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Nutritional Requirements for Gimmizah Males from 2-Calcium

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ABSTRACT

This work aimed to estimate the nutritional requirement of calcium under two housing systems for Gimmizah cockerels and its effects on productive, reproductive and physiological performance traits. Seventy two cockerels, 26 weeks age, similar in their weights were divided into two groups, the 1st group was housed in individual cages, while, males in the 2nd group were kept on litter floor. Birds of each group were distributed randomly to three subgroups based on dietary calcium levels (0.3, 0.5 and 0.7%). All birds were kept under the same managerial conditions. - Caged males had significantly heavier final body weight than that of cockerels kept on litter floor. Feed intake of cockerels kept on litter floors was significantly higher than those kept in cages. Daily Ca intake of Gimmizah cockerels increased significantly (P≤0.01) with increasing calcium level in the diet. Cockerels reared in cages produced significantly higher ejaculate volume and abnormal sperm percentage than those reared in floor pens. The highest value of ejaculate volume was achieved due to feeding the cockerels on diet with 0.7% Ca. The highest sperm motility was obtained when cockerels were housed on floor and fed on the diet with 0.5% Ca. Plasma albumin level decreased (P≤0.05) while, plasma globulin level increased (P≤0.01) with increasing dietary Ca level. Feeding cockerels a diet with 0.3% calcium resulted in significant increase in plasma total testosterone compared with those fed diets containing 0.5 or 0.7% Ca. Rearing cockerels on litter floors led to significant increase in plasma level of inorganic phosphorous and lower activity of plasma alkaline phosphatase (P≤ 0.05) compared with those of cockerels kept in cages. Feeding cockerels diet with 0.3% Ca increased total calcium absorption when it was measured as mg/g dry matter compared with those fed diets of 0.5 or 0.7% Ca. -Seminal plasma activity of LDH was significantly higher for cockerels fed diet with 0.3% calcium than those fed 0.5 or 0.7% Ca. Males fed the diet containing 0.5% Ca had higher activity of AST but lower activity of ALT compared with those fed 0.3 or 0.7% Ca diets. -Seminal plasma level of total testosterone was significantly higher (P≤0.05) in cockerels reared on litter floors than that of males kept in cages.- Interaction between dietary calcium level and housing system had significant effect on all seminal plasma parameters.

Keywords: Gimmizah cockerels, Calcium, Semen quality, Seminal plasma.

INTRODUCTION

The single largest mineral present in animals body is calcium, regardless of species. Nearly half of all minerals in the body is calcium. It plays many crucial roles in the overall scheme of animal and poultry nutrition. The most recognized function is structural role as a component of bone. Many other regulatory functions require calcium, including egg production, heart beat, hormonal secretion, reproductive functions, nerve impulses, muscle contractions, and enzyme activation.

Males differ in nutrient requirements than females. Gimmizah cockerels breeder require less protein. (Alderey *et al*., 2017). Excess calcium intake can cause kidney problems of the roosters such as kidney asymmetry and urolithiasis (Moyle *et al.* 2011).

Limited research has been reported dealing with the calcium requirements of the adult male chickens and the effect of dietary calcium levels on their semen production and fertility. Fowl semen contains high concentrations of zinc, calcium and copper in ionic and bound forms. Seminal plasma is vital because it provides a nutritive and productive environment for spermatozoa to survive (Cheah and Yang, 2011). Contact of sperms with toxic mineral elements in the seminal plasma can affect developing spermatozoa. Abnormal levels of these elements may affect spermatogenesis with respect to sperm production, maturation, motility and fertilizing potential (Wong *et al.*, 2001).

This study was aimed to estimate the nutritional requirement of calcium under two housing systems for Gimmizah cockerels and its effects on productive and reproductive performance traits.

MATERIALS AND METHODS

This study was conducted at El-Gimmizah Poultry Research Station (Gharbia governorate), Animal Production Research Institute, Agricultural Research Center, Egypt. A total of 72 Gimmizah cockerels, aged 26 weeks, were divided into two groups, the 1st group was housed in individual cages, and the 2nd group was kept on litter floor under the same managerial and hygienic conditions. The cockerels of each group were randomly assigned into three dietary calcium levels (0.3, 0.5, 0.7% of the diet). The composition and calculated analysis of the experimental diets are shown in Table 1. The experimental treatments were terminated at 42 weeks of age.

Table 1. The composition and calculated analysis of the experimental diets fed to Gimmizah cockerels.

Ingredients	Dietary calcium levels		
	1	2	3
Yellow corn	66.00	65.50	65.90
Soybean meal (44%)	10.60	10.25	11.00
Wheat bran	21.82	22.21	20.50
Limestone	0.70	1.16	1.72
Methionine	0.04	0.04	0.04
Lysine	0.14	0.14	0.14
Vit. &Min. premix*	0.30	0.30	0.30
Salt	0.40	0.40	0.40
Total	100	100	100
**Calculated analysis			
ME kcal/kg	2719	2700	2708
CP %	13.08	12.95	13.05
Ca %	0.328	0.501	0.705
Available P.%	0.169	0.169	0.165
Lysine %	0.701	0.698	0.711
Methionine %	0.28	0.279	0.281
Meth. + Cyst., %	0.523	0.519	0.522
CF %	4.59	4.60	4.47

CP: Crude protein, ME: metabolizable energy

*** Each 3 Kg of Vit and Min. premix contains: 10000000 IU Vit. A; 2000000 IU vit. D3; 10000 mg Vit. E; 1000 mg Vit. K3; 1000 mg Vit. B; 5000mg Vit. B2; 10 mg Vit. B12; 1500 mg Vit. B6;30000 mg Niacin; 10000 mg Pantothenic acid; 1000 mg Folic acid ;50 mg Biotin; 300000 mg Choline; 4000 mg Copper; 300 mg Iodine; 30000 mg Iron; 50000 mg Zinc; 60000 mg Manganese; 100 mg Selenium; 100 mg Cobalt and $CaCO_3$ as carrier to 3000 g. **Calculated analysis according to NRC (1994).**

Collected data and parameters estimated:

Body weight and feed intake:

Individual live body weights (g) at the beginning and at the end of the experimental period were recorded to estimate the body weight change. Daily feed intake and calcium intakes (g) were calculated (g) throughout the experimental period.

Semen evaluation:

Semen samples were randomly collected from eighteen cockerels (3 per treatment) at 30, 34 and 38 weeks of age by using the massage method. Semen samples were checked according to Kalamah *et al*. (2000) for the following:

a-The ejaculate volume to the nearest 0.01 ml.

b-Mass motility score (from 1 to 5 grades); then, it was expressed as a percentage.

c-Percentages of live and abnormal sperms which determined after staining with eosin and nigrosin.

Fertility:

Seventy two of Gimmizah hens at the same age were housed in individual cages and fed on a layer ration (16% crude protein (CP) and 2750 kcal/kg metabolizable energy (ME) with 3.2% Ca to test the fertilizing ability of cockerels. Hens were divided into six groups (12 hens/group). At 30, 34 and 38 weeks of age, semen of each experimental group of cockerels was collected twice weekly. Freshly collected semen was immediately inseminated to each group of female chickens. Eggs produced from hens of each group for one week post-insemination were collected, then incubated in Petersime incubator. Fertility was expressed as a percentage.

Blood biochemical parameters:

At 42 weeks of age, 30 blood samples (5 per treatment) were collected from the wing veins of cockerels. Heparinized blood samples were centrifuged at 3000 r.p.m for 15 minutes immediately after collection and plasma was transferred and stored in the deep freezer at approximately -15oC till the time of chemical analysis. Plasma concentrations of total protein, albumin, globulin, glucose, calcium, inorganic phosphorus, creatinine, uric acid and activity of aspartate aminotransferase (AST) and alanine aminotransferase (ALT) and alkaline phosphatase were determined using commercial kits. Total testosterone in blood plasma was also determined using the enzyme-linked immunosorbent assay (ELISA).

Chemical analysis of some seminal plasma constituents:

Seminal plasma activities of lactate dehydrogenase (LDH), AST and ALT were determined using commercial kits. Total testosterone was determined using the ELISA technique at the end of experimental period.

Rate of calcium absorption (*in vitro*) through the small intestine:-

At the end of the experimental period, 3 cockerels from each experimental group were randomly selected for an in vitro estimation of calcium absorption rate through the various parts of the small intestine, then expressed as total calcium absorption through the whole small intestine. The intestinal sac method was used, as described by Madge (1975) with the modification applied by Radwan *et al*. (1984).

Calcium retention:

At the end of the experimental period, a digestion trial was conducted to estimate calcium retention. Three cockerels from each calcium level were chosen randomly and caged individually in wire cages. Birds of each treatment were fed on their respective experimental diet for 3 days then the excreta were quantitatively collected for a 3-day period during which feed intake data were recorded. Just after collection, the excreta were dried in an oven at 60o C for 24 hours, then ground. Three pooled samples of ground excreta from each treatment were taken for calcium determination. The calcium contents of diet and dried excreta were determined according to AOAC (1995).

Statistical analysis: Data were statistically analyzed according to SPSS program (SPSS, 2011). Mean differences were tested by Duncan's new multiple range test (Duncan, 1955).

The statistical model was

$$Yijk = \mu + Ci + Hsj + CiHsj + eijk$$

Yijk: observation measured
μ : overall mean
Ci: calcium levels (1,2,3)
Hsj: housing system (1,2)
CiHsj: effect of calcium levels x housing systems (1,……..6)
eijk: experimental error

RESULTS AND DISCUSSION

Body weight:

Calcium level in the diet had no significant effect on the final body weight and body weight change of cockerels at the end of the experimental period (Table, 2). On the other hand, housing system affected significantly on the final body weight. It was obviously clear from Table 2 that caged males tended to be heavier and gained more weight than did those reared on litter floors (2609.7 and 184.3 g vs. 2552.7 and 133.6 g for the two variables, respectively). This may be due to higher and more efficient metabolic rates coincided with less energy expenditure by caged cockerels than in those kept in litter floored houses. Similar results were obtained by Sekeroglu *et al*. (2009), who indicated that the free-range housing system significantly decreased body weight of broilers. Using battery cages led to an increase in body weight of Japanese quail compared with floor pens (Roshdy *et al*., 2010).

Significant variations were found in body weight due to interaction between calcium level and housing system. Results obtained indicated that, feeding caged cockerels a diet with 0.7% calcium increased their final body weight and then gained more weight compared with other groups. Our results are in agreement with those of Khalil et at. (2012), who found that dietary calcium levels for cockerels had no significant effect on body weight and body weight gain.

Feed intake:

Data presented in Table 2 showed that calcium level in the diet had no significant effect on feed intake of Gimmizah cockerels. In contrast, daily calcium was significantly affected by dietary calcium level. The observed differences in daily intake Ca was positively correlated with the level of Ca in cockerels' diet.

Gimmizah cockerels fed diet with 0.7% calcium had the highest Ca intake (0.89 g/day), while, the lowest value was recorded by males fed 0.3% calcium. Housing system had a significant effect ($P \leq 0.05$) on feed intake. Cockerels housed in floor pens consumed significantly higher amount of feed as compared to those housed in cages (128.2 vs. 119.3 g/day). It may be logic to attribute

the significant variation in feed intake to housing system, which may be related to the amount of energy lost as a result of the increasing physical activity which is greater in deep litter laying houses than in cages.

Table 2. Effect of dietary calcium levels and housing system on live body weight (BW), daily feed intake and daily Ca intake of Gimmizah cockerels

Treatments	Initial BW(g)	Final BW (g)	Chang in BW (g)	Daily Feed intake (g)	Daily calcium intake (g)
calcium levels 0.3	2413.54	2579.58	166.04	124.47	0.42[c]
0.5	2433.67	2583.17	149.50	124.08	0.62[b]
0.7	2419.58	2580.79	161.21	123.63	0.89[a]
Sig.	NS	NS	NS	NS	**
SEM	14.69	17.88	12.60	1.26	0.007
Housing systems					
Cages (CA)	2425.42	2609.69[a]	184.28[a]	119.25[b]	0.62±0.04
Floor (FL)	2419.11	2552.67[b]	133.56[b]	128.22[a]	0.67±0.05
Sig.	NS	*	*	*	NS
SEM	11.67	13.56	9.32	0.15	0.05
Interactions					
0.3XCA	2420.42	2603.33	182.92	119.73	0.40
0.3XFL	2406.67	2555.83	149.17	129.21	0.43
0.5XCA	2434.17	2597.08	162.92	119.33	0.60
0.5XFL	2433.17	2569.25	136.08	128.83	0.65
0.7XCA	2421.67	2628.67	207.00	118.70	0.85
0.7XFL	2417.50	2532.92	115.42	128.57	0.92
Sig.	NS	*	**	**	**
SEM	20.35	23.49	15.62	0.20	0.0003

[a-b]: For each of the main effects, means in the same column bearing different superscripts differ significantly
NS = not significant *:P< 0.05, **:P< 0.01).

It was obviously clear in Table 2 that the interaction between the two studied factors had a significant effect on feed intake and daily calcium intake. Cockerels which were housed on litter floors and fed diets with 0.3, 0.5 or 0.7% calcium consumed more feed when compared with those fed the same diets and kept in cages. These results are in harmony with those reported by Lee *et al.* (1989) and Khalil *et al*.(2012), who indicated that calcium level in cockerels' diet (from 0.9 to 3.5%) had no significant influence on feed intake. In addition, Abd El-Maksoud (2010) reported that increasing dietary calcium level in layer diet up to 4% for the whole experimental period had no significant effect on feed consumption of laying hens. On the other side, daily calcium intake of the birds significantly increased with increasing dietary calcium level (Moreki, 2005).

Semen characteristics and fertility:

Data listed in Table 3 showed that differences in parameters of semen quality or fertility of cockerels attributed to calcium levels in the diet were not significant. The present results are in agreement with that obtained by Khalil *et al.* (2012), who indicated that semen volume, sperm concentration and number of live sperms were not significantly different among the experimental groups fed different levels of calcium (Smith and Tabia, 1996). The 0.9% dietary calcium level was enough to promote a good reproductive performance in broiler breeder males as reported by Rosa *et. al*. (2010).

Housing system had a significant effect on ejaculate volume and abnormal sperms only. Our results are in agreement with those of Renden and Pierson (1982), who found that broiler breeders males kept in cages consistently produced larger amounts of more concentrated semen than males reared on litter floors.

Housing system had insignificant effect on egg fertility. This result agrees with that reported by Ansah *et. al.* (1983) who indicated that there was no significant difference between the fertilities of the turkey males kept in cages and those reared on floor. It was observed that Gimmizah cockerels housed in cages had the higher ejaculate volume than those reared on floor (0.46 vs. 0.36ml). However cockerels reared on litter floors had significantly lower abnormal sperm percentage (6.96 vs. 8.09%).

Table 3. Effect of dietary calcium levels and housing system on semen quality and fertility Gimmizah cockerels

Treatments	Ejaculate volume (ml)	Sperm Motility %	Live sperms %	Dead sperms %	Abnormal sperms %	Egg fertility %
calcium levels						
0.3	0.40	80.28	85.39	14.61	7.89	94.06
0.5	0.41	80.42	86.00	14.00	7.17	93.56
0.7	0.42	79.03	85.67	14.33	7.53	93.25
Sig.	NS	NS	NS	NS	NS	NS
SEM	0.02	1.00	0.77	0.77	0.47	1.57
Housing systems						
Cages (CA)	0.46[a]	78.89	84.98	15.02	8.09[a]	92.92
Floor (FL)	0.36[b]	80.93	86.39	13.61	6.96[b]	94.33
Sig.	**	NS	NS	NS	*	NS
SEM	0.02	0.81	0.62	0.62	0.38	1.27
Interactions						
0.3XCA	0.44	78.33	84.11	15.89	8.22	93.50
0.3XFL	0.36	82.22	86.67	13.33	7.56	93.00
0.5XCA	0.45	78.06	85.06	14.94	7.67	92.25
0.5XFL	0.37	82.78	86.94	13.06	6.67	94.63
0.7XCA	0.48	80.28	85.78	14.22	8.39	94.13
0.7XFL	0.36	77.78	85.56	14.44	6.67	94.25
Sig.	**	*	NS	NS	NS	NS
SEM	0.03	1.36	1.09	1.09	0.65	2.20

[a-b]: For each of the main effects, means in the same column bearing different superscripts differ significantly
NS = not significant, *:P≤ 0.05, **:P≤ 0.01).

The interaction between the two studied factors had a significant effect on ejaculate volume and sperm motility. Feeding cockerels in cages on diets with 0.3, 0.5 or 0.7% calcium increased their ejaculate semen volume compared with those reared on floor. Semen volume per ejaculate

recorded its highest value as a result of feeding the caged cockerels a diet with 0.7% calcium. Sperm motility recorded the highest value in semen of males fed diet with 0.5% calcium and reared in floor pens. On the other hand, males fed diet with 0.7% of calcium and reared on litter floor recorded the lowest percentage of semen motility.

Blood constituents:

Data listed in Table 4 showed that, calcium level in the diet had a significant effect on plasma albumin and globulin only. Cockerels fed ration with 0.3% calcium recorded the highest level of plasma albumin (2.05 g/dl). Plasma albumin decreased with increasing dietary calcium level, while, plasma globulin was increased with increasing calcium level in the diet. On the other hand, calcium level in the diet had no significant effect on the other blood constituents (Table 4 and 5). Housing system had no significant effect on all blood plasma constituents except plasma alkaline phosphatase and plasma inorganic phosphorus only (Table 4 and 5).

The interaction between the two studied factors had a significant effect on all plasma parameters, except plasma glucose and creatinine. The current findings are in harmony with those of Vargas Junior *et al.* (2004) and Sa *et al.* (2004), who indicated that calcium is required by birds for enzyme activation and has a role in the secretion of different hormones. It was noticed that cockerels reared on litter floor and fed the ration with 0.7% calcium had the highest values of plasma total protein and globulin. Plasma uric acid recorded its highest value in cockerels housed on floor and fed diet with 0.5% calcium when compared with other treatments, Our results indicate also that inorganic phosphorus increased by increasing calcium level in diet. Feeding cockerels which were kept in cages a diet with 0.3% calcium had higher level of plasma calcium and lower level of plasma inorganic phosphorus. Insignificant variation in plasma calcium levels due to dietary calcium level may be attributable to the fact that the blood calcium concentration is primarily affected by reproductive state of the birds and secondly by photoperiod or pattern of feed intake (Parson and Combs, 1981). The present results agree with those of Kanyinji and Maeda (2010), who stated that increasing calcium level in the diet resulted in lower calcium level in blood. On the other hand, Abd-El Maksoud (2010) found that there was no significant effect on blood plasma parameters of increasing Ca level in laying hen diets. Activity of plasma alkaline phosphatase was significantly higher in the males reared in cages compared with those reared on floor. Plasma total protein and globulin recorded the highest values in cockerels fed ration with 0.7% calcium and reared on litter-floored houses.

Table 4. Effect of dietary calcium levels and housing systems on blood plasma parameters of Gimmizah cockerels

Treatments	Total protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Glucose (mg/dl)	Calcium (mg/dl)
calcium levels					
0.3	4.03	2.05[a]	1.98[b]	316.17	8.85
0.5	4.14	1.95[a]	2.19[b]	312.08	8.93
0.7	4.23	1.50[b]	2.73[a]	300.00	8.60
Sig.	NS	*	**	NS	NS
SEM	0.13	0.10	0.12	10.98	0.32
Housing systems					
Cages (CA)	4.15	1.78	2.37	313.56	9.10
Floor (FL)	4.12	1.88	2.23	305.28	8.48
Sig.	NS	NS	NS	NS	NS
SEM	0.10	0.10	0.12	8.95	0.25
Interactions					
0.3XCA	4.10[a]	1.95	2.15	337.00	9.75
0.3XFL	3.95	2.15	1.80	295.33	7.95
0.5XCA	4.40	2.15	2.25	296.17	9.15
0.5XFL	3.88	1.75	2.13	328.00	8.70
0.7XCA	3.95	1.25	2.70	307.50	8.40
0.7XFL	4.52	1.75	2.77	292.50	8.80
Sig.	**	**	*	NS	*
SEM	0.16	0.13	0.13	14.35	0.41

[a-b]: For each of the main effects, means in the same column bearing different superscripts differ significantly P≤ 0.05, NS = not significant

***:P≤ 0.05, **:P≤ 0.01).**

Table 5. Effect of dietary calcium levels and housing systems on blood plasma parameters of Gimmizah cockerels

Treatments	Inorganic phosphorus mg/dl	Creatinine mg/dl	Uric acid mg/dl	Alkaline Phosphatase U/L	Testosterone (ng/ml)
calcium levels					
0.3	7.10	0.35	5.13	303.83	16.66[a]
0.5	7.70	0.33	5.40	365.75	10.01[b]
0.7	8.10	0.35	5.25	318.67	10.72[b]
Sig.	NS	NS	NS	NS	**
SEM	0.39	0.02	0.35	33.06	1.00
Housing systems					
Cages (CA)	6.73[b]	0.33	4.90	376.39[a]	11.78
Floor (FL)	8.53[a]	0.35	5.62	282.44[b]	13.15
Sig.	*	NS	NS	*	NS
SEM	0.26	0.02	0.27	0.26	1.04
Interactions					
0.3XCA	5.50	0.35	5.55	314.50±19.65	19.86
0.3XFL	8.70	0.35	4.70	293.17±34.26	13.47
0.5XCA	6.75	0.30	4.55	386.67±59.11	9.04
0.5XFL	8.65	0.35	6.25	344.83±74.75	10.97
0.7XCA	7.95	0.35	4.60	428.00±15.00	6.45
0.7XFL	8.25	0.35	5.90	209.33±11.98	15.00
Sig.	**	NS	*	*	**
SEM	0.37	0.03	0.41	35.79	0.68

[a-b]: For each of the main effects, means in the same column bearing different superscripts differ significantly P≤ 0.05, NS = not significant *:P≤ 0.05, **:P≤ 0.01).

Plasma total testosterone:

Data presented in Table 5 indicated that, plasma total testosterone was not affected by dietary calcium level. It was observed that cockerels reared on litter floor had significantly higher concentration of plasma testosterone than those reared in cages. Interaction between the two studied factors had high significant effect (P≤0.01) on plasma testosterone level. Its highest value in plasma was recorded for cockerels fed diet which contained 0.3% calcium and reared in cages.

Seminal plasma biochemical parameters:

Table 6 presented the biochemical analysis values of LDH, AST, ALT and total testosterone in the seminal plasma for all experimental groups of Gimmizah cockerels. Dietary calcium level had highly a significant effect (P≤0.01) on activity of LDH, AST and ALT of seminal plasma, while, total testosterone concentration was not affected. Activity of LDH in seminal plasma for cockerels fed diet contained 0.3% calcium (18.92) was significantly higher than those of cockerels fed diets with 0.7 or 0.5% calcium (16.75 and 18.45 u/L, respectively). Seminal plasma Activity of AST increased while ALT decreased in cockerels fed diet with 0.5% compared with those fed 0.3 or 0.7% Ca. Housing system had a significant effect on concentration of seminal plasma total testosterone only. Cockerels in floor houses displayed significantly higher level seminal plasma total testosterone compared with those kept in cages (0.35 vs. 0.16 ng/ml). Interaction between the two studied factors had a significant effect (P≤0.01) on all estimated seminal plasma parameters. Cockerels that were kept in litter floors and fed diet with 0.5% calcium exhibited the highest level of seminal plasma activity of LDH as compared to other experimental groups. Seminal plasma of cockerels kept in litter floors and fed diet contained 0.7% calcium had the highest value of ALT and total testosterone as compared to other treatments (Table 6).

Table 6. Effect of dietary calcium levels and housing system on certain seminal plasma parameters of Gimmizah cockerels

Treatments	LDH (U/L)	AST (U/L)	ALT (U/L)	Total testosterone ng/ml
calcium levels				
0.3	18.92[a]	4.70[b]	14.85[a]	0.24
0.5	15.48[b]	8.40[a]	11.15[b]	0.28
0.7	16.75[b]	4.25[b]	15.10[a]	0.26
Sig.	**	**	**	NS
SEM	0.56	0.26	0.40	0.40
Housing systems				
Cages (CA)	17.38	5.90	13.74	0.16[b]
Floor (FL)	16.72	5.67	13.66	0.35[a]
Sig.	NS	NS	NS	**
SEM	0.71	0.69	0.72	0.01
Interactions				
0.3XCA	17.67	5.70	15.70	0.16
0.3XFL	15.47	7.90	11.53	0.31
0.5XCA	19.00	4.10	14.00	0.20
0.5XFL	20.17	3.70	14.00	0.35
0.7XCA	15.50	8.90	10.77	0.13
0.7XFL	14.50	4.40	16.20	0.38
Sig.	**	**	**	**
SEM	0.18	0.07	0.27	0.21

[a-b]: For each of the main effects, means in the same column bearing different superscripts differ significantly P≤ 0.05, NS = not significant *:P≤ 0.05, **:P≤ 0.01). LDH: Lactic dehydrogenase, ALT: Alanine aminotransferase AST: Aspertate aminotransferase

Rate of calcium absorption (in vitro) throughout the small intestine:

Total calcium absorption, absorption per cm intestinal length and per g dry matter are found in Table 7. Dietary calcium level had a significant effect on calcium absorption relative to dry matter. Feeding Gimmizah males a diet with 0.3% calcium significantly increased (P≤0.05) the absorbed calcium as mg/g dry matter compared with those fed the diet containing 0.5% Ca. Variation in the amount of calcium absorption may be due to the variation in the amount of dietary calcium consumed. It is well known that the percentage of calcium absorption through the small intestine decreases as the amount of calcium intake increased. Results obtained are in harmony with those of Berne and Levy (1998), who reported that Ca is actively absorbed in all intestinal segments, particularly in the duodenum and the jejunum. The speed of Ca absorption is higher than that of any other ions, except for Na. Nutritional status affects calcium absorption. Animals fed Ca deficient diets increase Ca absorption levels, whereas high dietary levels of this mineral reduce its absorption.

Ca absorption as measured by the three tested methods in the experimental cockerels was not affected by housing system (Table 7). There were significant interactions between dietary Ca level and housing system on Ca absorption (Table 7). Feeding cockerels diet with 0.3% calcium and reared on litter floors produced the highest rate of total calcium absorption (85.50 mg/hr), while the least value recorded by caged cockerels fed diet with 0.7% calcium (76.90 mg/hr). Feeding caged cockerels diet contained 0.3% calcium caused the highest rates of Ca absorption (per g dry matter and per cm of intestinal length) compared with the other treatments.

Table 7. Effect of dietary calcium levels and housing systems on *in vitro* calcium absorption through the small intestine of Gimmizah cockerels

Treatments	Total calcium absorption (mg/ hr)	calcium absorption (mg/ g dry matter)	Total calcium absorption (mg/ cm)
calcium levels			
0.3	79.78	11.58[a]	0.75
0.5	83.13	10.02[b]	0.70
0.7	80.27	10.23[ab]	0.69
Sig.	NS	*	NS
SEM	1.81	0.46	0.02
Housing systems			
Cages (CA)	80.57	10.11	0.71
Floor (FL)	81.56	11.10	0.72
Sig.	NS	NS	NS
SEM	1.50	0.39	0.02
Interactions			
0.3XCA	79.30	12.00	0.79
0.3XFL	85.50	11.16	0.71
0.5XCA	80.27	8.89	0.69
0.5XFL	80.77	11.15	0.71
0.7XCA	76.90	9.46	0.65
0.7XFL	83.63	10.99	0.73
Sig.	*	**	*
SEM	2.36	0.57	0.03

[a-b]: For each of the main effects, means in the same column bearing different superscripts differ significantly NS = not significant *:P≤ 0.05, **:P≤ 0.01).

Calcium retention:

Data presented in Table 8 shows the effect of dietary calcium level on calcium intake, excreted and calcium retention (g / day). Calcium intake and calcium excreted (g) were increased by increasing dietary calcium level. Feeding cockerels diet with 0.7% calcium recorded significantly the highest (P≤0.01) value of calcium intake and calcium excreted (g) while, calcium retention % recorded the lowest values when compared with other dietary Ca levels. Cockerels fed a diet contained 0.5% calcium had significantly the highest (P≤0.01) values of calcium retention in as g/day and calcium retention percentage. These results are in agreement with those of Hamdi *et al.* (2015) who reported that increasing the dietary Ca decreased its fractional retention from 74% with dietary Ca at 0.5 to 46% with Ca at 0.9% in broiler chicks, which agree with those of Mitchell and Edwards (1996) and Ziaei *et al.* (2008), who reported that reducing mineral content of diets resulted in a higher apparent retention of Ca leading to a reduction in mineral excretion. In addition, Browning *et al.* (2012) showed that reducing dietary Ca/available P concentrations were associated with increased efficiency of Ca retention as compared to high Ca/available P diets, which indicates a physiological response by the chicken to overcome a Ca deficiency by up-regulating its nutrient transfer and deposition infrastructure. Contrarily, Hurwitz & Bar (1967), and Clunies *et al.* (1992) reported that total Ca retention by the bird increased with dietary Ca levels.

Table 8. Effect of dietary calcium levels on calcium retention of Gimmizah cockerels..

Calcium levels	Ca intake (g)	Calcium excreted (g)	Calcium retained(g)	Calcium retention %
0.3	0.384±0.018^{c}	0.246±0.019^{b}	0.138±0.027^{b}	35.52±5.89^{b}
0.5	0.595±0.005^{b}	0.277±0.010^{b}	0.318±0.009^{a}	53.47±1.55^{a}
0.7	0.847±0.004^{a}	0.746±0.021^{a}	0.101±0.017^{b}	11.90±2.02^{c}
Sig.	**	**	**	**

$^{a-b}$: For each of the main effects, means in the same column bearing different superscripts differ significantly

****:P≤ 0.01).**

CONCLUSION

Taking the egg fertility attributable to Gimmizah cockerels into account, the optimal dietary Ca level suggested to be 0.3% and the cockerels must be kept in floor pens.

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الاحتياجات الغذائية لديوك الجميزة من الكالسيوم

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أجريت هذه الدراسة لتقدير الاحتياجات الغذائية لديوك الجميزة من الكالسيوم فى نظامين إسكان وتأثير ذلك على بعض الصفات الانتاجية والتناسلية والفسيولوجية. استخدم فى هذه الدراسة عدد 72 من ديوك الجميزة المتجانسة فى الوزن عند عمر 26 أسبوع حيث قسمت الى مجموعتين, تم تسكين المجموعة الاولى فى أقفاص فردية بينما تم تسكين المجموعة الثانية على فرشة أرضية , هذا وقد قسمت ديوك كل مجموعة الى ثلاثة أقسام تبعا لمستوى الكالسيوم فى العليقة (0,3, 0,5, 0,7 %على الترتيب) وقد استمرت الدراسة 16 أسبوع. وجاءت النتائج كالتالى:-- أدى تغذية الديوك المرباه فى أقفاص فردية الى زيادة معنوية فى الوزن النهائى للجسم مقارنة بالديوك المرباه على فرشة أرضية. - زاد معدل الاستهلاك اليومى من العليقة معنويا للديوك المرباه على فرشة أرضية مقارنة بالديوك المرباه فى الاقفاص الفردية.- زاد معدل المأكول اليومى من الكالسيوم معنويا بزيادة مستوى الكالسيوم فى العليقة.- كان لتغذية الديوك على عليقة تحتوى على 0,7% كالسيوم تأثيرا معنويا فى زيادة حجم القذفة.- كانت الديوك المرباه فى اقفاص هى الاعلى معنويا فى حجم القذفة ونسبة الحيوانات المنوية الشاذة مقارنة بتلك المرباه على فرشة أرضية.- كانت الديوك المرباه على فرشة أرضية والتى غذيت على عليقة تحتوى على 0,5% كالسيوم هى الأعلى فى معدل حركة الحيوانات المنوية.- زاد مستوى الجلوبيولين فى بلازما الدم معنويا وبصورة تدريجية بزيادة مستوى الكالسيوم فى العليقة بينما تناقص مستوى الالبيومين.- أدت التغذية على عليقة تحتوى على 0,3% كالسيوم الى زيادة معنوية فى هرمون التستوستيرون فى بلازما الدم مقارنة بتلك التى غذيت على عليقة تحتوى على 0,5 أو 0,7% كالسيوم.- حققت الديوك المرباه على الفرشة الارضية زيادة معنوية فى مستوى الفوسفور الغير العضوى فى بلازما الدم بينما تناقص مستوى انزيم الفوسفاتيز القاعدى مقارنة بالديوك المرباه فى أقفاص.- كان لتغذية الديوك على عليقة تحتوى على 0,3% كالسيوم تأثيرا معنويا على زيادة الممتص الكلى من الكالسيوم (ملجرام /جرام مادة جافة) خلال الأمعاء الدقيقة مقارنة بتلك التى غذيت على عليقة تحتوى على 0,5 أو 0,7% كالسيوم.- أدت التغذية على عليقة تحتوى على 0,3% كالسيوم الى زيادة معنوية لكل من انزيم LDH فى بلازما السائل المنوى. بينما أدت التغذية على مستوى 0,5% كالسيوم الى زيادة انزيم AST وانخفاض مستوى انزيم ALT .- زاد مستوى هرمون التستوستيرون معنويا فى بلازما السائل المنوى للديوك المرباه على فرشة أرضية مقارنة بالديوك المرباه فى أقفاص.- كان للتداخل بين مستوى الكالسيوم فى العليقة ونظام الإسكان تأثيرا معنويا على جميع القياسات فى بلازما السائل المنوى. نستخلص من هذه الدراسة : أن رعاية الديوك على فرشة أرضية وتغذيتها على عليقة تحتوى على 0,3% كالسيوم هو الأمثل آخذين فى الاعتبار نسبة الخصوبة.