein diet with ZnO at level of 100 mg/kg could significantly enhance the growth performance, and nutrients digestibility of growing rabbit without harmful effect on blood constituents. Furthermore, using ZnO in the growing rabbit diets (LP or HP) was more economical than the non-supplemented diets.

Key words: Rabbits, Zinc oxide, growth performance, digestibility, blood biochemistry.

INTRODUCTION

In developing countries, rabbits are an excellent and economical producer animals for protein to satisfy the ever-increasing demand human needs (Nehad *et al.*, 2009). Feed is the major item of cost in the animal production. In particular, protein represents a substantial cost but it is considered the most important component in the ration as the high-protein feed being viewed as superior to a lower protein one(Cunha and Cheeke, 2012).

A protein deficiency, caused by either one or more limiting amino acids or an overall inadequate consumption of protein, will result in decreases in some parameters such as growth rate, N retention, feed consumption and utilization (Church, 1991). Several nutritional solutions have been adopted with low-protein diets to improve nutrient utilization with economic efficiency like supplementation of commercial products of amino acids and enzymes (Alagawany *et al.*, 2014; Alagawany *et al.*, 2016).

Zinc (Zn) is an essential nutrient required for many physiological functions including acid base balance, nutrient metabolism ,polymeric organization of macromolecules like DNA and RNA, protein synthesis, cell division besides immune and antioxidant function (Shay and Mangian, 2000; Lukác and Massányi, 2007; García-Contreras *et al.*, 2011). Additionally, Zn

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has both structural and catalytic functions in more than 200 metalloenzymes (McCall *et al.*, 2000; Shinde *et al.*, 2006). Thus, the presence of Zn in the proper concentration in the diet of the animals is of immense importance not only for the well-being of the animals but also for optimizing the overall performance of the animals and to enhance their production potential (Shinde *et al.*, 2006).

Traditionally, Zn is supplemented in the animal diets as inorganic salt (Wang *et al.*, 2010). Unfortunately, with the introduction the intensive cropping system, and extensive fertilizer application, the mineral profile of the animal feedstuffs has rapidly deteriorated in many parts of the world. More than half of the soil samples were found deficient in Zn in many with the result that feeds and fodders have been found to be Zn deficient (Shinde *et al.*, 2006). Additionally, a previous study reported that soybean meal and wheat bran were major ingredients of rabbit diets, which were rich in phytate and had an antagonistic effect on available Zn (Baker and Halpin, 1988). However, supplemental Zn could compensate for dietary Zn complexes with phytic acid in feed ingredients. The proposed Zn requirements for rabbits vary from 25 to 60 mg/kg (Mateos *et al.*, 2010). Better weight gain and feed intake were observed in rabbits receiving a diet supplemented with 90 mg/kg Zn (Hossain and Bertechini, 1993). Similarly, a previous work demonstrated that growing rabbits responded positively to 100 mg/kg of supplemental Zn, in terms of a significant improvement in live body weight gain (Nessrin *et al.*, 2012).

However, no recent trials have been conducted in rabbits to study the response to low protein diets supplemented with ZnO. Thus, the present study aimed at evaluating the effect of zinc oxide at low and high protein diet levels in growing rabbits. Emphasis was also placed on productive performance, mortality rate, nutrients digestibility coefficients, carcass characteristics, blood constituents and economical evaluation.

MATERIALS AND METHODS

The experimental work was carried out in the Animal Production Department, Faculty of Agriculture, Zagazig University, Egypt. Twenty eight New Zealand White (NZW) male rabbits with average body weight 734.6 ± 14.69 g were randomly allotted to 4 groups (7 animals in each). Two dietary levels of crude protein, *i.e.* 14 and 18% and two levels of zinc oxide (0 and 100 mg/kg diet) were used in 2 × 2 factorial design for 8 weeks .The experimental diets were formulated to ensure an adequate supply of all nutrients recommended by (NRC, 1977) for growing rabbits. Ingredients and chemical analysis of the experimental diets were illustrated in Table 1.

Daily fresh water was available all time. Live body weight of rabbits was recorded weekly in grams; the average daily weight gain (DWG) was individually calculated. Average daily feed intake (DFI) was recorded weekly and feed conversion ratio (g feed /g gain) was calculated. Mortality rate was recorded weekly .At the end of the experimental period, apparent nutrients digestibility were determined for experimental diets. Four animals from each experimental group were housed individually in metabolic cages that allowed feces separation. The feed intake was accurately determined. Feces excreted were collected in labeled polyethylene bags and samples were taken for the chemical analysis. Proximate analysis of the experimental diets and feces samples were carried out according to the (AOAC, 1990).

At the end of the experimental feeding period, blood samples of 4 rabbits were collected at slaughter time to estimate blood parameters. Hemoglobin and hematokrite concentrations as well as red blood cells count were determined. Also, serum total protein, albumin, aspertate amino transferase (AST) and alanine amino transferase (ALT) were analyzed using commercial kits purchased from Diamond Diagnostics Company, Egypt. The globulin values were obtained by subtracting the values of albumin from the corresponding values of total proteins. Also, the internal organs (liver, kidneys, heart and lungs) were removed from the body, and then weighted. Economic evaluation was calculated according to (Ayyat, 1991) as the following equation: Final margin (Profit) = Income from body gain weight - feed cost.

Table 1. Formulation and chemical analysis of the basal-diets fed to rabbits

Ingredient (%)	Low protein diet	High protein diet
Alfalfa hay	20	29
Yellow corn	24	23
Wheat straw	5	4
Wheat bran	44	29
Soybean meal	5	13
Sodium chloride	0.5	0.5
Limestone	1.2	1.2
Minerals and vitamins mixture*	0.3	0.3
Total	100	100
Chemical analysis (% on DM basis)		
Organic matter	89.42	90.56
Crude protein	14.76	18.53
Crude fiber	12.51	12.39
Ether extract	3.92	4.87
Nitrogen free extract	58.23	54.78
Ash	10.58	90.56

* Each 1.5 kg of minerals and vitamins mixture contains: manganese 80 g, zinc 60 g, iron 30 g, copper 4 g, iodine 0.5 g, selenium 0.1 g and cobalt 0.1 g, vitamin A 12000000 IU, vitamin D_3 3000000 IU, vitamin E 10000 mg, vitamin K_3 2000 mg, vitamin B_1 1000 mg, vitamin B_2 5000 mg, vitamin B_6 1500 mg, vitamin B_{12} 10 mg, Biotin 75 mg, folic acid 1000 mg, nicotinic 30000 mg and pantothenic acid 10000 mg.

The data were statistically analyzed using two-way ANOVA method according to (SAS, 2002). Duncan's new Multiple Range procedure was performed to separate means (Duncan, 1955). The following model was applied:

$$Y_{ijk}=\mu+P_i+Z_j+(PZ_{ij})+e_{ijk}$$

Where:

μ=general mean. P_i=dietary crude protein effect, Z_j= zinc supplementation effect, PZ_{ij}= zinc by protein interaction effect and e_{ijk}= experimental error.

RESULTS AND DISCUSSION

Growth Performance and Feed Utilization

Growth performance results of growing NZW rabbits as affected by dietary protein level and ZnO supplementation are presented in Table 2. Results indicated that the low protein (14.76%, LP) caused a significant ($P<0.001$) decrease in FBW and DWG from 7 to 15 weeks of age. However, significant ($P<0.01$) increase in DFI and FCR has been observed in group fed LP compared with high protein (18.53%, HP) group.

ZnO supplemented group was significantly ($P<0.01$) increased in FBW, DWG and FCR, while the DFI was not affected .Similarly, rabbits supplemented with 170 mg Zn/kg of diet as $ZnSO_4$ showed a significant increase in the body weight gain (El-Rahim *et al.*, 1995). Also, (Ayyat and Marai, 2000) reported that supplementing rabbit diets with 100, 200 or 300 Zn mg/kg significantly ($P<0.05$) increased live weight gains, but had no effect on DFI compared with the control group.

The significant improvement in body weight of rabbits given the additional Zn may be attributed to sufficient Zn level to plays an important role in polymeric organization of macromolecules like DNA and RNA which are responsible for the growth and development of skeleton and synthesis of body protein

Table 2. Growth performance of New Zealand White rabbits as affected by protein level, dietary zinc supplementation and their interactions

	Initial body weight (g)	Final body weight (g)	Daily weight gain (g/day)	Feed intake (g/day)	Feed conversion ratio
Protein level effect					
Low	732.25±25.57	1959.08±34.62	21.91±0.59	115.19±2.19	5.35±0.11
High	736.85±16.61	2219.46±40.78	26.48±0.62	107.13±1.46	4.22±0.08
Sig.	NS	***	***	**	***
Zinc effect					
Control	726.45±18.10	2016.55±49.37	23.04±0.94	108.90±2.63	4.93±0.22
Zn	741.07±22.50	2155.71±49.90	25.26±0.77	112.65±1.69	4.63±0.16
Sig.	NS	**	**	NS	**
The interaction effect					
Low protein					
Control	735.40±35.34	1862.40±36.16	20.13±0.58	113.63±4.53	5.68±0.09
Zn	730.00±38.19	2028.14±35.15	23.18±0.53	116.30±2.18	5.12±0.11
High protein					
Control	719.00±18.54	2145.00±28.39	25.47±0.67	104.95±2.22	4.31±0.09
Zn	752.14±26.36	2283.29±64.25	27.34±0.92	109.00±1.78	4.14±0.13
Sig.	NS	NS	NS	NS	NS

Means in the same column bearing different letters differ significantly (P<0.05).
NS = Not significant, **P<0.01 and *** P<0.001.

(García-Contreras *et al.*, 2011). In addition, Zn is one of trace elements essential for biological functions of all living matter and necessary for growth, appetite, skin integrity and mental activity, Zn is an essential trace element required for the action of more than 200 metalloenzymes (Shinde *et al.*, 2006). The obtained results showed no significant effects related to the interaction between protein level and ZnO supplementation (Table 2).

Digestibility Coefficient and Nutritive Values

The results of digestibility coefficient and nutritive values as affected by protein level and ZnO supplementation or their interaction are shown in Table 3. Digestibility coefficient values of dry matter (DM), organic matter (OM) and nitrogen free extract (NFE) recorded in rabbit feed LP were significantly (P<0.05) lower than those fed HP diet. No significant differences in crude protein (CP), ether extract (EE) and crude fiber (CF) digestibility were observed between groups fed LP and HP diets. The rabbits fed the LP diet obtained significantly (P<0.01) the lowest values of digestible crude protein (DCP), total digestible nutrients (TDN) and digestible energy (DE).

Rabbits fed diets supplemented with ZnO was significantly (P<0.05) higher than the rabbits fed the control diet in DM, OM, CP digestibility and nutritive values (DCP, TDN and DE, Table 3). These results are in agreements with those reported by Gad Alla (2001) who found that apparent digestibility of DM, OM and EE was significantly (P<0.05)

Table 3. Digestibility and nutritive values of the experimental diets as affected by protein level, dietary zinc supplementation and their interactions

	Digestibility coefficient (%)						Nutritive values (%)		
	DM	EE	CP	CF	NFE	OM	DCP	TDN	DE
Protein level effect									
Low	66.45±1.02	77.35±1.66	69.36±1.55	51.77±0.93	72.49±1.18	68.06±1.00	10.24±0.23	68.65±0.91	2995.33±39.93
High	69.88±0.57	79.39±1.30	72.59±1.06	52.57±1.72	76.35±0.76	72.34±0.52	13.45±0.20	71.30±0.52	3142.33±23.50
Sig.	**	NS	NS	NS	*	***	***	**	***
Zinc effect									
Control	66.87±1.17	76.67±1.01	68.78±1.16	50.64±0.45	73.51±1.55	68.86±1.32	11.48±0.71	68.68±0.94	3010.67±46.77
Zn	69.45±0.71	80.07±1.64	73.17±1.14	53.69±1.66	75.32±0.85	71.53±0.81	12.21±0.75	71.27±0.49	3127.00±27.69
Sig.	*	NS	*	NS	NS	**	**	**	**
The interaction effect									
Low protein									
Control	64.66±1.28	76.20±1.51	67.17±1.94	51.53±0.40	70.47±1.48	66.20±1.16	9.91±0.28	66.93±1.04	2920.00±46.19
Zn	68.23±0.58	78.50±3.20	71.55±1.86	52.00±2.04	74.51±0.80	69.91±0.51	10.56±0.28	70.36±0.31	3070.67±12.81
High protein									
Control	69.08±0.57	77.14±1.61	70.39±0.61	49.75±0.27	76.56±0.70	71.52±0.56	13.04±0.12	70.43±0.56	3101.33±24.18
Zn	70.67±0.82	81.63±0.88	74.78±0.63	55.38±2.61	76.14±1.53	73.15±0.59	13.85±0.11	72.17±0.54	3183.33±22.26
Sig.	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means in the same column bearing different letters differ significantly (P < 0.05).
NS = Not significant, *P<0.05, **P<0.01 and *** P<0.001.

greater due to adding of Zn, but CP, and CF tended to be insignificantly higher than the control group. Hafez *et al.* (2002) also found that rabbit's diets supplemented with Zn recorded higher digestibility of nutrients.

A previous research showed that feeding 3000 mg/kg Zn as ZnO to weanling pigs had an enteric effect of producing deeper crypts in the duodenum and a trend for longer villi (Carlson *et al.*, 1998). Thus the enhanced digestibility and nutrient utilization following ZnO supplementation could be directly related to the superior absorptive capacity of the mucous membrane. Also, the improvement of digestion coefficients may be due to Zn supplementation affects protein and carbohydrate metabolism, which found in many highly purified enzymes functioning in protein and carbohydrate digestion (Underwood and Suttle, 1999).

Increasing the digestive ability of rabbit by Zn supplementation may be attributed to increasing the activity of some enzymes related to the digestion of carbohydrates, fats and protein such as amylase, lipase, trypsinogen, chemotrypsinogen and some peptidases, since these enzymes are known to be Zn-dependent enzymes (Banerjee, 1988). No significant differences in EE, CF and NFE digestibility were observed as a result of ZnO supplementation. Also, the results of the interaction effects between protein level and ZnO supplementation (Table 3) showed insignificant effects on digestibility coefficient and nutritive values.

Blood Parameters

As shown in Table 4, the concentrations of total protein, albumin, globulin and ALT were significantly (P<0.05) decreased with rabbits fed LP diets. However, ZnO supplementation showed insignificant effect in estimated blood parameters (Tables 4 and 5). Similarly, an experiment in fattening pigs supplemented with Zn either as inorganic salt ($ZnSO_4$, 84.3 mg/kg of diet) or metallo-organic complex (Zn-Met,

Table 4. Blood parameters of New Zealand White rabbits as affected by protein level, dietary zinc supplementation and their interactions

	Albumin (g/dl)	Total Protein (g/dl)	Globulin (g/dl)	Albumin/ globulin ratio	AST (u/l)	ALT (u/l)	Urea (mg/dl)	Glucose (mg/dl)
Protein level effect								
Low	2.62±0.09	4.48±0.18	1.88±0.16	1.44±0.14	15.00±1.69	26.83±4.30	16.83±2.56	125.17±7.68
High	3.12±0.12	5.48±0.12	2.35±0.09	1.33±0.08	19.83±2.70	39.67±2.08	26.17±3.09	111.33±5.55
Sig.	**	**	*	NS	NS	*	NS	NS
Zinc effect								
Control	2.73±0.14	4.85±0.24	2.12±0.13	1.31±0.07	16.00±1.93	32.33±5.66	19.00±2.46	119.33±8.75
Zn	3.00±0.15	5.12±0.29	2.12±0.20	1.46±0.14	18.83±2.82	34.17±2.63	24.00±4.03	117.17±5.65
Sig.	NS	NS	NS	NS	NS	NS	NS	NS
The interaction effect								
Low protein								
Control	2.43±0.03	4.40±0.26	2.00±0.25	1.27±0.15	12.00±1.15	22.33±7.26	14.67±3.28	128.33±16.50
Zn	2.80±0.10	4.57±0.30	1.77±0.23	1.61±0.21	18.00±2.00	31.33±4.41	19.00±4.16	122.00±3.61
High protein								
Control	3.03±0.07	5.30±0.10	2.23±0.07	1.35±0.03	20.00±1.15	42.33±2.73	23.33±0.88	110.33±5.46
Zn	3.20±0.25	5.67±0.18	2.47±0.15	1.31±0.17	19.67±5.93	37.00±2.65	29.00±6.24	112.33±11.10
Sig.	NS	NS	NS	NS	NS	NS	NS	NS

Means in the same column bearing different letters differ significantly (P<0.05).
NS=Not significant, *P<0.05 and **P<0.01.

Table 5. Hematological parameters of New Zealand White rabbits as affected by protein level, dietary zinc supplementation and their interactions

	WBCs count (10^3/ml)	RBCs count (10^6/ml)	Haemoglobin (g/dl)	Hematocrit (%)	Lymphocytes (10^3/ml)
Protein level effect					
Low	10.13±1.43	5.36±0.07	10.27±0.16	29.98±0.63	5669.67±1263.32
High	9.85±0.89	5.66±0.17	10.88±0.39	31.88±1.35	5527.83±754.60
Sig.	NS	NS	NS	NS	NS
Zinc effect					
Control	9.37±1.22	5.40±0.11	10.40±0.24	30.25±0.87	5070.83±678.70
Zn	10.62±1.10	5.62±0.16	10.75±0.38	31.62±1.28	6126.67±1263.05
Sig.	NS	NS	NS	NS	NS
The interaction effect					
Low protein					
Control	9.27±2.20	5.31±0.13	10.13±0.28	29.20±0.90	4378.67±212.58
Zn	11.00±2.16	5.41±0.07	10.40±0.15	30.77±0.73	6960.67±2503.58
High protein					
Control	9.47±1.59	5.48±0.20	10.67±0.38	31.30±1.38	5763.00±1333.73
Zn	10.23±1.12	5.83±0.27	11.10±0.75	32.47±2.63	5292.67±1006.47
Sig.	NS	NS	NS	NS	NS

Means in the same column not bearing different letters differ significantly.
NS = Not significant.

40.9 mg/kg of diet) did not show any significant differences in the total protein and albumin (Rupić *et al.*, 1997). On the contrary, the serum albumin concentration of female Holstein calves was increased when their basal diet was supplemented with 20, 40, or 80 ppm $ZnSO_4$ (Guang Zhou *et al.*, 1995). But this difference could be related to the animal species used.

The results of the interaction effects between protein level and ZnO supplementation showed insignificant differences on estimated blood parameters (Tables 4 and 5).

Carcass Traits

Results representing some carcass characteristics at 15 weeks of age are shown in Table 6. Slaughter weight (SW) affected significantly with protein level ($P<0.001$) and ZnO supplementation ($P<0.05$), while carcass weight was significantly affected with protein level ($P<0.01$) only. In regard to dressing percentage and relative weights (g/kg SW) of liver, kidney, heart, lung and spleen presented no significant differences were observed within all groups as a result of either protein level, ZnO supplementation or their interaction. Correspondingly, Al-Khalifa (2006) reported that supplemental dietary Zn by levels of 50, 100, or 200 ppm had no significant effect on dressing percentage of rabbits. Also, (Ayyat and Marai, 2000) reported that supplementing rabbit diets with 100, 200 or 300 Zn mg kg^{-1} had no effect on dressing yield of the rabbits compared with the control.

Economical Evaluation

Table 7 show that the feed cost and income from gain per rabbit were increased with ZnO supplementation within each protein groups. Final margin was increased with ZnO supplementation in rabbits fed LP and HP diets by 27.17 and 9.23%, respectively. The improvement in final margin may be due to the enhancement of weight gain and feed conversion ratio with ZnO supplementation. Hence the economical feed efficiency in this study showed that the using ZnO in the growing rabbit diets (LP or HP) was more economical than the non-supplemented diets.

Table 6. Carcass and some internal organ weights of growing New Zealand White rabbits as affected by protein level, dietary zinc supplementation and their interactions

	Slaughter weight (SW, kg)	Carcass weight (kg)	Dressing (%)	Liver (g/kg SW)	Kidney (g/kg SW)	Heart (g/kg SW)	Lunges (g/kg SW)	Spleen (g/kg SW)
Protein level effect								
Low	1.93±0.05	1.09±0.04	56.79±0.64	33.14±1.20	6.75±0.50	3.20±0.12	8.46±1.05	0.64±0.05
High	2.21±0.05	1.28±0.04	57.76±0.59	29.43±1.03	6.49±0.39	3.02±0.14	7.33±0.58	0.61±0.05
Sig.	***	**	NS	NS	NS	NS	NS	NS
Zinc effect								
Control	1.99±0.07	1.14±0.05	56.97±0.52	31.80±1.32	6.21±0.41	2.95±0.12	7.84±0.76	.65±0.04
Zn	2.15±0.07	1.24±0.05	57.59±0.74	30.77±1.42	7.02±0.42	3.26±0.12	7.94±0.99	.60±0.06
Sig.	*	NS	NS	NS	NS	NS	NS	NS
The interaction effect								
Low protein								
Control	1.84±0.04	1.04±0.03	56.40±0.66	34.30±1.41	5.93±0.29	3.13±0.19	8.27±1.17	.67±0.08
Zn	2.01±0.06	1.15±0.05	57.19±1.21	31.97±1.96	7.56±0.70	3.27±0.19	8.65±2.02	.61±0.07
High protein								
Control	2.14±0.03	1.23±0.03	57.54±0.76	29.30±0.66	6.49±0.82	2.78±0.08	7.42±1.15	.63±0.01
Zn	2.28±0.08	1.32±0.06	57.99±1.06	29.56±2.20	6.48±0.31	3.26±0.20	7.24±0.59	.59±0.11
Sig.	NS	NS	NS	NS	NS	NS	NS	NS

Means in the same column bearing different letters differ significantly ($P < 0.05$).
NS = Not significant, *P<0.05, **P<0.01 and *** P<0.001.

Table 7. Economical visibility of growing New Zealand White rabbits as affected by protein level, dietary zinc supplementation and their interactions

	Total feed intake (kg)	Feed cost LE/rabbit	Total gain kg	Income from gain LE/rabbit	Final margin LE/rabbit
Protein level effect					
Low	6.451	13.91	1.227	29.44	15.53
High	5.999	13.84	1.483	35.58	21.74
Zinc effect					
Control	6.098	13.26	1.290	30.97	17.70
Zn	6.308	13.78	1.415	33.95	20.17
The interaction effect					
Low protein					
Control	6.363	13.36	1.127	27.05	13.69
Zn	6.513	13.74	1.298	31.15	17.41
High protein					
Control	5.877	13.22	1.426	34.23	21.01
Zn	6.104	13.80	1.531	36.74	22.95

Conclusion

It could be concluded that the growing rabbit responded positively to 100 mg supplemental ZnO/kg of low (14.76%) or high protein (18.53%) diet, in terms of significant improvement in FBW, DWG, FCR, and SW. Additionally, the former level of ZnO had no negative effect on blood biochemistry so it could be used safely.

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REFERENCES

Alagawany, M., M. Farag, R. Tiwari, S. Sachan, K. Karthik and K. Dhama (2016). Positive and negative impacts of dietary protein levels in laying hens. Asian J. Anim. Sci., 10: 165-174.

Alagawany, M., M.E.A. El-Hack, V. Laudadio and V. Tufarelli (2014). Effect of low-protein diets with crystalline amino acid supplementation on egg production, blood parameters and nitrogen balance in laying Japanese quails. Avian Biol. Res., 7: 235-243.

Al-Khalifa, K.H. (2006). The effect of zinc on growth performance of meat rabbit. Saudi J. Biol. Sci., 13: 71-78.

AOAC (1990). Official Methods of Analysis, Association of Official Analytical Chemists. Washington, USA.

Ayyat, M. (1991). Growth and carcass production performance of growing rabbits as affected by dietary energy level. Zagazig J. Agric. Res., Egypt.

Ayyat, M. and I. Marai (2000). Growth performance and carcass traits as affected by breed and dietary supplementation with different zinc levels, under Egyptian conditions. Proc. 8th World Rabbit Cong., Puebla. Colegio de Postgraduados, Montecillo, Spain, 83-88.

Baker, D.H. and K.M. Halpin (1988). Zinc antagonizing effects of fish meal, wheat bran and a corn-soybean meal mixture when added to a phytate-and fiber-free casein-dextrose diet. Nut. Res., 8 : 213-218.

Banerjee, G.C. (1988). Feeds and principles of animal nutrition. Rev. Oxford and IBH Publishing Co. PVT Ltd. New Delhi.

Carlson, M., S. Hoover, G. Hill, J. Link and J. Turk (1998). Effect of pharmacological zinc on intestinal metallothionein concentration and morphology in the nursery pig. J. Anim. Sci., 86 : 57 - 76.

Church, D. (1991). The Nutrients, Their Metabolism, and Feeding Standards. Livestock Feeds and Feeding, 3rd Ed. Prentice Hall. Englewood Cliffs, New Jersey.

Cunha, T.J. and P.R. Cheeke (2012). Rabbit Feeding and Nutrition. Elsevier, Sh. 4, 34-61.

Duncan, D.B. (1955). Multiple Range and Multiple F tests. Biomet., 11: 1-42.

El-Rahim, M., M. El-Gaafary, M. Tawfeek, El-H. Kelawy and S. Rawia (1995). Effect of dietary supplementation with different levels of zinc on growth performance, nutrient digestibility, mineral metabolism, blood constituents, organ histology and reproductive efficiency in NZW rabbits. Egypt. J. Rabbit Sci., 5: 11-31.

Gad Alla, S.A.Z. (2001). Effect of dietary zinc and iodine supplementation on growth performance, apparent digestibility, blood metabolites and reproductive efficiency in Bauscat rabbits. Proc. 2nd Sci. Cong. On Animal Production and Health in Semi Arid Area, 4-6 Sep, El Arish, Egypt, 363-373.

García-Contreras, A., Y. De Loera, C., García-Artiga, A. Palomo, J.A. Guevara, J., Herrera-Haro, C. López-Fernández, S., Johnston and J. Gosálvez (2011). Elevated dietary intake of Zn-methionate is associated with increased sperm DNA fragmentation in the boar. Reprod. Toxicol., 31: 570-573.

Guang Zhou, L., L. ZhiNian and D. XiaoMing (1995). Effect of oral supplemental zinc on calves around weaning. Acta Vet. Zootech. Sin., 26: 207-213.

Hafez, S.I., N. El-Awady, T.A.A. Deraz and M.H.M. Yacout (2002). Response of supplemental some mineral elements in rabbits diets on digestibility nutritional balances and feed efficiency. J. Agric. Sci. Mansoura Univ., 27(3):1393-1403.

Hossain, S. and A. Bertechini (1993). Requirement of zinc for growing rabbits. Arq. Bras. Med. Vet. Zootec, 45: 323-329.

Lukác, N. and P. Massányi (2007). Effects of trace elements on the immune system. Epidemiologie, mikrobiologie, imunologie: casopis Spolecnosti pro epidemiologii a mikrobiologii Ceske lekarske spolecnosti, J.E. Purkyne., 56: 3-9.

Mateos, G.G., P.G. Rebollar and C. de Blas (2010). Minerals, Vitamins and Additives. In: de Blas C., Wiseman J. (Ed). The nutrition of the rabbit, CABI Publishing, Wallingford, UK, 119-150.

McCall, K.A., C.C. Huang and C.A. Fierke (2000). Function and mechanism of zinc metalloenzymes. J. Nut., 130: 1437S-1446S.

Nehad, A.R., A.A. Sedki and A.M. El-Neney (2009). New trend in rabbit's growth in relation to energy and protein requirements. Egypt. J. Rabbit Sci., 19: 87-106.

Nessrin, S., A. Abdel-Khalek S.M. Gad (2012). Effect of supplemental zinc, magnesium or iron on performance and some physiological traits of growing rabbits. Asian J. Poult. Sci., 6: 23-30.

NRC (1977). National Research Council. Nutrient requirements of rabbits. Nat. Acad. Sci., Washington, DC.

Rupić, V., L. Ivandija, S. Luterotti, M. Dominis-Kramarić and R. Bozac (1997). Plasma proteins and haematological parameters in fattening pigs fed different sources of dietary zinc. Acta Vet. Hungarica, 46: 111-126.

SAS (2002). Statistical Analysis System, Software Version 9.00 Inst. Inc. Cary. Nc. USA.

Shay, N.F. and H.F. Mangian (2000). Neurobiology of zinc-influenced eating behavior. J. Nut., 130: 1493S-1499S.

Shinde, P., R.S. Dass, A.K. Garg, V.K. Chaturvedi and R. Kumar (2006). Effect of zinc supplementation from different sources on growth, nutrient digestibility, blood metabolic profile, and immune response of male Guinea pigs. Biol. Trace Elem. Res., 112: 247-262.

Underwood, E.J. and N.F. Suttle (1999). In: The Mineral Nutrition of Livestock 3rd Ed. CABI Publishing, CAB International, Wallingford, Oxon, UK

Wang, Y., J. Tang, W. Ma and J. Feng (2010). Dietary zinc glycine chelate on growth performance, tissue mineral concentrations, and serum enzyme activity in weanling piglets. Biol. Trace Elem. Res., 133: 325-334.

تأثير مستويات بروتين الغذاء وإضافة الزنك علي أداء النمو، الهضم، مكونات الدم وخصائص الذبيحة فى الأرانب النامية

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أجريت هذه الدراسة لتقييم تاثير إضافة الزنك للعلائق المنخفضة أو المرتفعة في مستوي البروتين علي أداء النمو، الهضم، مكونات الدم وخصائص الذبيحة فى الأرانب النامية، تم إستخدام عدد ٢٨ من ذكور الأرانب النيوزلاندية البيضاء متوسط وزن ٧٣٤.٦ ±١٤.٦٩ جم، قسمت الأرانب إلى أربع مجموعات متجانسة، كل مجموعة مكونة من سبعة أرانب تم تغذيتها لمدة ٨ أسابيع، تم أستخدام مستويين من البروتين (١٤و١٨%) ومستويين من الزنك (صفر، ١٠٠ مجم/كجم من العليقة) في تصميم عاملي ٢×٢، أظهرت النتائج قدرة الزنك علي إحداث تحسن معنوي لوزن الجسم الحي ومعدل النمو اليومي ومعدل التحويل الغذائي ومعاملات الهضم (المادة الجافة، المادة العضوية، البروتين الخام) وكذلك القيم الغذئية (البروتين الخام المهضوم والمركبات المهضومة الكلية والطاقة المهضومة) دون ظهور أي تأثيرات معنوية للتدخل مع مستوي البروتين، وعلى الرغم من ذلك فلم تحدث إضافة الزنك أي تغيير معنوي في أيا من مؤشرات الدم أو نسبة التصافي أو الأوزان النسبية للكبد والكلي والقلب والرئة والطحال، لكن هامش الربح النهائي زاد بصورة معنوية عند إضافة الزنك للعلائق منخفضة أو مرتفعة البروتين بنسبة ٢٧.١٧ و ٩.٢٣% على التوالي، إجماليا فقد أظهرت النتائج أن إضافة الزنك للعلائق المنخفضة أو المرتفعة في البروتين أحدث تحسن معنوي في أداء النمو والهضم للأرانب النامية دون إحداث أي تأثير سلبي على مكونات الدم، علاوة على ذلك فإن إضافة الزنك للعلائق المنخفضة أو المرتفعة في البروتين أظهر كفاءة أقتصادية واضحة.

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