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RESPONSE OF LAYING JAPANESE QUAIL TO DIFFERENT LEVELS OF PROTEIN WITH OR WITHOUT VITAMIN E AND SELENIUM SUPPLEMENTATION

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ABSTRACT

A total number of 270 Japanese quail (180 females and 90 males) at 4 weeks of age were used in an experiment lasted 22 weeks. Experimental japanese quail (*Coturnix coturnix japonica*), were used in a 3x2 factorial arrangement. Quail were randomly divided into three treatment groups, each of 60 quail females and 30 males, that received three dietary protein levels (16, 18 or 20 % CP). Each quail group was randomly divided into two sub-groups (30 females and 15 males each). The first sub-group of each group received diet without any supplementation, while the second sub-group was given diets supplemented with a mixture of 50 mg Vitamin E (VE) and 1 mg Se selenium (Se) /kg diet. All diets were isocaloric (2900 kcal ME/kg) and isofibrous.

Results obtained could be summarized as follows:

- Live body weight and body weight change were improved with the medium protein level (18%) followed by high protein (20%) and the low protein level (16%) during the whole experimental period.
- Egg weight was significantly (P<0.05) decreased, while egg number increased (P<0.05) with the decrease of protein level.
- Feed intake recorded an increase (P< 0.05) with the decrease of protein level.
- Feed conversion ratio (g feed intake /g egg mass) revealed significantly worst (P<0.05) decrease by low protein level in diet.
- Protein intake recorded an increase with increasing of protein level.
- Efficiency of protein utilization was improved with low protein level 16% in the diet.
- Hatchability recorded a non-significant difference (P>0.05) among groups.
- Albumen % showed a significant (P<0.05) increase, while yolk % decrease with the increase of protein level.
- Digestibility coefficients and the nutritive values expressed as DCP, TDN % and ME kcal/kg were significantly varied (P<0.05) among the different experimental diets, the different levels of protein did not significantly influence digestion coefficient of NFE.
- Supplementing diet with VE and Se affected the final live body weight and body weight change were significant (P<0.05) during the experimental period as compared to unsupplemented diets.
- Improvement of egg number and egg mass by 10.45 and 15.39 % compared to that of the unsupplemented, respectively.
- Feed intake recorded an increase (P<0.05) with the supplemented of VE and Se.
- Feed conversion ratio and hatchability percentage improved (P<0.05) with supplemented of VE and Se.
- Digestibility coefficients and the nutritive values expressed as DCP, TDN % and ME kcal/kg were improved as compared to unsupplemented diets.
- sThe higher economical efficiency was obtained by using 18% CP with supplemented of VE and Se obtained the best economical efficiency.

- Interaction between dietary protein levels, VE and Se supplementation, indicated that supplemented experimental diets with VE and Se resulted enhanced the performance of these diets especially with 18 % CP levels.
- It could be concluded that crude protein level of 18 % supplemented with Vitamin E and selenium (50 mg VE and 1 mg Se /kg diet) in the laying Japanese quail diet improve the productive performance and the economic efficiency.

Keywords: Quail, protein level, vitamin E, selenium, productive performance, egg quality, digestion trials and economical efficiency.

INTRODUCTION

Dietary protein is considered one of the most expensive nutrients in poultry nutrition. Hence, it is to be expected that great effect will be made to reduce its use without lowering the productive and reproductive performance of birds. Among the most important attempts made to minimize the feeding cost. During the laying period, Vohra and Roudybush (1971) reported that a level of 25% dietary protein is recommended for the laying Japanese quail. Kumar *et al* (1978) suggested a protein level of 22% for the laying Japanese quail, while Murakami *et al*.(1993) recommended 18% crude protein for laying Japanese quail, which is lower than the level of recommended by NRC (1994) for laying Japanese quail (20%).

Vitamin E acts as an antioxidant, supports the immune system, and is needed for cardiovascular and nervous system health. Some studies have been shown that vitamin E increase egg production and hatchability in laying hens (Tengerdy and Nockels, 1973). Gore and Qureshi (1997) suggested that vitamin E prevents oxidation of unsaturated lipid materials within cell, thus protecting the cell membrane from oxidative damage.

Deficiency of V.E in chicks depressed bursa weight reduced number of lymphocytes and resulted in the destructive histological changes within the primary lymphoid organs and spleen (Huang and Chen, 1999). Chicken, cannot synthesize vitamin E, therefore their requirements must be met from dietary source (Chan and Decker, 1994).

Selenium is a trace mineral that is a part of an antioxidant enzyme called glutathione peroxides. It is also necessary for normal growth and proper utilization of the trace element, iodine, for normal thyroid function. Primary Selenium uses, supports the antioxidant effects of vitamin E and glutathione peroxides and secondary uses, normal growth and thyroid function.

In addition, selenium is required by the chicks for the normal transit function of methionine to cystine (Bunk and Combs, 1981). Lavorgna and Combs (1982) observed that adding Se in chicken diets improved the sulfur amino acids metabolism.

Selenium deficiency can manifest itself in many diseases and dysfunctions such as liver necrosis, muscular dystrophy, microangiopathy, exudative diathesis, pancreatic fibrosis, poor feathering, retained placenta, mastitis, cystic ovaries, general unthriftiness, Keshan disease, Kashin-Beck disease, cancer, numerous heart diseases, immune deficiencies, reduced fecundity and many others and can affect humans and animals alike (Shamberger, 1983).

Selenium supplementation to laying diets improved egg production, fertility and hatchability (Latshaw *et al*. 1977). Schultz (1989) suggested that vitamin E and selenium appears to stimulate immune responses when fed to levels more than the requirement. Shamberger (1983) found that adding Vitamin E and selenium have a direct effect on pituitary gland and gonads activity.

Moreover, selenium and vitamin E are very important in the functioning of the immune system and promotes healthy growth, fertility and hatchability. Thompson and Scott (1970) suggested that selenium may conserve vitamin E by controlling its retention or preventing its destruction in the tissues.

The mixture of vitamin E and selenium significantly reduced both mortality and the effects of disease on body weight gain. Abd EL-Latif (1999) suggested that supplemented with Vitamin E and selenium improved productive performance of laying quail. The toxic level of sodium selenate in immature laying hen diets was 5 mg/kg (Ort and Latshew,1978).

Hence, it is expected that great efforts will be directed to maximize the utilization of low protein diets. Supplementing low protein diets with growth promoters may be an alternative way to improve laying quail performance and economic efficiency.

The experiment study aimed to find out the response of laying japanese quail to different levels of protein with or without vitamin E and selenium supplementation.

MATERIALS AND METHODS

The present work was carried out at Maryiout Experimental Research Station (South West of Alexandria), which belongs to the Desert Research Center.

A total number of 270 Japanese quail (180 females and 90 males) at 4 weeks of age were used in an experiment lasted 22 weeks. Experimental Japanese quail (*Coturnix coturnix japonica*), were kept under similar managerial, hygienic and environmental conditions and were used in a 3x2 factorial arrangement.

Quail were randomly divided into three treatment groups, each of 60 quail females and 30 males (each of 2 females and one male), that received three dietary protein levels (16, 18 or 20 % CP). Each quail group was randomly divided into two sub-groups (30 females each). The first sub-group of each group received diet without any supplementation, while the second sub-group was given diets supplemented with a mixture of 50 mg Vitamin E (VE) and 1 mg selenium (Se)/kg diet (according to Abd EL-Latif, 1999). The source of supplemented selenium was sodium selenite (Na_2-SeO_3), while Vitamin E was α-tocopherol acetate.

The highest level of protein (20%) was formulated to meet the nutrient requirements of laying Japanese quail according to NRC (1994). All diets were isocaloric (2900 kcal ME/kg) and isofibrous were fed in mash form.

Quail were housed in metallic cages, feed and water supplied *ad libitum*. Chemical analysis of the experimental diets and dried excreta were assayed using methods of A.O.A.C (1990).

During the experimental period, individual live body weight and feed intake were determined. Feed conversion ratio (g feed intake / g egg mass) and protein intake and efficiency of protein utilization (g egg mass / g protein intake) was calculated. The mortality was recorded daily.

Table (1): Composition and proximate chemical analysis of the experimental diets

Ingredient, %	Levels of protein		
	16%	**18%**	**20%**
Yellow corn	68.00	63.60	59.80
Soybean meal (44% CP)	2.30	4.00	6.40
Concentrate *(52% CP)	10.00	10.00	10.00
Corn gluten meal (60% CP)	4.52	7.52	9.84
Wheat bran	9.50	9.31	8.30
Dicalcium phosphate	0.50	0.40	0.50
Limestone	4.30	4.30	4.30
Vit. and min. premix**	0.30	0.30	0.30
L- lysine	0.35	0.34	0.34
Dl- methionine	0.23	0.23	0.22
Total	**100**	**100**	**100**
Proximate chemical analysis %			
Crude protein	16.17	18.15	20.21
Crude fiber	3.01	3.11	3.13
Ether extract	3.56	3.64	3.59
Calculated values:			
Metabolizable energy (kcal/kg)***	2900	2900	2900
Calcium %	2.50	2.50	2.51
Available phosphorus%	0.35	0.35	0.30
Methionine %	0.45	0.45	0.46
Lysine %	1.00	1.00	1.00
Methionine+Cysteine%	0.70	0.70	0.70
Selenium (mg/kg)	0.21	0.22	0.21

*** Protein concentrate contain: 52%Crude protein, 2.03% Crude fiber, 6.17% Ether extract, ME 2800 (Kcal/Kg), 1.50 % Methionine, 2.00% Methionine and Cystine, 3.0 % Lysine, 7.00% Calcium, 2.93 % Avalailable Phosphorus, 2.5 % Nacl.**

**** Each 3 kg Vitamins and minerals premix contains (per ton of feed), Vit. A 10000000 IU, Vit. D_3 2000000 IU, Vit.E I0g, Vit.K_3 1000 mg, Vit. B_1 1000 mg, Vit. B_2 5000mg, Vit. B_6 1.5g, Vit. B_{12} 10 mg, Pantothenic acid 10g, Niacin 30g, Folic acid 1g, Biotin 50 mg, Iron 30g, Manganese 70g, Choline chlorite 10g, Iodine 300 mg, Copper 4g, Zinc 50g and Selenium 100 mg.**

*****Calculated according to *NRC* of poultry (1994).**

Age at sexual maturity was determined at the first egg laying. Eggs were collected daily and weighed, so egg number, egg mass were calculated during the experimental period. At 15 weeks of age, 20 eggs were randomly taken from each sub-group and were used to evaluate egg quality, yolk weight and shell weight were recorded, while albumen weight was calculated by subtracting yolk and shell weight from egg weight. Shell thickness (without membrane) was measured by micrometer. Yolk, shell and albumen percentage were calculated as a percentage of egg weight.

At 15 weeks of age, the eggs were then collected and incubated. Hatchability percentage was calculated for each sub-group.

At the end of the experimental feeding period, digestion trials were conducted using 24 adult quail males (four from each sub-group) to determine the digestibility coefficients of the experimental diets. Males were housed individually in metabolic cages. The digestibility trials extended for 9 days of them 5 days as a preliminary period followed by 4 days as collection period.

The individual live body weights were recorded during the main collection period to determine any loss or gain in the live body weights. During the main period, excreta were collected daily and weighed dried at 60°C bulked finally ground and stored for chemical analysis. The faecal nitrogen was determined according to Jakobsen *et al.*(1960). Urinary organic matter was calculated according to Abou-Raya and Galal (1971).

The digestion coefficients % of crude protein (CP), crude fiber (CF), ether extract (EE) and nitrogen free extract (NFE) of the experimental diets were estimated.

The nutritive values expressed as digestible crude protein (DCP), total digestible nutrients (TDN) were calculated. Metabolizable energy (ME) was calculated as 4.2 kcal per gram TDN as suggested by Titus (1961).

Economical efficiency for egg production was calculated from the input / output analysis according to the costs of the experimental diets and selling price of one kg egg.

Data were statistically analyzed according to SAS (1996) A factorial design (3x2) according to the treatment was carried out using the following model:

$$Y_{ijk} = \mu + P_i + S_j + PS_{ij} + e_{ijk}$$

Where:

Y_{ijk} = Represented observation.

μ = Overall mean.

P_i = Effect of protein level (i = 16,18 and 20%).

S_j = effect of Se and VE (with or without).

PS_{ij}= interaction between crude protein level and VE and Se.

e_{ij} = Random error.

Duncan's New Multiple Range Test (Duncan, 1955) separated differences among treatment means.

RESULTS AND DISCUSSION

Live body weight and body weight change

Live body weight and body weight change of productive performance of quail females as affected by dietary protein level, vitamin E (VE) and selenium (Se) supplementation and their interaction during laying period are summarized in Table (2).

The effects of dietary protein levels on final live body weight and body weight change were varied significantly (P<0.05) between the experimental groups during the whole experimental period.

It is clear that live body weight was improved with medium protein level (18%) followed by high protein (20%) and low protein level (16%) during the whole experimental period.

Regardless of protein level, results showed that supplementing diet with VE and Se affected live body weight and body weight change were significantly (P<0.05) improved during the experimental period as compared to unsupplemented diets (Table 2).

It is worthy noting that body weight change was improved with supplementing VE and Se by 4.69% than that of the unsupplemented of VE and Se.

Interaction effect between dietary protein levels, VE and Se supplementation on the previous studied traits indicated that the presence of supplemented VE and Se with any level of dietary protein resulted in improvements in live body weight and body weight change.

Table (2): Live body weight, body weight change and age at sexual maturity ($\bar{X}$±SE) of laying Japanese quail as affected by protein level, VE and Se supplementation and their interaction

Treatments		Initial live body weight (g)	Final live body weight (g)	Body weight change (g)	Age at sexual maturity/bird/day
Protein level	VE and Se				
16	-	115.70±6.01	239.37±7.61^{b}	123.67±3.12^{b}	49.52±0.23
18	-	115.35±5.21	249.89±6.12^{a}	134.54±2.19^{a}	49.32±0.20
20	-	115.95±5.67	249.51±7.15^{a}	133.06±3.04^{a}	49.24±0.17
Sig.		n.s	*	*	n.s
-	S0	114.93±6.51	242.36±8.01^{b}	127.43±2.99^{b}	49.55±0.24
-	S1	116.40±5.32	250.15±6.41^{a}	133.41±3.41^{a}	49.17±0.19
Sig.		n.s	*	*	n.s
Interaction					
16	S0	115.01±4.22	235.41±9.21^{b}	120.40±4.01^{b}	49.75±0.32
16	S1	116.38±3.94	243.32±8.63^{b}	126.94±3.15^{b}	49.29±0.25
18	S0	114.38±4.01	244.15±9.01^{ab}	129.77±3.12^{ab}	49.50±0.40
18	S1	116.32±4.34	255.62±8.40^{a}	139.30±2.91^{a}	49.14±0.29
20	S0	115.40±3.53	247.52±8.09^{a}	132.12±3.15^{a}	49.40±0.19
20	S1	116.50±3.41	251.50±7.51^{a}	134.00±3.09^{a}	49.08±0.15
Sig.		n.s	*	*	n.s

[a,b]. means in each column within each item, bearing the same superscripts are not significantly different (P<0.05).
Sig.= Significant. n.s= not significant.
S0= diet without Vitamin E and selenium.
S1= diet with Vitamin E and selenium.

Age at sexual maturity

The effects of dietary protein levels on age at sexual maturity ranged from 49.24 to 49.52 day, showing that different levels of CP in laying quail diets did not significantly affect this trait (Table 2). It is clear that higher protein level reached sexual maturity earlier than those given less protein level. Lee *et al.(*1977) reported that the quail given more protein level reached sexual maturity earlier than those given less protein.

Irrespective of protein level, results cleared that the age at sexual maturity ranged from 49.17 to 49.55 day showing that supplemented of VE and Se in laying quail diets earlier than those unsupplemented of VE and Se as shown in Table (2).

Egg weight, egg number and egg mass

The effects of dietary protein levels, results in Table (3) indicate significant (P<0.05) decrease in egg weight and significant (P<0.05) increase in egg number for layers with the decrease of protein level during the whole experimental period.

It is clear that level of 16 % CP decreased egg weight by 3.31 or 3.13 than that of the protein level 20 or 18 %, respectively. Level of protein 20% decreased egg number by 4.41 and 5.88 % than that of the protein level 18 or 16 %, respectively. Increased egg weight this may be due to increase egg components with increase of protein level in the diet.

Similar results were recorded by Abou Raya *et al*. (1982) found that the egg weight increased, while less egg yield as a result of increasing the protein level and the lower protein level improved more egg production but not for egg weight in the laying diets. Shrivastav *et al*.(1983) reported that egg weight was significantly lower in quail given protein with a low level in comparison with the high level. Aboul-Ela *et al*.(1992) who found an increase in the egg weight with an increasing level of protein (21%), while decreasing the protein level from 12 to 15% significantly increased egg production in the quail diets. Hussein (2002) found that the dietary protein level in the layer diet on egg weight was significantly higher in hens fed the higher protein layer diet (19% CP) than the lower protein layer (17% CP), while egg production increased by using the decreasing protein level diet during the laying period. Hassanein (2004) who found a significant (P<0.01) decrease in the egg weight and significant (p<0.01) increase egg number with an decreasing level of protein in the quail diets. Abdel-Azeem *et al.*(2005) and Zofia *et al.*(2006) showed that feeding laying Japanese quail on low protein diets significantly (P<0.01) decreased in the egg weight.

Egg mass during the whole experimental period of laying quail showed a decrease (P<0.05) with increasing CP levels. It is worth noting that substitution of diet by 20 % decreased (P<0.05) egg mass by 4.19 and 2.54 % compared to that of the 18 or 16 %, respectively (Table 3)..

Irrespective of protein level, results of egg weight, egg number and egg mass during the whole experimental period of laying quail showed an improvement (P<0.05) with supplemented of VE and Se. It is worth noting that supplemented of VE and Se improved of egg number and egg mass by 10.45 and 15.39 % compared to that of the unsupplemented, respectively, while egg weight improved by 4.84 % (Table 3), the results show that the higher values of egg weight and egg number were observed for laying which received diets supplemented with VE and Se during the experimental period.

Utomo and Mitchell (1995) reported that VE increased circulating yolk precursor concentrations in laying hens, so it increases egg number. Abd EL-Latif (1999) reported that VE and Se supplemented to laying quail diets were improved egg weight, egg number and egg mass. Sheehy *et al*.(1991)and Salwa *et al.*(2004) whom found that supplemented of VE with Se improved egg production, egg weight, egg mass during the laying hen period.

Vitamin E tends to maintain or increase egg production laying hen (Tengerdy and Nockels, 1973 and Metwally, 2003).

Interaction effect between dietary protein levels and VE and Se supplementation on the previous studied traits indicated that the presence of supplemented VE and Se with any level of dietary protein resulted in improvements in egg weight and egg number and egg mass (Table 3). It could be concluded that the level of 18% CP along with VE and Se supplementation would be recorded the highest egg mass.

Feed intake and feed conversion ratio

The effects of dietary protein levels on feed intake during the whole experimental period recorded an increase (P<0.05) with the decrease of CP levels as shown in table 3. It is worthy noting that feeding quail on 16 % CP resulted in 5.30 and 8.42 % higher in feed intake than that of 18 or 20 % CP, respectively. Regarding the amount of feed intake (g/period) by the experimental quail, it is observed that feed intake increased with decreasing CP levels.

These results are in agreement with those obtained by Mohammed (1990) who found that increasing level of protein in the quail diets caused a decrease in the amount of feed intake. Aggoor *et al.*(1997) in broiler, also Abdel-Azeem *et al.*(2005) found that feed intake of laying quail significantly (P<0.05) decreased with increasing protein levels. Abou Raya *et al.*(1982) found that the feed intake of laying hen decreasing level of protein caused a increase in the amount of feed intake.

Feed conversion ratio (g feed intake /g egg mass) revealed significantly worst (P<0.05) decreased by low protein level in diet (Table 3). Level of 16% became significantly (P<0.05) worst values, while level of 18% recorded best ones.

Regardless of protein level results cleared that feed intake during the whole experimental period recorded an increase (P<0.05) with the supplemented of VE and Se compared to unsupplemented diets (Table 3). Feed conversion ratio revealed significantly (P<0.05) improved with VE and Se in diet (Table 3). The reduction observed in feed conversion ratio may result from the decreased egg mass as a result of unsupplemented in the diets. It appears that, quail fed on diets with VE and Se improved feed conversion ratio by 9.72 % compared to unsupplemented in the diets.

Improvement could be attributed to the biological functions of VE such as its role in enzymatic oxidation reduction, nucleic acids metabolism and in promoting the activity of oxidized substances such as carotenoids (Kennedy *et al*.,1992; Hossain and Sergio,1995).

Interaction effect between dietary protein levels and VE and Se supplementation indicated that supplemented VE and Se with any level of dietary protein resulted in improvement in feed conversion ratio. It is worthy noting that feeding quail on 18 % CP with VE and Se in diet improved feed conversion ratio.

Protein intake and efficiency of protein utilization

Effects of dietary protein level on protein intake and efficiency of protein utilization as shown in Table (3). It is clear that the quail fed diet of high protein (20%) recorded higher protein intake than those fed low protein level (16%). This may be due to that the protein intake was increase with increased percentage of protein level in the diets.

The efficiency of protein utilization was higher with lower protein level during the whole experimental period. Level of 16% CP recorded highest values (1.57) followed by 18%, while 20% recorded the lowest values.

These results are in agreement with those of Aggoor *et al*.(1997) who found that protein intake increased with increasing protein level, while protein efficiency ratio decreased with increasing protein level. Zeweil (1996) found that efficiency of protein utilization improved significantly ($P<0.01$) by decreasing protein level of quail diet. Abou Raya *et al.*(1982) found that efficiency of protein utilization was higher with lower protein level in laying hens.

Regardless of protein level results cleared that protein intake (g) during the whole experimental period recorded an increase with the supplemented of VE and Se compared to unsupplemented diets as shown in Table (3). Efficiency of protein utilization during the whole experimental period was improved by supplemented of VE and Se, which recorded higher value.

Interaction between dietary protein levels and VE and Se supplementation indicated that the presence of supplemented with any level of dietary protein resulted in improvements in the obtained values of protein efficiency of utilization (Table 3).

Hatchability

Results on hatchability percentage ranged from 79.32 to 81.85 in the present study recorded a non-significant difference among groups (Table 3).

It is worthy noting that feeding quail on the higher protein level (20% CP) had the lowest hatchability percentage (79.32%), the best hatchability percentage for the 18% protein diets (81.85%), while the lower protein level (16% CP) gave the intermediate hatchability percentage (80.24%).

Similar results were recorded by Begin and Insko (1972), Lee *et al*.(1981) and Shrivastav *et al*.(1983) who found that the protein level had no significant effect on hatchability in quail. Abdel-Azeem *et al.*(2005) found that higher protein level (20% CP) had the lowest hatchability percentage, while the best hatchability percentage was obtained by 18%.

Regardless of protein level results cleared that hatchability percentage increased ($P<0.05$) with supplemented of VE and Se by 5.75% compared to that of the unsupplemented (Table 3). These results are in agreement with those reported by Abd EL-Latif (1999) who found that VE and Se supplemented to laying quail diets were improved ($P<0.05$) of hatchability percentage.

These results assert the biological function of VE or Se. Tengerdy and Nockels (1973) reported that Vitamin E tends to maintain or increase egg production and hatchability laying hens.

3

Interaction effect between dietary protein levels, VE and Se supplementation indicated that supplemented VE and Se with any level of dietary protein resulted in improvement (P<0.05) in hatchability percentage.

Mortality rate

There was no incidence of mortality occurred during the experimental period. Johri and Vohra (1977) and Mohammed (1990) found that the mortality rate did not significantly influence by dietary protein levels. Salwa *et al.*(2004) reported that dietary additions of VE and Se supplementation caused an increase in the values of antibody. Moreover, Franchini *et al*. (1995) indicated that the main role of VE is the activation disease resistance of birds.

Egg quality traits

Results in table 4 showed that egg quality traits, albumen %, showed a significant (P<0.05) increase, while yolk % (P<0.05) decrease with the increase of protein level. Yolk index, eggshell and shell thickness (mm) were not significantly affected by different dietary level crude protein.

These results are in agreement with those of Zofia *et al.*(2006) found that increasing protein level (17,19 or 20% CP) on laying quail cause significantly (P<0.05) increase of albumen %, while yolk % decrease (P<0.05) with the increased protein level. Abdel-Azeem *et al.*(2005) who found that increasing crude protein level in laying quail diets decreased yolk index.

Irrespective of protein level, Albumen and yolk were improved (P<0.05) with supplemented of VE and Se (Table 4). It is clear that supplemented of VE and Se increased yolk % by 3.59%, while albumen % decreased by 1.53 % than that of the unsupplemented of VE and Se.

Interaction effect between dietary protein levels and VE and Se supplementation on the previous studied traits indicated that the presence of supplemented VE and Se with any level of dietary protein resulted in improvements in egg quality traits.

Digestibility and nutritive values of the experimental diets

Apparent digestion coefficients of nutrients content and nutritive values as affected by dietary protein levels, VE and Se supplementation and their interaction during laying period are summarized in Table (5).

The digestibility of CP, CF and EE% decreased significantly (P<0.05) as dietary protein increases, this may be due to the dietary protein level increases the amount of uric acid increases, consequently the digestion coefficient decreases.

Yamazaki *et al*. (1996) showed that the excretion of nitrogen increased as protein level increased. Mitchell (1942) found that when protein intake exceeds the efficiency of protein requirement, its utilization decreases rapidly, since protein can be not stored in body to any appreciable extent.

4

5

These results are in agreement with those of Aggoor *et al*.(1997), Attia (1986) and Ghazalah *et al*.(1988) who found that increasing protein levels decreased digestibility of CP and CF%. Abd–Elsamee (2002) reported that digestibility coefficients of CP, EE and NFE were increased significantly (P<0.05) with using 18% level of crude protein.

On the other hand, It is worthy noting that there were no significant differences in digestibility of NFE among the different experimental diets.

Nutritive values expressed as DCP, TDN % and ME (kcal/kg) of the experimental diets were gradually increased (P<0.05) with the increasing of CP level in the diet.

Irrespective of protein level, digestion coefficients of nutrients content as affected by supplemented of VE and Se are illustrated in Table (5).

It appears that quail fed on diets with VE and Se significantly (P<0.05) improved digestion coefficients CP, CF, EE and nutritive values compared to unsupplemented diets.

Selenium may affect metabolism and production performance because it is essential for the synthesis of active thyroid hormones. Thyroid hormones increased metabolic rate (Hadley, 1984). Ferit *et al.* (2003) found that influenced by dietary VE and Se inclusions in a greater (P<0.01) serum concentration of triiodothyronine (T3), thyroxine (T4) thyroid stimulating hormone (TSH), Ca, P and K, while urea, cholesterol and Na were decreased (P<0.01).

Furthermore, the improvement of performance as a result of adding growth promoter may be due to reducing bacterial utilization of essential nutrients, allowing increased synthesis of vitamins and growth factors, improving the absorption of nutrients by reducing the thickness of intestinal epithelium; reducing intestinal mucosa epithelial cell turnover and reducing intestinal motility (Prescott and Baggot,1993).

Generally, the results showed that the improvement of digestibility coefficients of nutrients and nutritive values with supplemented of VE and Se compared to unsupplemented diets (Table 5).

It is of great importance to note that the results of the digestion trial were coincided generally with the positive response in productive performance and feed utilization of quail birds with supplemented of VE and Se.

Interaction effect between dietary protein levels and VE and Se supplementation on the previous studied traits indicated that the presence of supplemented VE and Se with any level of dietary protein resulted in improvements in digestibility coefficients. The nutritive values expressed as DCP, TDN % and ME kcal/kg were increased significantly (P<0.05) by any level of dietary protein with supplemented VE and Se.

Economical evaluation

Economical values as affected by the dietary protein level or VE and Se are in presented in Table (6). A higher economical efficiency recorded by using 18% CP level followed by 16 % CP than that of 20% CP level.

Table (6): Economical evaluation of laying Japanese quail as affected by dietary protein levels and VE and Se supplementation and their interaction

Protein level	VE and Se	Feed convers-ion ratio	Cost of Kg feed (L.E)	Feed cost of kg egg (L.E)	Net revenue (L.E)	Economic efficiency
16	-	3.95	1.269	5.013	9.987	199.22
18	-	3.68	1.325	4.876	10.124	207.63
20	-	3.71	1.405	5.213	9.787	187.74
-	S0	3.95	1.308	5.167	9.833	190.30
-	S1	3.60	1.358	4.889	10.111	206.81
Interaction						
16	S0	4.11	1.244	5.113	9.887	193.37
16	S1	3.78	1.294	4.891	10.109	206.69
18	S0	3.87	1.300	5.031	9.959	198.15
18	S1	3.48	1.350	4.698	10.302	219.28
20	S0	3.88	1.380	5.354	9.646	180.16
20	S1	3.53	1.430	5.048	9.952	197.15

Market price of one kg egg = 15 L.E.
Cost of kg feed calculated according to price of feed ingredient at the same time of the experiment (2006).
S0= diet without Vitamin E and selenium.
S1= diet with Vitamin E and selenium.

Irrespective of protein levels, VE and Se supplementation resulted in improvement in the obtained value of economical efficiency comparable with the unsupplemented diet during the experimental periods.

Interaction between dietary protein levels, VE and Se showed that the medium protein level (18%) with VE and Se supplementation recorded the higher economical efficiency followed by low protein level (16%) then those fed high protein 20%(Table 6).

Generally, quail fed diets containing 18% CP and supplemented with VE and Se improved net revenue the economical efficiency.

Conclusion, based on results obtained in the present study, it could be concluded that crude protein level of 18 % supplemented with Vitamin E and selenium (50 mg VE and 1 mg Se /kg diet) in the laying Japanese quail diet improve the productive performance and a better economic efficiency.

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استجابة السمان اليابانى البياض لمستويات مختلفة من البروتين مع أو بدون إضافة فيتامين هـ والسيلينيوم

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استخدم في هذا البحث عدد ٢٧٠ طائر سمان ياباني عمر ٤ أسابيع و حتى عمر ٢٢ أسبوع. استهدفت التجربة دراسة استجابة السمان الياباني البياض لمستويات مختلفة من البروتين مع أو بدون إضافة فيتامين هـ والسيلينيوم . حيث قسم السمان عشوائيا في نظام تحليل تباين عاملى (٢x٣) الى ثلاثة مجموعات رئيسية غذيت على نسب متدرجة من البروتين الخام ١٨،١٦ و٢٠% على التوالى. وقسمت كل مجموعة رئيسية إلى تحت مجموعتين بكل منها ٣٠ أنثى و١٥ ذكر. غذيت تحت المجموعة الأولى على عليقة بدون إضافة (فيتامين هـ وسيلينبوم) , بينما غذيت تحت المجموعة الثانية على عليقة أضيف إليها فيتامين هـ (الفا توكوفيرول) والسيلينيوم (سيلينات الصوديوم) بمعدل ٥٠ مجم فيتامين هـ و ١مجم سيلينيوم. وكانت العلائق المستخدمة متشابهة في الطاقة الممثلة ٢٩٠٠ كيلو كالورى /كيلوجرام و الألياف الخام.

يمكن إيجاز أهم النتائج في النقاط التالية:

- سجل كل من وزن الجسم الحي والتغير في وزن الجسم تحسنا مع مستوى البروتين ١٨% بينما سجلت المجموعة المغذاة على ١٦ % بروتين خام اقل القيم خلال الفترة التجريبية.
- لم يسجّل العمر عند النضج الجنسي فروقا معنوية باختلاف مستوى البروتين الخام.
- سجل وزن البيضة انخفاضا معنويا(عند مستوى ٥%) بينما سجل عدد البيض وكتلة البيض زيادة معنوية(عند مستوى ٥%) وذلك بانخفاض مستوى بروتين العليقة أثناء الفترة التّجريبيّة.
- لوحظ زيادة استهلاك الغذاء معنوياً (عند مستوى ٥%) وذلك بانخفاض نسبة البروتين, حيث سجلت المعاملة المغذاة على ١٦ % اكبر القيم استهلاكا للغذاء.
- سجل معدل تحويل الغذاء(جم غذاء مستهلك / جم كتلة البيض) عند نسبة ١٨ % بروتين خام افضل القيم معنويا(عند مستوى ٥%) بينما سجلت نسبة ١٦ % بروتين خام أسواء القيم.
- لوحظ زيادة استهلاك البروتين وذلك بزيادة مستوى البروتين فى العليقة.
- سجلت الكفاءة النسبية للبروتين افضل القيم مع مستوى البروتين المنخفض.
- لم تسجل النسبة المئوية للفقس فروق معنوية باختلاف نسبة البروتين في العليقة.
- سجّلت النسبة المئوية للبياض وسمك القشرة ووزن القشرة ارتفاعا معنويا(عند مستوى ٥ %) بينما سجلت النسبة المئوية للصفار انخفاضا غير معنوي وذلك بزيادة نسبة البروتين.
- أظهرت معاملات الهضم الظاهرية لكلا من البروتين والألياف الخام و معامل هضم مستخلص الأثير انخفاضا معنويا (عند مستوى ٥ %) بزيادة البروتين بينما لم يتأثر معنويا معامل هضم المستخلص الخالي من النتروجين بمستوى البروتين.
- حققت المجموعة المغذاة على ١٨ % بروتين أفضل عائد صافي للتغذية بالإضافة إلى أعلى قيمة كفاءة اقتصادية .
- لوحظ أن هنالك تأثير إيجابي ومعنوي بإضافة فيتامين هـ والسلينيوم على وزن الجسم والتغير في وزن الجسم و معدل التحويل الغذائي.
- أدى إضافة فيتامين هـ والسيلينيوم إلى تحسن معنويا (عند مستوى ٥%) في عدد وكتلة البيض بمقدار ١٠،٤٥- ١٥،٣٩ % على التوالي , مقارنة بعدم الإضافة.
- أدى إضافة فيتامين هـ والسيلينيوم إلى تحسن معنوي(عند مستوى ٥ %) في نسبة الفقس.

تحسنت معاملات الهضم الظاهرية والقيم الغذائية بإضافة فيتامين هـ والسيلينيوم.

- حققت نسبة ١٨ % بروتين مع إضافة فيتامين هـ والسيلينيوم و افضل معدل تحويل غذائي و أفضل عائد صافي وكفاءة اقتصادية.
- تحسنت الكفاءة النسبية للبروتين بإضافة فيتامين هـ والسيلينيوم.
- لوحظ وجود تأثيرات معنوية راجعة للتداخل بين مستوى البروتين واضافة فيتامين هـ والسيلينيوم وقد كان التحسن واضح باستخدام مستوى البروتين ١٨ % مع إضافة فيتامين هـ والسيلينيوم.

من الوجهة الغذائية والاقتصادية توصى الدراسة بإمكانية استخدام مستوى بروتين ١٨ % مع إضافة فيتامين هـ والسيلينيوم حيث كان التأثير إيجابي على معدلات أداء الإنتاج و العائد الاقتصادي.

Table (3). Egg weight, egg number, egg mass, feed intake, feed conversion, protein intake, efficiency of protein utilization and hatchability ($\bar{X}$ ±SE) of laying Japanese quail as affected by protein level, VE and Se supplementation and their interaction

Treatments		Egg weight (g)	Egg number/ bird / day	Egg mass (g)/ bird/day	Feed intake (g)/ bird/day	Feed conversion ratio	Protein Intake (g)/ bird/day	Efficiency of Protein utilization	Hatchability %
Protein level	VE and Se								
16	-	11.19±0.06 b	0.72±0.07 a	8.07±0.22 ab	31.72±1.20 a	3.95±0.33 a	5.13±1.05	1.57±0.33	80.24±3.92
18	-	11.54±0.03 a	0.71±0.05 a	8.20±0.21 a	30.04±1.00 ab	3.68±0.20 b	5.45±1.10	1.50±0.20	81.85±.4.05
20	-	11.56±0.04 a	0.68±0.05b	7.87±0.19 b	29.05±1.05 b	3.71±0.22 ab	5.87±1.13	1.34±0.22	79.32±4.97
Sig.		*	*	*	*	*	n.s	n.s	n.s
-	S0	11.16±0.07b	0.67±0.08b	7.47±0.41 b	29.53±1.21 b	3.95±0.32 a	5.35±1.15	1.40±0.32	78.22±4.65 b
-	S1	11.70±0.05 a	0.74±0.06a	8.62±0.30 a	31.01±1.05 a	3.60±0.41 b	5.62±1.07	1.54±0.41	82.72±3.01 a
		*	*	*	*	*	n.s	n.s	*
Interaction									
16	S0	10.86±0.08 b	0.69±0.06b	7.49±0.25b	30.78±1.22 a	4.11±0.30 a	4.98±1.32 b	1.50±0.35	77.92±4.01 b
16	S1	11.52±0.05 a	0.75±0.04 a	8.64±0.22 a	32.66±1.10 a	3.78±0.41ab	5.28±1.21 b	1.64±0.30	82.56±3.06 a
18	S0	11.30±0.07b	0.68±0.08 b	7.68±0.30 b	29.72±1.05 ab	3.87±0.29 a	5.39±1.10 a b	1.42±0.20	79.72±3.91 b
18	S1	11.78±0.05 a	0.74±0.06 a	8.72±0.26 a	30.35±1.11 b	3.48±0.32 b	5.51±1.09 a	1.58±0.22	83.98±3.22a
20	S0	11.32±0.07 ab	0.64±0.07b	7.24±0.29b	28.09±1.20b	3.88±0.39 a	5.68±1.30a	1.27±0.25	77.01±4.30 b
20	S1	11.80±0.06 a	0.72±0.05 a	8.50±0.26 a	30.01±1.09b	3.53±0.42 b	6.07±1.13a	1.40±0.29	81.62±3.09 a
Sig.		*	*	*	*	*	*	n.s	*

a,b. means in each column within each item, bearing the same superscripts are not significantly different (P<0.05).
Sig.= Significant. n.s= not significant.
S0= diet without Vitamin E and selenium.
S1= diet with Vitamin E and selenium.

Table (4). Egg quality ($\overline{X}$ ±SE) of laying Japanese quail as affected by protein level, VE and Se supplementation and their interaction

Treatments		Egg weight (g).	Yolk %	Albumen %	Egg shell %	Yolk index %	Shell thickness (mm)
Protein level	VE and Se						
16	-	10.82±0.06[b]	31.98±0.03[a]	53.46±0.08[b]	13.57±0.03	49.74±0.05	0.22±0.05
18	-	11.51±0.09[ab]	31.60±0.02[ab]	54.06±0.07[ab]	13.75±0.02	49.37±0.09	0.23±0.03
20	-	11.69±0.10[a]	30.91±0.03 [b]	54.34±0.05[a]	13.94±0.03	49.26±0.10	0.24±0.04
Sig.		*	*	*	n.s	n.s	n.s
-	S0	11.16±0.04[b]	30.92±0.11[b]	54.36±0.09[b]	13.65±0.03	49.30±0.07	0.22±0.04
-	S1	11.52±0.02[a]	32.07±0.09[a]	53.54±0.06[a]	13.86±0.02	49.60±0.05	0.23±0.03
Sig.		*	*	*	n.s	n.s	n.s
Interaction							
16	S0	10.51±0.10[b]	31.41±0.08[b]	53.91±0.09[ab]	13.51±0.05	49.62±0.07	0.22±0.03
16	S1	11.13±0.09[b]	32.55±0.05[a]	53.00±0.07[b]	13.62±0.04	49.85±0.09	0.23±0.05
18	S0	11.46±0.06[ab]	31.11±0.07[b]	54.50±0.08[a]	13.60±0.04	49.28±0.08	0.22±0.04
18	S1	11.55±0.07[a]	32.09±0.06[ab]	53.61±0.06[b]	13.90±0.02	49.45±0.06	0.23±0.03
20	S0	11.51±0.06[a]	30.25±0.08[b]	54.68±0.08[a]	13.83±0.05	49.01±0.05	0.23±0.05
20	S1	11.87±0.08[a]	31.57±0.07[b]	54.00±0.06[a]	14.05±0.03	49.51±0.09	0.24±0.04
Sig.		*	*	*	n.s	n.s	n.s

[a,b]. means in each column within each item, bearing the same superscripts are not significantly different (P<0.05).
Sig.= Significant. n.s= not significant.
S0= diet without Vitamin E and selenium.
S1= diet with Vitamin E and selenium.

Table (5). Digestion coefficients and nutritive values ($\overline{X}$ ±SE) of the experimental diets as affected by dietary protein level, VE and Se supplementation and their interaction

Treatments		Apparent digestion coefficients %				Nutritive values		
Protein level	VE and Se	Crude protein (CP)	Crude fiber (CF)	Ether extract (EE)	Nitrogen free extract (NFE)	Digestible crude protein (DCP)	Total digestible nutrients (TDN)	Metabolizable energy (ME)
16	-	83.39±2.53^{a}	27.32±2.52^{a}	89.12±2.02^{a}	87.75±2.89	13.48±1.01^{b}	63.04±1.02^{b}	2648±12.01^{b}
18	-	82.69±2.12^{ab}	27.02±2.01^{ab}	88.10±1.99^{ab}	87.54±3.01	15.01±1.23^{a}	63.43±1.11^{b}	2664±14.11^{b}
20	-	82.44±2.29^{b}	26.20±2.45^{b}	87.88±2.07^{b}	88.01±3.10	16.66±1.45^{a}	65.51±1.30^{a}	2751±13.21^{a}
Sig.		*	*	*	n.s	*	*	*
-	S0	82.18±2.32^{b}	26.35±2.44^{b}	87.00±3.01^{b}	86.88±3.20	14.93±1.00^{b}	63.51±2.01^{b}	2667±14.24^{b}
-	S1	83.42±2.01^{a}	27.34±2.25^{a}	89.73±2.53^{a}	88.27±2.87	15.15±1.19^{a}	64.46±1.79^{a}	2707±10.51^{a}
Sig.		*	*	*	n.s	*	*	*
Interaction								
16	S0	82.79±3.05^{b}	27.03±2.41^{a}	88.01±2.20^{a}	87.00±3.02	13.39±1.14^{b}	62.49±1.92^{b}	2625±12.23^{b}
16	S1	83.99±2.25^{a}	27.61±2.01^{a}	90.23±2.03^{a}	88.50±2.95	13.58±1.32^{b}	63.59±2.01^{b}	2671±15.36^{b}
18	S0	81.76±2.39^{b}	26.54±2.26^{b}	87.00±2.01^{ab}	87.15±2.24	14.83±1.01^{ab}	62.98±1.56^{b}	2645±14.02^{b}
18	S1	83.38±2.06^{a}	27.50±2.19^{a}	89.20±2.08^{a}	87.92±2.56	15.13±1.78^{a}	63.83±1.44^{b}	2681±11.30^{ab}
20	S0	81.98±3.01^{b}	25.48±2.51^{b}	86.00±3.01^{b}	87.63±3.01	16.57±1.90^{a}	65.07±1.83^{a}	2733±10.42^{a}
20	S1	82.89±2.95^{ab}	26.92±2.27^{ab}	89.75±2.91^{a}	88.39±2.91	16.75±1.81^{a}	65.95±1.58^{a}	2770±14.42^{a}
Sig.		*	*	*	n.s	*	*	*

^{a,b}. means in each column within each item, bearing the same superscripts are not significantly different (P<0.05).
Sig.= Significant. n.s= not significant.
S0= diet without Vitamin E and selenium.
S1= diet with Vitamin E and selenium.