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EFFECT OF DIETARY CALCIUM LEVEL ON THE PRODUCTIVE PERFORMANCE OF NAKED NECK (SHARKASI) LAYING HENS

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SUMMARY

A total number of 428 laying hens from three genotypes, heterozygous naked neck (Na/na), homozygous naked neck (Na/Na) and normally feathered (na/na) was used to study the combining effect of Na gene and dietary calcium level (3.47%, 2.51%) on egg production and egg shell quality till 54 wks of age. The results were as follows:

1- *The presence of Na gene or high calcium level (3.45%) reduced significantly (P<0.01) the age of sexual maturity.*
2- *The Na gene improved egg number and average laying rate by 11.7% and 10.1% respectively, whereas egg mass increased by 18.9% and 15.5% for the Na/na and Na/Na genotypes, respectively. High calcium level (3.47%) significantly (P<0.01) improved average laying rate and total egg number by 3.5%, whereas it increased the total egg mass by 6% when compared with low dietary calcium level (2.51%). A significant interaction (P<0.01) was found between Na gene and dietary calcium level where the improvement in egg production due to high calcium level (3.47%) was more pronounced for the Na/- birds than the normal feathering (na/na) counterparts.*
3- *The presence of Na gene significantly (P<0.01) increased egg weight and albumen percentage, whereas it reduced yolk and shell quality. High calcium level had no effect on albumen and yolk percentages, whereas it improved significantly egg shell percentage and shell thickness but without any effect on its breaking strength.*
4- *The naked neck birds (Na/-) exhibited a significant reduction (P<0.01) in abdominal fat with an improvement of dressing by about 5.3%. Also, an increase in ovary and oviduct percentage due to Na gene was observed with a significant reduction (P<0.05) of serum calcium level. Dietary calcium level did not affect anatomical parameters and dressing percentages. High calcium level significantly increased oviduct and serum calcium percentages.*

It can be concluded, that the Na/- exhibited remarkable superiority in productive performance. Also, high dietary calcium (3.47%) was more effective than low level (2.51%) to enhance the performance of the Na/- genotypes as compared with normal (na/na) counterparts.

Keywords: Sharkasi layers, naked neck gene, calcium level, egg production

INTRODUCTION

In Upper Egypt, the naked neck gene (Na) is widespread in unselected local chickens and known by farmers at various areas as Sharkasi chicken (Abd El-

Rahman, 1998). This gene reduces feather by 20-40% and is associated with an advantage in egg production performance under moderate conditions which was more pronounced under tropical and subtropical conditions (Abd El-Rahman, 1990, 2000a,b; Abd El-Rahman and El-Hammady, 2000; Horst *et al.*, 1996; Singh *et al.*, 2001 and Abd El-Rahman and Makled, 2006). The findings of Horst and Mathur (1994), Horst *et al.* (1996) and Abd El-Rahman (1990, 2000a,b) indicated that the advantage of Na gene involved with the persistency not only in medium or heavy body weight but also in lighter ones.

Slight disadvantage of naked neck birds (Na/-) was noticed for egg shell quality as measured by percentages of shell-less eggs and craked eggs, breaking strength and shell thickness (Merat, 1990; Abd El-Rahman, 2000a&b, 2003 and Singh *et al.* 2001). However, Galal and Fathi (2002), El-Safty *et al.* (2003) and Mahrous *et al.* (2003) reported that Na gene increased shell weight and percentage compared to na allele.

Many investigators have established that calcium level is an essential nutrient for laying hens (Clunies *et al.*, 1992; Bar *et al.*, 2002 and Chowhdury and Smith, 2002). Inadequate calcium intake causes a remarkable demineralization of bone, low serum calcium and subsequently reduction in shell weight which followed by a decrease in egg production (Gilbert *et al.*, 1981 and Roland *et al.*, 1996). Excess of dietary calcium may cause reduction in egg production performance (Keshavarz, 1986 and El-Gendi *et al.*, 1999). The NRC (1994) reported Ca requirements of 3.25% for hens consuming 100 g/day. It was reported that dietary calcium levels between 2.2% and 3.5% were necessary to maintain optimum production and shell quality (Hurwitz and Griminger, 1960 and Admosun and Kalango, 1973).

On the other hand, Cheng and Coon (1990), Abdallah *et al.* (1993); Bar *et al.* (2002) and Sohail and Roland (2002) showed that calcium level had no significant effect on egg production and weight. Abou-Egla (1995) reported that no significant differences due to calcium levels (3%, 3.5% and 4%) on egg production whereas 4% calcium level increased significantly egg shell quality. Despite the differences between breeds and strains in egg shell quality, the calcium level had a highly significant effect on egg shell quality (Cluines *et al.*, 1992; Abou Egla, 1995; Roland *et al.*, 1996; Gordon and Roland, 1998 and Abd El-Rahman, 2003).

The aim of the present study was to evaluate the impact of different dietary calcium levels on egg production and shell quality of the naked neck (Sharkasi) laying hens.

MATERIALS AND METHODS

Birds and experimental diets

This study was carried out at Poultry Research Farm of Assiut University. From a basic stock, local brown heterozygous naked neck (Na/na) males and females mated to produce the offspring which were classified into the three genotypes to be used in this study namely: Heterozygous naked neck (Na/na), homozygous naked neck (Na/Na) and normal feathering genotype (na/na).

At 18 wks of age, pullets from each genotype were leg banded, randomly divided in pens into two equal subgroups one of them fed diet with high calcium level (3.47%) and the other received diet with low calcium level (2.51%) as shown in Table (1).All birds were raised in floor pens under prevailing environmental

conditions (Table 2). Birds received 14 lighting hours, and feed and water were available *ad libitum* throughout the whole experimental period (18-54 wks of age).

Table 1. Composition and analysis of the experimental diets

Ingredients (%)	High calcium	Low calcium
Ground yellow corn	62.60	64.10
Soybean meal	17.00	17,00
Gluten	5.00	5.00
Wheat bran	5.00	6.00
Vitamin mixture (1)	0.25	0.25
Mineral mixture (2)	0.10	0.10
Salt	0.25	0.25
Lysine	0.20	0.20
Methionine	0.10	0.10
Limestone	7.50	5.00
Bone meal	2.00	2.00
Calculated analysis:		
Crude protein, %	16.97	17.10
ME (Kcal/kg)	2850	2800
Calcium, %	3.47	2.51
Available phosphorus %	0.37	0.37
Total phosphorus %	0.61	0.63
Salt, %	0.33	0.33
Crude fiber, %	3.32	3.46
Lysine, %	0.94	0.95
Methionine,%	0.42	0.43
Methionine + Cystine, %	0.69	0.69

1- Vit. mix. Supplied the following per kilogram of the diet; Vit. A, 5000 IU; Vit. D_3, 1200 IU; B_2, 4 mg; Vit. E, 2 mg; Pantothenic, 15 mg; Niacin, 20 mg; Vit. B_{12}, 4 mg; and Choline, 1500 mg.

2- Min. Mix. Supplied the follwing in milligram per kilogram of the diet; Mn, 60; Zn, 50; Fe, 30; Cu, 5; I, 1.05, and Se, 0.1.

Table 2. Minimum and maximum degrees of ambient temperature (°C) and relative humidity (%) during the experimental period (18-54 wks).

Laying period	Age (wks)	Ambient temp. (°C)		Relative humidity (%)	
		Min.	Max.	Min.	Max.
-	18-22	14	30	20	57
1	23-26	16	32	25	55
2	27-30	18	30	25	58
3	31-34	20	33	30	65
4	35-38	13	31	30	63
5	39-42	16	30	25	68
6	43-46	14	25	30	70
7	47-50	13	23	30	73
8	51-54	14	21	35	75
Average		**15.80**	**28.30**	**27.80**	**64.90**

Traits studied

The following parameters were recorded and calculated: body weight (BW) at 24, 40 and 52 wk of age, age of sexual maturity (ASM), laying rate (LR,%) throughout 8 successive laying periods (28 days each), total egg number (TEN), average egg weight (AEW), average laying rate (ALR,%) egg number and laying rate till 90 days from age at sexual maturity (E90 and LR90,%) and total egg mass (TEM) .

At 40 and 52 wk of age, a random sample of 240 eggs from all genotypes were taken to determine egg quality parameters: egg weight, proportions and percentages of albumen, yolk and shell. Shell quality was measured as shell thickness and strength using a cracking machine (Germany - Wazau). At the same ages also, a random sample of 120 females from the different genotypes were slaughtered, defeathered and eviserated, then carcass, giblets, abdominal fat and reproductive organs were removed and weighed (Gilbert *et al.*, 1983). Serum calcium and phosphorus were determined using commercial diagnostic kits.

Statistical analysis

Data of body weight, age at sexual maturity and different parameters of egg production from 428 laying hens (154, 132 and 142 hens of Na/na, Na/Na and na/na genotypes, respectively) were subjected to analysis of variance using General Linear Models (GLM) procedure of SAS (SAS, Institute 1990) by the following model:

$$Y_{ijk} = \mu + G_i + T_j + (GxT)_{ij} + E_{ijk}$$

where Y_{ijk} is the k^{th} observation of the i^{th} genotype and j^{th} calcium level, μ is the overall mean, G_i is the effect of i^{th} genotype, T_j is the effect of j^{th} calcium level; $(GxT)_{ij}$ is the interaction effect of genotype with calcium level and E_{ijk} is the random error.

Results of egg quality and physiological parameters were analysed according to the following model:

$$Y_{ijkl} = \mu + G_i + T_j + A_k + (GxT)_{ij} + (GxA)_{ik} + (TxA)_{jk} + E_{ijkl}$$

where A_k is the effect of k^{th} age; $(GxT)_{ij}$ is the interaction between genotype and calcium level; $(GxA)_{ik}$ is the interaction between genotype and age and $(TxA)_{jk}$ is the interaction between calcium level and age. The other factors in this model are similar to those in the first model.

Duncan's Multiple Range Test was used for evaluating the significance of the differences between group means (Duncan, 1955).

RESULTS AND DISCUSSION

Laying rate (%) of 8 successive laying periods (28 days each) and the other parameters of egg production and body weight are presented in Tables (3, 4). Homozygous naked neck (Na/Na) was significantly ($P<0.01$) earlier in sexual maturity (170.9 d) than the other genotypes (173.4 d). This result is in an agreement with that reported by Abd El-Rahman (2000a,b) and Abd El-Rahman and Makled (2006).

Within genotype or calcium level the maximum laying rates were from the 2^{nd} to the 4^{th} laying periods, whereas the lowest rates were observed mainly at the 5^{th} and the 8^{th} laying periods (Table 3). The results showed highly significant ($P<0.01$) effect due to genotype or calcium level with a significant interaction between the

main factors during most of the laying periods. Under high or low temperature (Table 2) the results exhibited that naked neck genotypes (Na/-) had significantly more persistent effect on laying than normals especially at the last two laying periods. The average of laying periods was about 60% for the Na/- birds whereas it was 54.2% for the na/na genotype. Similar results were also obtained by Abd El-Rahman (1990) and Abd El-Rahman and El-Hammady (2000) and Abd El-Rahman and Makled (2006).

With regard to egg number, the results showed a superiority due to the presence of Na gene, where egg number and laying rate during the first 3 months (E90) improved by 4% and 8.5% for the Na/na and Na/Na genotypes, respectively. Similar effect was observed for total egg number (TEN), where the Na/na and Na/Na laid more eggs than their normal partners by about 11.7% and 10.1%, respectively. The presence of Na led to an increase in average egg weight by about 6.4% and 4.9% for the Na/na and Na/Na genotypes, respectively. The obtained results are in an agreement with those reported by Abd El-Rahman (2000a,b), Singh *et al.* (2001), El-Safty *et al.* (2003), Mahrous *et al.* (2003) and Abd El-Rahman and Makled (2006).

Table 3. Laying rate (%) of Sharkasi layers during 8 successive periods as affected by genotype (G) and dietary calcium levels (T)

Factor	Group	LR1 23-26 wks	LR2 27-30 wks	LR3 31-34 wks	LR4 35-38 wks	LR5 39-42 wks	LR6 43-46 wks	LR7 47-50 wks	LR8 51-54 wks	ALR 23-54 wks
(G)	G_1	36.70^{A}	69.50^{B}	77.10^{A}	80.90^{A}	53.00^{A}	60.10^{A}	51.10^{B}	50.50^{A}	60.30^{A}
	G_2	31.80^{C}	71.50^{A}	77.20^{A}	77.60^{B}	51.50^{AB}	58.70^{A}	54.60^{A}	50.90^{A}	59.60^{A}
	G_3	34.40^{B}	71.20^{A}	73.90^{B}	62.10^{C}	49.80^{B}	53.40^{B}	48.80^{C}	39.30^{B}	54.20^{B}
(T)	T_1	36.10^{A}	71.80^{A}	77.10^{A}	74.80^{A}	51.90	58.20^{A}	51.30	48.30^{A}	59.10^{A}
	T_2	32.70^{B}	69.70^{B}	75.10^{B}	72.30^{B}	51.00	56.50^{B}	51.70	45.60^{B}	56.90^{B}
(G x T)	G_1xT_1	39.00^{A}	70.00	76.40^{B}	81.30^{A}	53.40	60.50^{A}	51.40	52.10	61.10^{A}
	G_1xT_2	34.40^{B}	69.10	77.80^{B}	80.50^{A}	52.60	59.60^{A}	50.80	49.00	59.80^{A}
	G_2xT_1	34.60^{B}	73.10	80.70^{A}	80.80^{A}	52.40	59.60^{A}	54.20	53.40	61.60^{A}
	G_2xT_2	29.30^{C}	70.00	73.80^{C}	74.50^{B}	50.60	57.80^{AB}	55.00	48.50	57.60^{B}
	G_3xT_1	34.60^{B}	72.40	74.20^{C}	62.50^{C}	50.00	54.60^{B}	48.30	39.50	54.50^{C}
	G_3xT_2	34.10^{B}	70.00	73.50^{C}	61.80^{C}	49.70	52.20^{C}	49.30	39.10	53.80^{C}
ANOVA	d.f	*Probabilities*								
G	2	**	**	**	**	**	**	**	**	**
T	1	**	**	**	**	N.S	**	N.S.	**	**
G x T	2	**	N.S.	**	**	N.S.	**	N.S.	N.S.	**
Error	422									

a,b,c, means within the same factor within the same column with different superscripts are significantly different (P<0.05).

** = Highly significant (P<0.01). N.S. = Not significant. LR = Laying rate (%)

G_1 = Na/na G_2 = Na/Na G_3 = na/na

T_1 = High dietary calcium level (3.47%). T_2 = Low dietary calcium level (2.51%).

Table (4): Egg production performance and body weight of Sharkasi layers as affected by Genotype (G) and dietary calcium level (T)

Factor	*Group*	A.S.M	TEN	AEW (g)	E90	LR90 (%)	TEM (kg)	W24 (g)	W40 (g)	W52 (g)
(G)	G_1	173.20^{A}	135.50^{A}	45.70^{A}	60.15^{B}	66.80^{B}	6.198^{A}	1323^{A}	1492	1600^{A}
	G_2	170.90^{B}	133.60^{A}	45.07^{A}	62.80^{A}	69.80^{A}	6.020^{A}	1293^{B}	1471	1576^{A}
	G_3	173.70^{A}	121.30^{B}	42.96^{B}	57.90^{C}	64.40^{C}	5.215^{B}	1288^{B}	1453	1552^{B}
(T)	T_1	171.50^{B}	132.40^{A}	45.14^{A}	60.30	67.00	5.975^{A}	1302	1472	1580
	T_2	173.70^{A}	127.90^{B}	44.10^{B}	60.20	66.80	5.640^{B}	1301	1473	1575
(G x T)	G_1xT_1	171.50	137.00^{A}	46.30	59.59	66.20	6.340^{A}	1337	1496	1600
	G_1xT_2	174.90	134.10^{AB}	45.15	60.69	67.45	6.050^{B}	1311	1489	1601
	G_2xT_1	169.50	138.10^{A}	45.85	63.60	70.65	6.330^{A}	1289	1465	1580
	G_2xT_2	172.30	129.20^{B}	44.35	62.04	68.95	5.730^{C}	1297	1476	1570
	G_3xT_1	173.40	122.00^{C}	43.15	57.88	64.30	5.272^{D}	1279	1451	1555
	G_3xT_2	173.90	120.60^{C}	42.80	58.00	64.45	5.161^{D}	1297	1454	1550
ANOVA	d.f	*Probabilities*								
G	2	**	**	**	**	**	**	*	N.S.	*
T	1	**	**	**	N.S	N.S	**	N.S.	N.S.	N.S.
G x T	2	N.S.	**	N.S	N.S.	N.S	**	N.S.	N.S.	N.S.
Error	422									

a,b,c, means within the same factor within the same column with different superscripts are significantly different (P<0.05).

** = Highly significant (P<0.01). *= Significant (P<0.05) N.S. = Not significant.

A.S.M. = Age at sexual maturity TEN = Total egg number AEW = Average egg weight TEM = Total egg mass

E90 = Egg number till 90 days from sexual maturity. LR90 (%) = Laying rate till 90 days from sexual maturity.

W24, W40, W52 = Body weight at 24, 40 and 52 wks of age, respectively.

As might be expected, the increase in egg number and weight due to Na gene improved total egg mass (TEM) of Na/na and Na/Na, genotypes by about 18.9% and 15.5%, respectively. Horst *et al.* (1996) found that under 18-20°C, the Na gene improved egg number, weight and mass by about 13.1%, 3.40% and 12.9%, respectively. The presence of Na gene improved significantly (P<0.05) body weight at 20 and 52 wks of age which agreed with the findings of Abd El-Rahman and Makled (2006).

Taking into consideration the effect of calcium level, the results obtained in Table (3) exhibited that high dietary calcium (3.47%) improved significantly (P<0.01) the laying rate by about 4%. High calcium level improved laying rate within the different laying periods whereas there were no differences due to calcium levels (3.47 vs 2.51%) at LR5 and LR7. Also, high calcium level reduced significantly (P<0.01) age at sexual maturity by about 2.2 days (Table 4).

Based on these data, there was 3.5% increase in TEN at high calcium level compared with the low calcium level. Abdallah *et al.* (1993) reported that egg production increased as Ca level increased from 2.2% to 3.9%. Also, there was an increase in average egg weight by about 2.4% due to high dietary Ca level. This increase in production is consistent with the published report of Roland *et al.* (1996). The significant effect of high Ca on egg number and weight may be attributed to parallel increase in the rate of calcium absorption through the intestine and thus to its level in blood serum and in the uterine glands (El-Gendi *et al.*, 1999). It has been reported that calcium regulates some important biological processes, including cellular information transfer, hormone biosynthesis and release (Hurwitz, 1987).

The increase in egg number and weight due to high dietary calcium (3.47%) improved significantly (P<0.01) TEM by about 6%. Keshavarz (1986) reported that egg mass was consistently lower for birds fed 1.5% or 5.5% calcium level compared to those fed 3.5%. Leeson *et al.* (1993) reported that 2.8% calcium level was more effective for increasing egg number and weight than other calcium levels (3.4%, 3.8% and 4.2%). Also, the results presented in Table (4) show that Ca levels (3.47% vs 2.51%) had no effect on body weight of birds at different ages. These results are in agreement with the findings of Chowdhury and Smith (2002).

With regard to the interaction between genotype and dietary calcium level for the important traits (ALR% or TEN and TEM), the results in Tables 3 and 4 showed that high dietary calcium level improved the TEN and TEM but the improvement ratio was more pronounced for the Na/- birds than the normal feathering sibs (na/na). The improvement in average laying rate or TEN due to high calcium level was 2.2%, 6.9% and 1.1% for the Na/na, Na/Na and na/na genotypes, respectively. The corresponding values of TEM were 4.8, 10.5 and 2.15% for the mentioned genotypes, respectively. In other words, the naked neck birds (Na/-) were more sensitive to the low dietary calcium level (2.51%) than their normal (na/na) counterparts.

Egg quality parameters

Results of egg quality are presented in Table (5). The results exhibited no significant interactions between the main factors (genotype, calcium level, and age). The naked neck birds (Na/-) had heavier egg weight (50.2 g) than those of their normal counterparts (48.1 g). Eggs from the naked neck birds had higher albumen percentage with lower yolk and shell percentages. The presence of Na gene increased albumin % by about 3.4% and 3.80% whereas it reduced yolk % by 3.3% and 3.8% for the Na/na and Na/Na genotypes, respectively. The present results are in agreement with those reported by Abd El-Rahman (2000a,b, 2003) and Abd El-Rahman and Makled (2006).

Table 5. Egg quality parameters of Sharkasi layers as affected by genotype (G) and calcium level (T) at different ages (A)

Factor	Group	Egg weight (g)	Albumen (%)	Yolk (%)	Shell (%)	Shell strength (kg/cm²)	Shell thickness (mm)
(G)	G_1	51.42^A	58.10^A	31.37^B	10.54^B	4.42^B	0.381^B
	G_2	50.03^B	58.32^A	31.26^B	10.42^B	4.18^B	0.361^C
	G_3	48.13^C	56.20^B	32.50^A	11.30^A	4.74^A	0.395^A
(T)	T_1	49.92	57.49	31.57	10.94^A	4.52	0.384^A
	T_2	49.80	57.58	31.85	10.57^B	4.37	0.371^B
(A)	A_1	48.08^B	58.13^A	31.09^B	10.78	4.60^A	0.382
	A_2	51.63^A	56.94^B	32.34^A	10.72	4.29^B	0.375
ANOVA	d.f.	*Probabilities*					
G	2	**	**	**	**	**	**
T	1	N.S.	N.S.	N.S.	**	N.S.	**
A	1	**	**	**	N.S.	**	N.S.
G x A	2	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
G x T	2	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
T x A	1	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Error	230						

a,b,c, means within the same factor within the same column with different superscripts are significantly different (P<0.05). ** = Highly significant (P<0.01). N.S.= Not significant. G_1 =Na/na G_2=Na/Na, G_3 = na/na T_1 = High dietary calcium level (3.47%). T_2 = Low dietary calcium level (2.51%). A_1 = At 40 wks of age A_2 = At 52 wks of age.

Na/Na birds recorded the lowest shell percentage value (10.42%) as compared with normal genotype (11.3%). The significant reduction in shell percentage led to a significant reduction ($P<0.01$) in egg breaking strength and shell thickness. Breaking strength was 4.42, 4.18 and 4.74 kg/cm^2 whereas shell thickness was 0.38, 0.36 and 0.4 mm for Na/na, Na/Na and na/na genotypes, respectively.

The remarkable disadvantage of Na gene in egg shell quality may be attributed to the significant increase in egg number and egg weight (Tables 4, 5). The reduction in egg shell quality support the findings of Abd El-Rahman (2000a,b, 2003) and Abd El-Rahman and El-Hammady (2000) who reported that reduction in shell quality was correlated with a significant decrease in serum calcium of Na/- birds as compared with na/na genotype. Also, Abdallah *et al.* (1993) reported that low egg shell hens were absorbing the calcium but had a problem of transferring it to the shell. This explanation may be another cause for reducing shell quality of Na/- birds. Therefore, Abd El-Rahman (2000a&b, 2003) suggested that more studies are still needed to determine the best requirements of dietary calcium for the naked neck genotypes (Na/-).

High dietary calcium (3.47%) did not affect albumen and yolk percentages, whereas it increased significantly ($P<0.01$) egg shell percentage and thickness (Table 5). The shell percentage was 10.94% and 10.57% of eggs from hens fed high (3.47%) and low (2.51%) dietary calcium levels, respectively. The corresponding values of shell thickness were 0.384 and 0.371 mm, respectively.

The improvement in egg shell quality with increasing Ca is in an agreement with the results reported by Clunies *et al.* (1992), Abdallah *et al.* (1993), Abou-Egla (1995) and Gordan and Roland (1998). The improvement in egg shell quality due to high Ca level was presumably a result of increasing the amount of Ca consumed, Ca retained, and Ca available for egg shell deposition. Also, calcium utilization was significantly better for the high egg shell weight hens than the low egg shell weight hens as reported by Abdallah *et al.* (1993). Clunies *et al.* (1992) found that hens laying eggs with thick shells retained and utilized significantly more Ca than hens laying eggs with thinner shells. Clunies *et al.* (1992) observed that calcium levels (2.5%, 3.5% and 4.5%) had no significant effect on egg production or weight, whereas shell weight increased significantly with increasing dietary calcium level. Similar result was also obtained by Gordan and Roland (1998) when birds fed on calcium levels 2.5%, 2.8% and 3.1%. Also, it has been reported that dietary calcium levels between 2.7% and 3.5% were required to maintain optimum egg shell quality (Hurwitz and Griminger, 1960).

The results in Table (5) show significant differences ($P<0.01$) due to age of birds on egg weight, albumen and yolk percentages and shell strength. Although advancing age from 40 to 52 wks reduced shell percentage and shell thickness, the differences were insignificant. It seems that reduced shell quality with aging is due to increased egg weight which in turn demands a higher shell weight without a proportional increase of the hen's ability to increase the absorption and utilization of Ca to fulfill a higher Ca demand for shell formation. Attia (1993) and Abou-Egla (1995) found that the response to dietary Ca levels on egg shell quality are dependent on age of hens.

Anatomical and physiological parameters

Results of some anatomical and physiological parameters are presented in Table (6). The results show no significant interaction between the main factors for the most studied parameters. However, the presence of Na gene reduced significantly (P<0.01) the percentage of abdominal fat by about 32% and 47% in Na/na and Na/Na genotypes, respectively. The reduction may be due to the increase in egg output (egg mass) of the naked neck birds (Na/-) compared with the na/na counterparts. Similar results were obtained by Abd El-Rahman and Makled (2006). Also, the naked neck birds (Na/-) exhibited an significant (P<0.01) increase in carcass and giblets. Such increases were coincided with higher dressing percentages by about 5.60% and 5.0% of Na/na and Na/Na genotypes, respectively.

Table 6. Anatomical and physiological parameters of Sharkasi layers as affected by genotype (G) and dietary calcium level (T) at different ages (A)

Factor	Group	Parameters							
		Abdominal fat (%)	Carcass (%)	Giblets (%)	Dressing (%)	Ovary (%)	Oviduct (%)	Calcium mg/100 ml	Phosphorus mg/100 ml
(G)	G_1	2.32^{B}	60.04^{A}	5.30^{B}	65.34^{A}	3.52^{A}	3.99^{A}	20.35^{B}	6.32
	G_2	1.81^{C}	59.40^{A}	5.60^{A}	65.00^{A}	3.53^{A}	3.85^{A}	20.28^{B}	6.30
	G_3	3.42^{A}	56.87^{B}	5.02^{C}	61.89^{B}	3.23^{B}	3.61^{B}	22.00^{A}	6.40
(T)	T_1	2.58	59.00	5.22	64.22	3.43	3.96^{A}	21.62^{A}	6.40
	T_2	2.46	58.54	5.39	63.93	3.43	3.67^{B}	20.13^{B}	6.27
(A)	A_1	2.34^{B}	59.29^{A}	4.97^{B}	64.26	3.54^{A}	3.92^{A}	21.37	6.33
	A_2	2.69^{A}	58.25^{B}	5.64^{A}	63.89	3.32^{B}	3.72^{B}	20.38	6.34
ANOVA	d.f.	Probabilities							
G	2	**	**	**	**	*	**	*	N.S.
T	1	N.S.	N.S.	N.S.	N.S.	N.S.	**	*	N.S
A	1	*	*	**	N.S	*	*	N.S	N.S
G x A	2	N.S	N.S	*	N.S.	N.S.	N.S.	N.S.	N.S.
G x T	2	N.S.	N.S.	*	N.S.	N.S.	N.S.	N.S.	N.S.
T x A	1	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
Error	110								

a,b,c, means within the same factor within the same column with different superscripts are significantly different (P<0.05). ** = Highly significant (P<0.01). * = Significant (P<0.05). N.S. = Not significant.
G_1 = Na/na G_2 = Na/Na G_3 = na/na
T_1 = High dietary calcium level (3.47%). T_2 = Low dietary calcium level (2.51%).
A_1 = At 40 wks of age A_2 = At 52 wks of age.

As shown in Table (6), there was an increase in ovary percentage by 8.4% and 9.3% ,and an increase in oviduct percentage by 10.5% and 7.0% of the Na/na, and Na/Na genotypes as compared with na/na counterparts. Abd El-Rahman and Makled (2006) reported that the increase in the reproductive organs may due to the higher productivity of Na/- layers than na/na or may be attributed to a linkage between Na gene and other genes responsible for hormone secretion.

Moreover, there was a significant reduction in serum calcium level (Table 6) due to the presence of Na gene. Serum calcium was 20.35, 20.28 and 22.0 mg/100 ml for the Na/na, Na/Na and na/na genotypes, respectively. The results obtained in this study confirm the findings obtained by Abd El-Rahman (2000a,b) and Abd El-Rahman and El-Hammady (2000) who reported that the remarkable reduction in egg shell quality of Na/- birds was due to the reduction in serum calcium as a result of low absorbtion of dietary calcium. The results showed no significant differences in serum inorganic phosphorus due to genotype (Table 6).

With regard to dietary calcium level, the results indicate that calcium levels (3.47 vs 2.51%) did not affect abdominal fat, carcass, giblets and dressing percentages.

Also, calcium level had no effect on ovary percentage whereas there was a significant ($P<0.01$) increase in the oviduct by about 7.3% due to high calcium level. This increase may be due to that hens fed high calcium level (3.47%) produced more eggs, and heavier egg weight than those fed low dietary calcium (2.51%).

It could be stated that the level of plasma calcium increased significantly ($P<0.05$) as calcium level increased. Serum calcium was 21.62 and 20.38 mg/100 ml from hens fed high (3.47%) and low (2.51%) dietary calcium levels, respectively. El-Gendy *et al.* (1999) reported that plasma calcium was 20.5, 24.4 and 24.9 mg/100 ml for pullets fed 3.5, 4.5 and 5.5% dietary calcium. The corresponding values for inorganic phosphorus were 7.83, 7.45 and 7.64 mg/100 ml, respectively. These results agree with the finding of Garlich *et al.* (1984) who reported that the serum calcium and phosphorus content of laying hens was influenced by age and production status. Also the results of Khalil and Gad (1994) indicated that hens which showed more calcium absorption produced more eggs than those of lower calcium absorption.

The results showed that no significant differences in inorganic phosphorus due to the differences in dietary calcium level. The level of plasma inorganic phosphorus may be a function of genetic action which produces enzymatic system responsible for regulating the rates of filteration or absorption. The mechanism of this regulation may be affected with the status of blood calcium homeostasis and mechanism of maintaining the electrical balance in the various body fluids compartments (El-Gendi *et al.*, 1999). Savaliya *et al.* (1997) showed that alkaline phosphates enzyme is associated with calcium metabolism and egg production.

It was observed that carcass, ovary and oviduct reduced significantly with advancing age whereas the abdominal fat and giblets were increased ($P<0.05$) with advancing age (Table 6).

From the above mentioned results, it is concluded that 1) The naked neck layers (Sharkasi) exhibited a remarkable superiority for the most important productive traits. 2) High dietary calcium level (3.47%) improved the productive performance of Sharkasi layers with an interaction between Na gene and dietary calcium level since the improvement due to high calcium level was more pronounced for the naked neck birds (Na/-) than the normal feathering (na/na) counterparts.

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تأثير مستويات الكالسيوم على الأداء الإنتاجى للدجاج العارى الرقبة (الشركسى)

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أستخدم فى البحث 428 دجاجة بياضة من ثلاثة تراكيب وراثية وهى الشركسى العارى الرقبة (الخليط والأصيل) والطبيعى التربيش لدراسة تأثير التداخل بين التركيب الوراثى ومستويات الكالسيوم (3.47% ، 2.51%) على أداء إنتاج البيض وجودة القشرة حتى 54 أسبوع من العمر وأمكن تلخيص النتائج كما يلى :

1- أدى وجود العامل الوراثى أو مستوى الكالسيوم المرتفع (3.47%) إلى خفض معنوى (مستوى 1%) للعمر عند النضج الجنسى .

2- تحسن معدل وضع البيض أو عدد البيض الكلى بحوالى 11.7% ، 10.1% وكتلة البيض بحوالى 18.9% ، 15.5% لكل من الدجاج العارى الخليط والأصيل بالمقارنة بالطبيعى التربيش . وأدى المستوى المرتفع من الكالسيوم إلى تحسن معنوى فى معدل الوضع أو عدد البيض الكلى وكتلة البيض بحوالى 3.5% ، 6% عند المقارنة بالمستوى المنخفض من الكالسيوم (2.51%). مع وجود تداخل بين جين الرقبة العارية و مستوى الكالسيوم حيث زاد إنتاج البيض بزياد مستوى الكالسيوم (3.47%) للطيور العارية الرقبة بالمقارنة بالطيور الطبيعية التربيش.

3- أدى وجود العامل الوراثى للرقبة العارية إلى زيادة معنوية فى وزن البيضة ونسبة البياض بينما أنخفضت نسبة الصفار وجودة القشرة عند قياس نسبة وسمك وقوة تحمل القشرة. لم تؤثر نسبة الكالسيوم على نسبة البياض والصفار ولكن تحسنت نسبة وسمك القشرة معنوياً (مستوى 1%) وبدون أى تأثير على قوة التحمل .

4- أظهرت الطيور العارية الرقبة انخفاضاً معنوياً (مستوى 1%) فى دهن التجويف البطنى مع تحسن نسبة التصافى بحوالى 5.3% . زادت نسبة المبيض والقناه المبيضية نتيجة لوجود جين الرقبة العارية مع انخفاض معنوى (مستوى 5%) فى نسبة كالسيوم الدم . لم يؤثر مستوى كالسيوم العليقة على الصفات التشريحية ونسبة التصافى وأدى المستوى المرتفع لكالسيوم العليقة إلى زيادة معنوية فى نسبة القناة المبيضية وكالسيوم الدم .

وتخلص الدراسة إلى أن الطيور العارية الرقبة قد أظهرت تميزاً ملحوظاً فى الأداء الإنتاجى كما توصى الدراسة باستخدام المستوى المرتفع للكالسيوم (3.47%) فى علائق الدجاج الشركسى .