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EFFECT OF DIETARY LEVELS OF CALCIUM AND VITAMIN D_3 AND THEIR INTERACTIONS ON THE PERFORMANCE OF JAPANESE QUAIL CHICKS.

By

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Abstract: *A total number of 450 unsexed day-old Japanese quail chicks were used to study the effect of different dietary levels of Ca , vit.D_3 and their relationship on the performance of Japanese quail chicks. Chicks were randomly distributed into 6 equal groups of 3 replicates each. Three levels of calcium (0.8, 1.0 &1.2 %) and 2 levels of vit.D_3 (1100 control & 2200 IU) were added to 6 starter-grower corn-soybean meal experimental diets that formulated to be of iso-nutritive value (24 % CP & 2900 kcal ME/kg). Three levels of calcium (2.5, 3.0 &3.5 %) and 2 levels of vit.D_3 (1100 control & 2200 IU) were also added to 6 layer corn-soybean meal experimental diets that formulated to be similar in their protein and energy content (20 % CP & 2900 kcal ME/kg).*

At 42 days of the age, 6 birds from each treatment were slaughtered to determine carcass traits, edible parts, immunological and reproductive organs and tibia bone measurements and analysis. Six blood samples were taken from each group and assayed to determine some serum biochemical parameters. Digestibility trials (3 cocks for each dietary treatment) were conducted to determine nutrients digestibility for different starter-grower experimental diets. At the laying period, egg weight (EW) , mass (EM) and production (EP), feed intake (FI) and conversion (FC) and hatching parameters were recorded. Ten eggs were randomly taken from each treatment every 4 weeks and broken out to determine some egg characteristics.

Regarding growing performance, the main results obtained illustrated that feeding diet containing 1.0 % Ca + 1100 or 2200 IU Vit.D_3 gave significant improvement in BW, BWG and FC as compared to the other dietary treatments. It also caused significant increase in carcass, dressing, edible giblets (liver, heart and gizzard), thymus, bursa, spleen, oviduct and ovary and significant decrease in abdominal fat % as compared to the other *dietary treatments. It also caused significant increase in the CP and CF digestibility as compared to other dietary treatments. Feeding diet containing Ca at the three mentioned levels + the high level of Vit.D_3 gave significant increase in serum Ca and P levels. Feeding diet containing 1.2 % Ca + Vit.D_3 levels gave significant increase in serum creatinine level.*

Concerning laying performance, the main results obtained illustrated that feeding diet containing 3.0 % Ca + 1100 or 2200 IU Vit.D_3 gave significant improvement in egg production (EP), egg number (EN), egg weight (EW), egg mass (EM) and feed conversion (FC) as compared to the other dietary treatments. It also caused significant increase in hatchability %, hatch weight and significant decrease in rickets % as compared to the other dietary treatments. It also caused significant increase in the egg shape index (ESI) %, shell weight (SW) %, shell thickness (ST) and shell Ca and P % as compared to the other dietary treatments.

INTRODUCTION

Japanese quail is the smallest species raised for meat and egg production **(Panda and Singh, 1990),** it has assumed worldwide importance as a laboratory animal for pilot studies that would be applied in chickens **(Baumgartner, 1990).** Distinct characteristics include rapid growth, enabling quail to be marketed for consumption at 6 weeks of age, early sexual maturity resulting in a short generation interval, high rate of lay and much lower feed intake and rearing space requirements than the domestic fowl.

Production of animal protein (meat or eggs) from commercial rearing of Japanese quail has been recently initiated in Egypt. However, one of major obstacle in quail industry is the limited knowledge of the nutrients requirements. Little work had been done on the effects of mineral requirements on the performance of Japanese quail in Egypt.

Calcium is the most abundant mineral element that plays an important role in variety of biological functions. It is one of the nutrients required for maintenance and production of Japanese quail chicks; it is largely used for skeleton, egg and eggshell formation **(Boling *et al*., 2000)**. The low cost of Ca, together with the fact that Ca is a limiting factor in egg production and egg shell quality, may lead to excessive use of this element in the laying hens diets.

Vitamin D_3 is necessary for the bird to absorb, transport and utilize calcium and phosphorus through the intestinal wall. Total calcium absorption and deposition are controlled by the active metabolite of cholicalciferol which converted to 1, 25 dihydroxycholicalciferol **(Holick and Deluca, 1974 and Norman, 1987). Cohene *et al.* (1978)** found that calcium absorption was enhanced by adding 75mg of cholicalciferol into Kg experimental diet. **Wood *et al.* (1998)** reported that sub-optimal cholicalciferol status may be an important factor in reducing plasma 1, 25 dihydroxycholicalciferol and intestinal calcium absorption efficiency. **Keshavarz (1996)** observed an improvement in eggshell quality and bone mineralization by increasing the level of dietary cholicalciferol above the practical level. Reduction in 1, 25 dihydroxycholicalciferol is highly responsible for the impairment of egg shell quality and calcium turnover of old layers.

Because of the demands for adequate skeletal development of the rapidly growing quails and the variability of Ca in animal by-product feeds, it is necessary to provide an adequate margin of safety in poultry diets including quail rations **(Yan *et al*., 2001).**

The National Research Council **(NRC,1994)** recommendations of calcium (Ca) and Cholicalciferol (vit.D_3) for starting-growing and laying quails are 0.8, 2.5 % and 750, 900 ICU, respectively.

The **purpose** of the current study is to evaluate the effects of dietary different levels of Ca & vit.D_3 and their interactions on growing and production performance of Japanese quails, during their early and late stages of production. Egg quality traits were also investigated.

MATERIALS AND METHODS

This experiment was carried out at El- Fayoum Poultry Research Station, Animal **Production** Research Institute, Agriculture Research Center, Ministry of Agriculture, Dokki, Egypt**.** It was started on March 2004 and terminated 20 weeks later. It was consisted of two periods, the first one served as growing period of 6 weeks, followed by 14-weeks as laying period.

Experimental Birds, Design, Diets and Treatments:

A total number of 450 unsexed one-day old Japanese quail chicks produced in one hatch were used in a 42 days growing experiment. Chicks were **individually** wing-banded, weighed and randomly distributed in battery cages into 6 equal groups of 3 equal replicates each (3 replicates × 25 birds/group) so that, the average initial live body weight (BW) was insignificantly different in all groups.

A total number of 324 six-weeks old Japanese quail chickens were used in a 90 days laying experiment. They were randomly distributed into 6 equal groups of 3 replicates each {3 replicates × 18 birds (6males &12 females)/group} and reared in battery laying cages.

Six starter-grower and layer corn-soybean meal diets were formulated to be of iso nutritive value being 24 & 20% CP and 2900 kcal ME/kg for the starter-grower and the layer diets, respectively. Experimental diets were formulated to cover all recommended nutrient requirements according to **NRC (1994)**, but differed only in calcium and vit.D_3 content.

Treatments were designed in a 3X2 factorial arrangement of 3 levels of Calcium (0.8, 1.0 &1.2 %) during starting / growing period and (2.5, 3.0 & 3.5 %) during laying period (with constant Ca: P ratio, being 2:1) and 2 levels of vit.D_3 (1100 control & 2200 IU /Kg diet). Therefore, six experimental groups were used in both starting-growing and laying periods, respectively. Diets and water were offered *ad-libtium* allover the experimental periods.

The composition and chemical analysis of the experimental diets are presented in Table (1).

Chicks in all treatments were kept as possible under similar managerial and hygienic conditions.

Measurements and Methods of Interpreting Results:

Growth Performance:

Individual live body weight (BW) and average feed intake (FI) values were weekly recorded. Live body weight gain (BWG) and feed conversion (FC, g feed/g gain) were also calculated. Mortality rate % was calculated when it happened.

Slaughter test:

On the day 42 of the experiment, a total number of 36 birds (3 males + 3 females/ treatment) were chosen based on treatment mean for slaughter test. Abdominal fat was removed from the gizzard and abdominal region and individually weighed for each carcass. Ovary and oviduct were carefully separated and accurately weighed. After the removal of head, viscera, shanks, spleen, gizzard, heart, liver and abdominal fat, the rest of the body was weighed. Each of carcass components was proportionate to the live body weight.

Blood constituents:

Thirty six blood samples (3 males & 3 females / treatment) were withdrawn from wing vein and serum samples were separated by centrifugation for 10 minutes (3000 rpm) and stored in vials at –20 ^{o}C for later analyses. Frozen serum was thawed and assayed to determine, on individual basis, some biochemical parameters using Atomic Absorption Spectrophotometer and values were expressed as mg/100 ml. Concentration of thytoxine (T_4) and triiodothytoxine (T_3) were determined by the double antibody radioimmunoassay with commercial purchased kits from antibodies incorporated (P.O. Box 442, Davis, California 95616). The radioactivity was measured by gamma counter as described by **Peebles and Marks (1991)**. Calcium and phosphorus content of serum and bones were determined by using chemical kits (Bicon, Germany). The spectrophotometric technique **(Henry, 1974)** was used to determine serum calcium and phosphorous.

Tibia bones were dissected out, cleaned of flesh and oven-dried at 60 ^{o}C to constant weight. Tibia bones were weighed; lengths and widths were determined using caliper to the nearest (mm.). Calcium of tibia bones was determined according to **A.O.A.C. (1990).**

Digestibility Trails:

A total number of 18 adult cocks of 7-wks old were individually housed in metabolic cages and used for carrying out 6 digestibility trials (3 trials /dietary treatment). Chemical analysis of the experimental diets, excreta and faces were carried according to **A.O.A.C. (1990)**. NFE was calculated by difference. Fecal nitrogen was determined according to **Jakobsen *et al*. (1960).**

Egg Traits:

Eggs were daily collected and weighed. Averages of egg number (EN), egg weight (EW) and egg mass (EM) were weekly calculated per each replicate and treatment from 8 to 20 weeks of age. At 12, 16 and 20 weeks of age, 10 eggs were randomly taken from each treatment and individually weighed. Egg shape index (ESI) was determined according to **Stadleman (1977)**. Eggs were broken out and shell weight (SW) % was measured. Shell thickness (ST) was also measured by using a micrometer as an average of three points (top, medial and base).

Shell nutrient analysis including Ca and P was also performed according to **Soltanpour and Schwab (1977).**

Fertility and Hatchability:

At 10, 14 and 18 weeks of age, 60 eggs / treatment were collected from eggs laid on 4 successive days and placed into 3 trays (20 eggs / tray) in electronically incubators. Fertility and hatchability % based on fertile eggs were calculated.

Data of egg production and quality were represented totally during the period from 8-20 weeks of age.

Statistical Analysis:

Data were statistically analyzed by two-way analysis of variance according to **Steel and Torrie (1980)**. Differences among means were tested using Duncan's Multiple Range Test (**Duncan, 1955).**

RESULTS AND DISCUSSION

Growth Performance:

The main effects of dietary factors (Ca and Vit.D_3) on quail performance are illustrated in Table (2). Data indicated significant effect of Ca levels either on growth or feed utilization, however, the effect of Vit.D_3 levels did not reach significance. Therefore, the significant effect of Ca X Vit.D_3 interaction (Table 2) could be attributed to the effect of Ca levels but not to that of Vit.D_3.

The mean BW, BWG, FI and FC values of birds at 0-3 and 0-6 weeks of age are given in Table (2). The initial BW values of day old quail chicks for all treatments were nearly similar. At 0-3 wk period, supplementing Ca at the medium level (1.0%) for birds receiving Vit. D_3 with the used two levels resulted in significant increase in BW and BWG and improved FC as compared to the other dietary treatments which did not significantly differ from each other. The FI of 3-wks-old birds did not significantly differ among all dietary treatments. Results regarding the 0-6 wks period followed the same trend noticed at 0-3 wks period. On the contrary, **Reddy *et al.* (1980)** found no differences in Japanese quail body weight gain, feed intake and feed efficiency due to varying dietary Ca and P concentrations.

Carcass characteristics:

From data obtained (Table 3), it shows that Ca was the main factor affecting carcass characteristics. While, Vit.D_3 levels did not affect.

The percentages of eviscerated carcass, dressing, total edible parts, offals and abdominal fat are presented in Table (3). Adding Ca at the medium level (1.0%) in starter-grower diets of birds given Vit. D_3 with two levels led to significant increase in eviscerated carcass, dressing and total edible parts % and significant decrease in abdominal fat % compared to those given the other dietary treatments which had insignificant differences among them in these respects. The offals % of birds did not differ significantly among all the experimental dietary treatments.

Edible giblets and immunological organs % & reproductive organs:

As mentioned previously for growth, feed utilization and carcass characteristics, Ca only effects in edible giblets and immunological organs % & reproductive organs.

The results concerning edible giblets, immunological organs % and reproductive organs are summarized in Table (4). The results showed that incorporated Ca at a level of 1.0 % to birds fed diet containing Vit. D_3 with two levels resulted in significant increase in liver %, heart %, spleen %, and oviduct and ovary weights as compared to the other dietary treatments. The results also illustrated that birds fed diet containing 1.2 % Ca significantly decreased thymus and bursa % as compared to the other dietary treatments that had similar values. No significant differences were observed in gizzard % as a result of feeding dietary Ca and Vit. D_3 levels.

Tibia bone measurements and analysis

The mean values of tibia bone measurements and analysis are presented in Table (5). It was observed that Ca level did not affect tibia measurements and analysis. The values of tibia length, weight, ash, calcium and phosphorus in birds fed high vit.D_3-diets were higher than those of birds fed low vit. D_3-diets. However, no significant differences in tibia width due to the different treatments were observed. Similarly, **Abdel-Azeem and El-Shafei (2006)** found that tibia ash, calcium and phosphorous % and its measurements increased as the level of vitamin D_3 increased in Japanese quail. In this respect, **Stevens and Blair (1983)** found that tibia ash was greater in poults when fed diet containing 2400 IU of vitamin D_3/kg as compared with those fed diet containing 900 IU. Also, **Mitchell *et al.* (1997)** found that feeding chickens diet containing 5 µg of vitamin D_3/kg increased bone ash. **Aburto *et al.* (1998)** indicated that adding 25-(OH) D_3 to the diet of young broiler chickens increased bone ash.

Blood biochemical parameters:

Table (6) indicates the main effects of dietary Ca as well as Vit.D_3 levels on serum Ca and P content. Due to the direct effect of Vit.D_3 on the metabolism of Ca and P , the results showed that as Vit.D_3 level increased , Ca and P in serum increased . Therefore, serum Ca and P content increased following Vit.D_3 level.

Data of blood biochemical parameters are shown in Table (6). At 3 wks of age, results showed that serum calcium and phosphorus in birds fed high vit.D_3-diets were higher than those fed low vit. D_3-diets. However, at 6 wks of age, it was noticed that serum calcium and phosphorus in birds fed the medium level of calcium (1.0 %) were significantly decreased as compared to those given the other dietary treatments which had insignificant differences among them. This may be attributed to that the bird was adapted to treatments by increasing age.

At 3 and 6 wks of age, the results illustrated that creatinine concentration of birds fed high Ca-diets were significantly higher than those fed low or medium Ca-diets. Creatinine concentration reflects the good and poor efficiently of the kidney to clear blood from creatinine.

Stevens and Blair (1983) reported that increasing dietary calcium level had significant linear effect on plasma calcium and inorganic phosphorus. **Aburto *et al.* (1998)** indicated that adding 25-(OH) D_3 to the diet of young broiler chickens increased plasma calcium. **Mitchell *et al.* (1997)** found that feeding chicks on diet containing 5 µg of vitamin D3/kg increased plasma calcium and phosphorous.

Digestibility coefficients of nutrients:

Data of nutrients digestibility coefficients for the different starter-grower experimental diets (Table 7) showed that the highest digestion coefficient of CP was recorded for diets containing 1.0 % Ca followed by those containing 0.8 % Ca and then those containing 1.2 % Ca.

The obtained data revealed that no significant differences were detected in EE and NFE digestibilities among all dietary treatments. Regarding the digestion coefficient of CF, it was found that increasing Ca level from 0.8 to 1. % did not significantly affect digestion coefficient value. However, the digestibility coefficients of CF for diets containing the high level of Ca (1.2 %) and Vit. D_3 with its two levels were significantly lower than those of the other diets.

Laying Performance:

In respective of Vit.D_3 levels, dietary Ca levels has significant effect on performance of laying quails, however, Vit.D_3 level did not (Table 8).

Results concerning laying performance are shown in Table (8). At all ages, the results showed that adding Ca at the medium level (3.0 %) in laying quail diets given Vit. D_3 with its two levels led to significant increase in EP %, EW, EN, EM and improvement in FC as compared to the other dietary treatments that had insignificant differences among them in these respects. No significant differences were found due to treatments on FI.

The significant effect of dietary calcium level on EP %, EW and EN may be attributed to the difference existed in the rate of calcium absorption and thus to its level in blood serum and in the uterine glands. Variation in FC due to treatments may be attributed to the variation existed in both EP % and EN.

A negative influence of excess dietary Ca levels on egg production and feed intake had been reported by **Scott *et al.*(1971) and Attia (1993)**. **Attia (1993)** also showed that ranging Ca between 2.8 and 4.5% caused a depression in feed intake. However, **Summers *et al.* (1976)** and **Atteh and Leeson (1983)** showed that Ca level had no significant effect on egg production. **Keshavarz (1986)** reaveled that egg mass was consistently lower for birds fed 1.5 or 5.5 % Ca level compared to those fed 3.5 %. **Roush *et al.* (1986)** found that Ca level of 2.5 and 3.75 % improved feed efficiency, while a 5 % Ca level does not.

Hatching parameters:

As was expected, Ca levels significantly affect on the hatchability of eggs laid by the experimental quail hens. While, Vit.D_3 level had no effect on such parameters.

Data of hatching parameters are shown in Table (9). There were no significant changes in fertility % among all treatments at the different ages. At all ages, the results illustrated that the highest hatchability % was obtained for birds fed medium calcium-diets followed by those fed low-calcium-diets, however, birds fed high calcium-diets gave the lowest rat of hatchability . The results also showed that dietary Ca 3.0 % caused significant increase in hatch weights and significant decrease in rickets % in comparison to the other levels of Ca that had statistically similar effect in this respect. In this connection, **Wilson *et al.* (1980), Cherry *et al.* (1984),** and **Hasb-El** Napy **(1989),** reported that Ca level did not affect percentage fertility. **Attia (1993)** found that fertility was higher for hens fed 2.8 % calcium levels than that from 3.4 or 4.0 % calcium level. **Attia (1993)** observed that hatchability of fertile eggs was higher for hens fed 3.4 % calcium levels than that from those fed 2.8 or 4.0 % calcium level. Earlier investigators **(Titus *et al.*, 1937, Gutowska and Parkhurst, 1942)** have shown that hatchability decreases as Ca level increases.

The improvement in hatchability % may attributed to the improvement in egg shell quality, since the poor hatchability in hot climate may be partially due to thin shell eggs **(Daghir, 1995)**. The decrease in hatchability could be explained by the decrease in shell porosity recorded by this group compared to the other groups, thus increasing embryonic mortality **Chirstensen, (1983).**

Egg Quality and Analysis:

Data concerning egg shape index (ESI), and egg shell quality and analysis are presented in Table (10). The results showed that dietary Ca 3.0 % caused significant increase in ESI in comparison to the other deitary levels of Ca that had similar effect in this respect. Regarding egg shell quality, it was noticed that there were no significant changes in egg specific gravity among all treatments at the different ages, however, at all ages the results illustrated that differences in egg shell weight % followed the same trend previously mentioned in egg shape index. Moreover, the highest value of egg shell thickness was obtained for birds fed medium calcium-diets followed by those fed low-calcium-diets; however, birds fed high calcium-diets gave the lowest value. Concerning egg shell analysis, it was noticed that differences in calcium and phosphorus % followed statistically the same trend previously mentioned in egg shell thickness. The same findings were obtained by **Clunies *et al*. (1992)**.

The improvement in egg shell quality can be due to the high level in serum calcium concentration. Specific gravity of eggs is often used for measuring egg shell quality, since it is an indirect measure of the amount of shell deposition on the egg, **(Harms *et al*., 1994).** More calcium deposition is required to maintain the same specific gravity when eggs are more oblong or with more surface area. The results disagree with the findings of **Holcombe *et al* (1975)** who found differences in egg specific gravity with increasing Ca levels in Japanese quails diets. **Winget and Smith (1958)** reported a decrease in the total plasma calcium in association with shell formation.

In conclusion, under the present experimental conditions, it could be concluded that the best Ca level in Japanese quail diets are 1.0 and 3.0 % during growing and laying period , respectively plus Vit.D3 at 1100 IU.

Table (1): Composition and calculated analysis of the experimental starter-grower and layer basal diets.*

Ingredients	Percentage (%)					
	starter-grower diet			Layer diet		
	1	2	3	1	2	3
Yellow Corn, ground	55.14	54.38	54.22	58.21	56.07	52.77
Soybean meal(44% CP)	33.54	33.26	31.32	25.40	25.65	26.25
Corn gluten meal(62% CP)	7.87	8.14	9.40	6.62	6.62	6.62
Dicalcium phosphate	1.61	2.25	2.89	2.30	2.95	3.55
Limestone	0.81	0.94	1.08	5.03	5.95	6.95
Common salt (NaCl)	0.32	0.32	0.32	0.34	0.34	0.34
Premix[1]	0.30	0.30	0.30	0.30	0.30	0.30
DL-Methionine	0.05	0.04	0.04	0.06	0.07	0.07
L-Lysine HCl	0.13	0.14	0.20	0.26	0.25	0.24
Choline chloride	0.23	0.23	0.23	0.23	0.23	0.23
Vegetable Oil	0.00	0.00	0.00	1.25	1.57	2.68
Total	100.00	100.00	100.00	100.00	100.00	100.00
Calculated analysis[2]						
CP %	24.03	24.02	23.99	20.06	20.00	20.00
ME (kcal/kg)	2892	2870	2870	2900	2866	2875
CF %	3.87	3.84	3.72	3.33	3.30	3.27
EE %	2.77	2.74	2.73	4.00	4.24	5.23
Ca %	0.80	1.00	1.20	2.50	3.00	3.51
Av. Phosphorus %	0.45	0.56	0.68	0.55	0.67	0.77
L-Lysine %	1.30	1.30	1.30	1.16	1.15	1.16
DL-Methionine %	0.51	0.50	0.51	0.45	0.46	0.46
Methionine + Cyst %	0.91	0.90	0.91	0.79	0.79	0.79
Sodium %	0.14	0.14	0.14	0.15	0.15	0.15

* Starter / grower and finisher diets were assigned to two levels of vitamin D3 {i.e. 1100(control) and 2200 IU/Kg}.

[1] Vitamins and minerals premix provides per kilogram of diet: 10000 IU vitamin A, 11.0 IU vitamin E, 1.1 mg vitamin K , 1100 ICU vitamin D3, 5 mg riboflavin, 12 mg Ca pantothenate, 12.1 µg vitamin B12, 2.2 mg vitamin B6, 2.2 mg thiamin, 44 mg nicotinic acid, 250 mg choline chloride, 1.55 mg folic acid, 0 .11 mg d-biotin. 60 mg Mn, 50 mg Zn, 0.3mg I , 0. 1 mg Co, 30 mg Fe, 5 mg Cu and 1 mg Se.

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

Table (2): Effect of dietary Ca & Vit.D_3 levels on the performance of growing Japanese quail at 0 – 3 and 0 – 6 weeks of age.

Treatments Ca (%)	Vit.D_3 (IU)	Initial body weight (g/bird)	Final body weight (g/bird)	Body weight gain (g/bird)	Feed intake (g/bird)	Feed conversion (g f/g gain)
		0 - 3 wks				
0.8		7.20±0.01	62.89±0.97[b]	55.70±0.68[b]	162.29±1.88	2.92±0.01[a]
1.0		7.24±0.04	81.58±0.19[a]	74.34±0.16[a]	162.48±1.45	2.19±0.02[b]
1.2		7.17±0.01	63.37±1.30[b]	56.20±0.09[b]	160.99±0.35	2.87±0.01[a]
	1100	7.21±0.04	68.59±6.59	61.38±6.56	161.89±1.05	2.69±0.25
	2200	7.20±0.01	69.97±5.71	62.77±6.20	161.94±1.11	2.62±0.25
0.8	**1100**	7.19±0.14	61.93±4.21[b]	54.74±0.52[b]	160.41±2.61	2.93±0.05[a]
	2200	7.21±0.11	63.86±5.23[b]	56.65±0.54[b]	164.16±3.63	2.90±0.06[a]
1.0	**1100**	7.28±0.16	81.77±5.06[a]	74.49±0.61[a]	163.92±2.10	2.20±0.02[b]
	2200	7.21±0.17	81.39±4.01[a]	74.18±0.41[a]	161.03±2.95	2.17±0.04[b]
1.2	**1100**	7.16±0.10	62.07±3.81[b]	54.91±0.46[b]	161.33±2.31	2.94±0.07[a]
	2200	7.18±0.18	64.66±3.92[b]	57.48±0.33[b]	160.64±2.62	2.79±0.08[a]
		0 - 6 wks				
0.8		7.20±0.01	187.41±0.7[b]	180.21±0.69[b]	543.15±1.05	3.02±0.01[a]
1.0		7.25±0.01	220.64±1.43[a]	213.40±1.43[a]	542.39±1.02	2.54±0.01[b]
1.2		7.17±0.01	185.09±1.03[b]	177.92±1.02[b]	541.06±0.99	3.04±0.02[a]
	1100	7.21±0.01	196.66±11.30	189.45±11.30	541.86±0.24	2.88±0.16
	2200	7.20±0.01	198.76±11.67	191.56±11.67	542.58±1.24	2.85±0.16
0.8	**1100**	7.19±0.14	186.71±3.88[b]	179.52±4.52[b]	542.10±2.71	3.02±0.04[a]
	2200	7.21±0.11	188.10±4.31[b]	180.89±3.54[b]	544.20±3.76	3.01±0.02[a]
1.0	**1100**	7.28±0.16	219.21±5.20[a]	211.93±3.90[a]	541.37±2.29	2.55±0.07[b]
	2200	7.21±0.17	222.07±4.67[a]	214.86±4.96[a]	543.41±2.98	2.53±0.03[b]
1.2	**1100**	7.16±0.10	184.06±4.79[b]	176.90±4.66[b]	542.11±3.81	3.06±0.03[a]
	2200	7.18±0.18	186.11±3.50[b]	178.93±3.71[b]	540.14±3.64	3.02±0.06[a]

Means in the same column having different letters are significantly different ($p \leq 0.05$).

Table (3): Effect of dietary Ca & Vit.D_3 levels on carcass characteristics of Japanese quail at 6 weeks of age.

Treatments Ca (%)	Vit.D_3 (IU)	Live body weight (gm)	Eviscerated carcass (%)	Dressing (%)	Total edible parts (%)	Offals (%)	Abdominal fat (%)
0.8		199.66±0.66[b]	61.34±0.09[b]	66.08±0.08[b]	6.01±0.01[b]	27.23±0.01	1.61±0.01[b]
1.0		211.69±0.49[a]	63.61±0.09[a]	68.26±0.08[a]	6.29±0.40[a]	27.32±0.01	1.31±0.01[c]
1.2		197.53±0.49[b]	61.40±0.09[b]	66.19±0.05[b]	6.04±0.02[b]	27.21±0.01	1.68±0.02[a]
	1100	202.41±4.43	62.03±0.75	66.81±0.69	6.10±0.08	27.24±0.03	1.52±0.11
	2200	203.50±4.39	62.21±0.75	66.88±0.73	6.12±0.10	27.26±0.04	1.54±0.11
0.8	**1100**	199.00±11.88[b]	61.25±0.96[b]	66.00±0.10[b]	6.00±0.35[b]	27.22±0.61	1.61±0.09[a]
	2200	200.31±10.31[b]	61.43±1.01[b]	66.16±0.17[b]	6.01±1.10[b]	27.23±0.66	1.60±0.04[a]
1.0	**1100**	211.20±12.20[a]	63.52±1.19[a]	68.18±0.14[a]	6.25±0.89[a]	27.31±0.31	1.30±0.06[b]
	2200	212.17±11.67[a]	63.70±1.80[a]	68.33±0.11[a]	6.32±1.21[a]	27.33±0.22	1.32±0.01[b]
1.2	**1100**	197.04±14.79[b]	61.31±1.04[b]	66.24±0.16[b]	6.05±0.13[b]	27.20±0.67	1.66±0.01[a]
	2200	198.01±15.50[b]	61.49±1.10[b]	66.14±0.19[b]	6.02±1.19[b]	27.22±0.30	1.69±0.02[a]

Means in the same column having different letters are significantly different ($p \leq 0.05$).

Table (4): Effect of dietary Ca & Vit.D_3 levels on edible parts, immuno organs % and reproductive organs of Japanese quail at 6 weeks of age.

Treatments		Edible giblets (%)			Immunological organs (%)			Reproductive organs	
Ca (%)	**Vit.D_3 (IU)**	**Liver (%)**	**Heart (%)**	**Gizzard (%)**	**Thymus (%)**	**Bursa (%)**	**Spleen (%)**	**Oviduct weight (g)**	**Ovary weight (g)**
0.8		2.01±0.01^b	0.91±0.01^b	3.09±0.02	0.33±0.02^a	0.18±0.01^a	0.06±0.01^b	8.13±0.02^b	0.71±0.01^b
1.0		2.14±0.01^a	1.07±0.01^a	3.08±0.02	0.37±0.01^a	0.13±0.01^a	0.12±0.01^a	9.85±0.02^a	0.97±0.01^a
1.2		2.02±0.02^b	0.92±0.01^b	3.10±0.01	0.21±0.01^b	0.06±0.01^b	0.07±0.01^b	8.11±0.01^b	0.72±0.01^b
	1100	2.05±0.04	0.96±0.05	3.09±0.02	0.29±0.05	0.13±0.04	0.08±0.02	8.70±0.58	0.79±0.08
	2200	2.06±0.05	0.98±0.05	3.08±0.01	0.31±0.05	0.12±0.04	0.08±0.02	8.69±0.57	0.80±0.09
0.8	**1100**	2.00±0.31^b	0.90±0.07^b	3.10±0.10	0.31±0.11^a	0.18±0.04^a	0.05±0.02^b	8.11±0.34^b	0.70±0.06^b
	2200	2.02±0.18^b	0.92±0.04^b	3.07±0.21	0.35±0.02^a	0.18±0.02^a	0.07±0.05^b	8.14±0.26^b	0.71±0.08^b
1.0	**1100**	2.13±0.09^a	1.06±0.06^a	3.06±0.08	0.37±0.12^a	0.14±0.01^a	0.12±0.01^a	9.86±0.22^a	0.96±0.07^a
	2200	2.15±0.07^a	1.08±0.09^a	3.09±0.14	0.36±0.08^a	0.12±0.04^a	0.12±0.02^a	9.83±0.26^a	0.97±0.06^a
1.2	**1100**	2.03±0.16^b	0.91±0.02^b	3.11±0.04	0.20±0.10^b	0.06±0.03^b	0.07±0.04^b	8.12±0.31^b	0.72±0.08^b
	2200	2.00±0.08^b	0.93±0.03^b	3.09±0.07	0.21±0.03^b	0.05±0.01^b	0.06±0.01^b	8.10±0.23^b	0.71±0.09^b

Means in the same column having different letters are significantly different ($p \leq 0.05$).

Table (5): Effect of dietary Ca & Vit.D3 levels on tibia bone measurements and analysis of laying Japanese quail at 6 weeks of age.

Treatments		Tibia bone measurements			Tibia bone analysis		
Ca (%)	Vit.D_3 (IU)	Length (cm)	Width (cm)	Dry wt. (g)	Tibia ash (%)	Tibia Ca (%)	Tibia P (%)
0.8		4.66±0.62	0.11±0.01	0.68±0.02	30.15±6.47	19.93±1.48	3.52±1.11
1.0		4.71±0.68	0.13±0.01	0.68±0.02	27.93±6.48	19.84±1.46	3.47±1.09
1.2		4.73±0.67	0.11±0.01	0.68±0.02	26.66±6.47	18.15±2.96	3.37±1.06
	1100	4.04±0.01[b]	0.11±0.01	0.67±0.01	21.77±1.02[b]	17.34±1.08[b]	2.37±0.03[b]
	2200	5.35±0.04[a]	0.12±0.01	0.70±0.01	34.71±1.02[a]	21.27±0.09[a]	4.54±0.06[a]
0.8	1100	4.04±0.08[b]	0.10±0.01	0.67±0.05	23.68±0.13[b]	18.45±0.59[b]	2.41±0.10[b]
	2200	5.27±0.04[a]	0.11±0.01	0.70±0.07	36.61±0.15[a]	21.40±0.70[a]	4.63±0.13[a]
1.0	1100	4.03±0.03[b]	0.12±0.01	0.66±0.04	21.45±0.14[b]	18.38±0.66[b]	2.38±0.16[b]
	2200	5.38±0.08[a]	0.13±0.01	0.70±0.03	34.40±0.18[a]	21.30±0.60[a]	4.56±0.12[a]
1.2	1100	4.06±0.06[b]	0.10±0.01	0.67±0.04	20.19±0.12[b]	15.19±0.71[b]	2.31±0.14[b]
	2200	5.40±0.02[a]	0.11±0.01	0.70±0.04	33.13±0.14[a]	21.10±0.62[a]	4.43±0.17[a]

Means in the same column having different letters are significantly different (p≤0.05).

Table (6): Effect of dietary Ca & Vit.D_3 levels on some serum blood parameters Of Japanese quail at 3 and 6 weeks of age.

Treatments		Serum Calcium (mg/100 ml)	Serum Phosphorus (mg/100 ml)	Serum T3 (mg/100 ml)	Serum T_4 (mg/100 ml)	Serum Creatinine (mg/100 ml)
Ca (%)	it.D_3 (IU					
		3 wks				
0.8		10.57±0.55	4.69±0.49	2.06±0.04	9.07±0.03	4.10±0.01[b]
1.0		10.59±0.51	4.72±0.51	2.19±0.02	9.18±0.03	4.10±0.04[b]
1.2		10.60±0.51	4.74±0.50	1.98±0.03	8.96±0.05	4.89±0.02[a]
	1100	10.06±0.02[b]	4.22±0.01[b]	2.05±0.06	9.03±0.07	4.38±0.26
	2200	11.11±0.01[a]	5.21±0.02[a]	2.10±0.06	9.10±0.05	4.34±0.27
0.8	1100	10.02±0.23[b]	4.20±0.41[b]	2.02±0.14	9.04±1.60	4.11±0.16[b]
	2200	11.11±0.49[a]	5.18±0.52[a]	2.10±0.34	9.10±1.71	4.09±0.18[b]
1.0	1100	10.08±0.70[b]	4.21±0.36[b]	2.17±0.31	9.15±2.00	4.14±0.20[b]
	2200	11.10±0.52[a]	5.23±0.49[a]	2.20±0.41	9.20±1.90	4.06±0.14[b]
1.2	1100	10.09±0.29[b]	4.24±0.32[b]	1.95±0.31	8.91±1.21	4.90±0.09[a]
	2200	11.11±0.50[a]	5.23±0.26[a]	2.00±0.22	9.01±1.02	4.87±0.21[a]
		6 wks				
0.8		11.09±0.02[a]	5.20±0.01[a]	2.62±0.01	7.84±0.03	4.08±0.02[b]
1.0		10.37±0.03[b]	4.41±0.04[b]	2.65±0.01	8.01±0.09	4.11±0.04[b]
1.2		11.12±0.01[a]	5.22±0.02[a]	2.55±0.03	7.74±0.03	4.92±0.02[a]
	1100	10.76±0.34	4.93±0.28	2.59±0.03	7.81±0.06	4.37±0.28
	2200	10.96±0.15	4.95±0.26	2.62±0.02	7.91±0.10	4.37±0.27
0.8	1100	11.07±0.50[a]	5.19±0.44[a]	2.61±0.37	7.81±2.41	4.10±0.17[b]
	2200	11.10±0.64[a]	5.21±0.36[a]	2.62±0.44	7.86±2.50	4.06±0.19[b]
1.0	1100	10.07±0.33[b]	4.37±0.41[b]	2.64±0.50	7.92±2.61	4.07±0.08[b]
	2200	10.66±0.72[b]	4.44±0.66[b]	2.65±0.56	8.10±1.81	4.14±0.15[b]
1.2	1100	11.13±0.60[a]	5.23±0.51[a]	2.52±0.61	7.71±2.10	4.93±0.13[a]
	2200	11.11±0.42[a]	5.20±0.63[a]	2.58±0.66	7.77±2.30	4.90±0.23[a]

Means in the same column having different letters are significantly different (p≤0.05).

Table (7): Effect of dietary Ca & Vit.D_3 levels on nutrients digestibility of the experimental diets.

Treatments		Digestibility coefficients			
Ca (%)	**Vit.D_3 (IU)**	**Crude Protein (CP)**	**Crude Fiber (CF)**	**Ether extract (EE)**	**Nitrogen free extract (NEF)**
0.8		87.25±0.05[b]	20.25±0.15[a]	71.45±0.05	77.40±0.10
1.0		89.70±0.20[a]	20.65±0.05[a]	71.75±0.05	77.75±0.05
1.2		86.30±0.10[c]	19.05±0.05[b]	71.25±0.05	77.30±0.10
	1100	87.70±0.93	19. 93±0.44	71.47±0.12	77.47±0.12
	2200	87.80±1.10	20.03±0.52	71.50±0.17	77.50±0.17
0.8	**1100**	87.2±0.2[b]	20.1±0.7[a]	71.4±1.1	77.3±1.0
	2200	87.3±0.4[b]	20.4±1.2[a]	71.5±0.6	77.5±1.2
1.0	**1100**	89.5±0.3[a]	20.6±1.0[a]	71.7±0.7	77.7±1.7
	2200	89.9±0.5[a]	20.7±0.4[a]	71.8±0.5	77.8±1.3
1.2	**1100**	86.4±0.7[c]	19.1±0.6[b]	71.3±1.0	77.4±1.1
	2200	86.2±0.6[c]	19.0±0.5[b]	71.2±1.2	77.2±1.4

Means in the same column having different letters are significantly different ($p \leq 0.05$).

Table (8): Effect of dietary Ca & Vit.D_3 levels on performance of laying Japanese quail at 8 – 20 weeks of age.

Treatments		Egg production (%)	Egg weight (g)	Egg Number /hen	Egg mass (g/hen)	Feed intake (g/hen)	Feed conversion (g feed/g egg)
Ca (%)	**Vit.D_3 (IU)**						
2.5		75.99 ± 2.54^{b}	10.28 ± 0.03^{b}	21.28 ± 0.71^{b}	218.72 ± 7.88^{b}	859.54±30.35	3.93 ± 0.01^{a}
3.0		81.30 ± 2.35^{a}	11.47 ± 0.04^{a}	22.77 ± 0.66^{a}	261.30 ± 8.33^{a}	846.37±30.07	3.24 ± 0.02^{b}
3.5		75.95 ± 2.55^{b}	10.30 ± 0.04^{b}	21.27 ± 0.71^{b}	219.15 ± 8.02^{b}	864.38±32.17	3.94 ± 0.01^{a}
	1100	77.85±2.15	10.66±0.19	21.80±0.60	232.76±9.42	856.65±23.70	3.71±0.11
	2200	77.65±2.16	10.71±0.20	21.74±0.60	233.35±9.62	856.87±25.39	3.70±0.12
2.5	**1100**	76.11 ± 1.10^{b}	10.25 ± 0.22^{b}	21.31 ± 0.40^{b}	218.61 ± 1.90^{b}	855.84±2.04	3.92 ± 0.09^{a}
	2200	75.86 ± 1.12^{b}	10.30 ± 0.15^{b}	21.24 ± 0.32^{b}	218.82 ± 1.76^{b}	863.24±2.00	3.94 ± 0.08^{a}
3.0	**1100**	81.41 ± 1.11^{a}	11.43 ± 0.26^{a}	22.79 ± 0.41^{a}	260.55 ± 1.70^{a}	847.70±2.11	3.25 ± 0.10^{b}
	2200	81.24 ± 1.10^{a}	11.52 ± 0.21^{a}	22.74 ± 0.37^{a}	262.05 ± 1.67^{a}	845.03±2.24	3.22 ± 0.09^{b}
3.5	**1100**	76.04 ± 1.11^{b}	10.29 ± 0.17^{b}	21.29 ± 0.32^{b}	219.11 ± 1.96^{b}	866.40±2.12	3.96 ± 0.09^{a}
	2200	75.86 ± 1.12^{b}	10.31 ± 0.18^{b}	21.24 ± 0.29^{b}	219.18 ± 1.75^{b}	862.35±1.75	3.93 ± 0.10^{a}

Means in the same column having different letters are significantly different ($p\leq0.05$).

Table (9): Effect of dietary Ca & Vit.D_3 levels on hatching parameters of Laying Japanese quail at 8– 20 weeks of age.

Treatments Ca (%)	Vit.D_3 (IU)	Fertility (%)	Hatchability (%)	Hatch Weight (g)	Rickets (%)
2.5		81.65±0.04	76.53±0.35[b]	7.05±0.01[b]	1.96±0.28[b]
3.0		81.83±0.04	79.98±0.53[a]	7.92±0.02[a]	1.60±0.32[c]
3.5		81.50±0.07	73.56±0.27[c]	7.03±0.01[b]	2.69±0.20[a]
	1100	81.62±0.06	76.70±0.98	7.34±0.15	2.09±0.27
	2200	81.70±0.06	76.68±0.98	7.33±0.15	2.08±0.27
2.5	**1100**	81.59±0.80	76.51±0.19[b]	7.02±0.11[b]	1.97±0.11[b]
	2200	81.72±0.71	76.54±0.12[b]	7.07±0.12[b]	1.94±0.12[b]
3.0	**1100**	81.77±0.27	80.05±0.10[a]	7.94±0.11[a]	1.58±0.09[c]
	2200	81.90±0.72	79.92±0.14[a]	7.91±0.12[a]	1.62±0.08[c]
3.5	**1100**	81.51±0.19	73.55±0.14[c]	7.06±0.11[b]	2.71±0.09[a]
	2200	81.49±0.51	73.56±0.15[c]	7.01±0.11[b]	2.67±0.11[a]

Means in the same column having different letters are significantly different (p≤0.05).

Table (10): Effect of dietary Ca & Vit.D_3 levels on specific gravity, egg shape index, and egg shell quality and analysis of laying Japanese quail at 8 - 20 weeks of age.

Treatments		Egg Shape Index	Egg Shell Quality			Egg Shell Analysis	
Ca (%)	**Vit.D_3 (IU)**		**Egg specific gravity (S.G.)**	**Shell Weight (%)**	**Shell Thickness (mm)**	**Shell Calcium (%)**	**Shell Phosphorus (%)**
2.5		0.66±0.02[b]	1.08±0.002	9.04±0.49[b]	0.36±0.02[b]	12.10±0.02[b]	0.47±0.01[b]
3.0		0.78±0.01[a]	1.08±0.002	10.71±0.03[a]	0.42±0.02[a]	14.10±0.02[a]	0.51±0.01[a]
3.5		0.66±0.01[b]	1.08±0.003	9.61±0.02[b]	0.29±0.02[c]	10.22±0.04[c]	0.43±0.01[c]
	1100	0.70±0.02	1.07±0.002	9.93±0.18	0.36±0.02	12.13±0.56	0.47±0.01
	2200	0.70±0.02	1.08±0.001	9064±0.43	0.35±0.02	12.15±0.56	0.47±0.01
2.5	**1100**	0.66±0.03[b]	1.075±0.002	9.50±0.56[b]	0.35±0.04[b]	12.10±1.18[b]	0.47±0.02[b]
	2200	0.66±0.04[b]	1.078±0.002	9.58±0.50[b]	0.36±0.05[b]	12.11±1.14[b]	0.47±0.02[b]
3.0	**1100**	0.78±0.06[a]	1.078±0.003	10.65±0.66[a]	0.42±0.04[a]	14.09±1.08[a]	0.51±0.01[a]
	2200	0.78±0.02[a]	1.077±0.002	10.77±0.53[a]	0.41±0.05[a]	14.11±1.10[a]	0.50±0.04[a]
3.5	**1100**	0.66±0.05[b]	1.075±0.002	9.64±0.56[b]	0.30±0.04[c]	10.21±1.21[c]	0.43±0.03[c]
	2200	0.65±0.03[b]	1.075±0.001	9.57±0.61[a]	0.29±0.04[c]	10.22±1.10[c]	0.43±0.02[c]

Means in the same column having different letters are significantly different (p≤0.05).

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الملخص العربى

تأثير المستويات الغذائية من الكالسيوم وفيتامين د$_3$ والتداخل بينهما على أداء كتاكيتِ السمان اليابانى

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استخدم فى هذه الدراسة عدد 450 كتكوت سمان ياباني غير مجنس عمر يوم لدراسة تأثير المستويات المختلفة من الكالسيوم وفيتامين د3 والتداخل بينهما على أداء كتاكيتِ السمان اليابانى. قسمت الكتاكيت إلى 6 مجاميع متساوية العدد كل منها فى 3 مكررات. استخدم الكالسيوم بثلاث مستويات (0.8 ، 1.0 ، 1.2٪) وداخل كل مستوى استخدم فيتامين د$_3$ بمستويين (1100لمجموعة الكنترول ، 2200 وحدة دولية) وذلك فى 6 علائق متساوية تقريبا فى محتواها من الطاقة الممثله والبروتين الخام (24٪ بروتين خام و2900 كيلو كالورى طاقة ممثلة/كجم) لتغذية الكتاكيت خلال فترة النمو (1-42 يوم). وفى فترة البياض اختزلت طيور كل مكررة داخل المجاميع الست السابقة إلى 18 طائر (12 أنثى + 6 ذكور) ثم استخدم الكالسيوم بثلاث مستويات (2.5 ، 3.0 ، 3.5٪) وداخل كل مستوى استخدم فيتامين د$_3$ بمستويين (1100 لمجموعة الكنترول ، 2200 وحدة دولية) وذلك فى 6 علائق بياض متساوية تقريبا فى محتواها من الطاقة الممثله والبروتين الخام (20٪ بروتين خام و2900 كيلو كالورى طاقة ممثلة/كجم) لتغذية الطيور خلال فترة إنتاج البيض (6-20 أسبوع).

فى نهاية تجربة النمو(على عمر 42 يوم) تم ذبح 6 طيور (3 أناث + 3 ذكور) من كل مجموعة (أنثى + ذكر من كل مكرر) لتقدير صفات الذبيحة وقياسات المبيض وقناة البيض وتحليل عظام الساق كما تم جمع 6 عينات دم من طيور كل مجموعة فى أعمار 21 ، 42 يوم لتقدير بعض مكونات سيرم الدم كما تم إجراء تجربة هضم لتقدير معاملات هضم المركبات الغذائية بإستخدام 3 ديوك لكل معاملة . وفى فترة البياض وخلال الفترات 8-12 ، 12- 16، 16- 20 أسبوع تم تسجيل عدد ووزن وكتلة البيض ومعدل إنتاج البيض والغذاء المأكول ومعدل تحويل الغذاء وصفات التفريخ كما تم تكسير 10 بيضات من كل مجموعة (خلال الفترات السابقه) لتقدير معامل دليل البيضة وجودة صفات القشرة والتحليل الكيماوى للقشرة.

فى فترة النمو: أدت التغذية على العليقة المحتوية على 1.0٪ كالسيوم + فيتامين د$_3$ بأى مستوى إلى ما يلى:-

1- تحسن معنوى فى كلا من وزن الجسم ، معدل الزيادة فى وزن الجسم ، معامل تحويل الغذاء وذلك مقارنة بباقى المعاملات.

2- زيادة معنوية فى النسب المئوية لكل من الذبيحة ، التصافى ، الأحشاء الداخلية المأكولة(الكبد ، القلب، القانصه) ، الغدة الثيموسية ، غدة البيرسا، الطحال كما زاد معنوياً وزن قناة البيض ووزن المبيض بينما انخفض معنوياً دهن البطن ٪ و ذلك مقارنة بباقى المعاملات.

3- أرتفاع معنوي فى معامل هضم كلا من البروتين والألياف الخام وذلك مقارنة بباقى المعاملات.

**العلائق المحتويه على الثلاث مستويات من الكالسيوم مع المستوى العالى من فيتامين د$_3$ (2200 وحدة دولية) اعطت ذيادة معنويه للكالسيوم و الفوسفور بسيرم الدم ، كذلك إرتفع مستوى الكرياتينين فى السيرم عند مستوى 1.2 كالسيوم مع كلا من مستويين فيتامين د$_3$.

فى فترة البياض أدت التغذية على العليقة المحتوية على 3.0٪ كالسيوم + فيتامين د3 بأى مستوى إلى ما يلى:-

1- تحسن معنوى فى كل من معدل إنتاج البيض ، عدد ووزن وكتلة البيض ، معامل تحويل الغذاء وذلك مقارنة بباقى المعاملات.

2- زيادة معنوية فى كل من الفقس ٪ ووزن الكتكوت عند الفقس بينما انخفض معنوياً الكساح ٪ وذلك مقارنة بباقى المعاملات.

3- زيادة معنوية فى كل من معامل دليل شكل البيضة٪ ، وزن القشرة ٪ ، سمك القشرة ، كالسيوم القشرة٪ ، فوسفور القشرة ٪ وذلك مقارنة بباقى المعاملات.

هذا ويستنتج من النتائج تحت ظروف التجربة الحالية أنه يمكننا التوصية – من وجهة النظر الغذائية – بأن أحسن مستوى للكالسيوم فى علائق السمان هو 1.0 و 3.0 ٪ فى فترة النمو والبياض على الترتيب مع فيتامين د3 بالمستوى 1100 وحدة دولية.