Egypt Poult. Sci. Vol (26) (I): (319-334)

IN VIVO STUDY OF INTESTINAL CALCIUM AND PHOSPHORUS ABSORPTION DURING DIFFERENT STAGES OF EGG FORMATION IN THE REPRODUCTIVE TRACT OF HIGH AND LOW EGG PRODUCTION LAYING HENS

By

Maysa M. Hanafy, A.M.H.El-Sheikh and Hanaa M. Khalil
Poult. Bre. Res. Dept., Anim. Prod. Res. Instit., Ministry of Agric., Giza, Egypt

Receive: **08/01 / 2006** Accept : **14/02 / 2006**

Abstract: *Ninty laying hens of Silver Montazah at 30 weeks of age were used in this study. All birds were individually housed in battery cages, eggs number and weight were recorded daily for three months. Hens were classified into two groups, high (73.27%), and low (32.29%) according to their egg production. At 42 weeks of age, thirty experimented birds for each group were used to estimate the calcium and phosphorus absorption in the small intestine (in vivo). The birds were classified as follows: 20 birds were used at 9 a.m represents the absorption after the egg laying directly; 20 birds were used at 9 p.m. and result from this group represent the absorption during the period of calcification and the last 20 birds were used at 3 p.m, showing the absorption during the soft egg formation. The results of this study indicated that the calcium and phosphorus absorption was significantly ($P\leq0.01$) higher in the high egg production hens than the low egg production ones. Also the absorption of the calcium and phosphorus at the calcification time was significantly ($P\leq0.01$) higher than those for the soft egg stage and after laying. Moreover, the higher calcium and phosphorus absorption was obtained in the ileum part while the lower was observed in the duodenum for the high and the low egg production groups in Silver Montazah laying hens. The relative tibia weight and the concentration of calcium and inorganic phosphorus either in tibia or serum were significantly ($P\leq0.01$) lower for the high egg production group than the lower ones. While serum alkaline phosphatase was significantly ($P\leq0.01$) high for the high egg production group compared with the low egg production. During the different stages of the egg formation, the phosphorus concentrations in tibia and serum had increased in the calcification time than after egg laying and soft egg stages, while serum alkaline phosphatase concentration was significantly ($P\leq0.01$) decreased in the calcification time than for other stages of the egg formation. Moreover, live body weight was* *significantly (P≤0.05) lower for the high egg production hens compared with the low egg production ones. However, largest follicle weight and the length of the oviduct parts were significantly (P≤0.01) increased for the high egg production group compared with the low one. No significant differences were observed in the lengths of the oviduct during the different stages of egg formation. Egg weight; shell weight and relative shell weight were significantly (P≤0.01) lower for the high egg production group than the low ones, while no significant differences of shell thickness were observed between both groups of egg production.*

INTRODUCTION

There are marked changes in the intestinal absorption of calcium during the process of egg formation. Radwan (1980) studied the total calcium absorption in each intestinal part in different stages of egg formation and reported that maximum calcium absorption (36 mg/hr) was reached at the calcification time decreased afterwards. Besides, efficiency of calcium absorption changed markedly to meet the requirements of biological and production process and reached the maximum during the egg formation stages particularly at calcification time. Bar *et al* (1976) found that the overall and the fractional calcium absorption in the duodenum, upper jejunum and upperlieum were significantly higher in the egg shell forming than in those for not forming an egg shell. During egg shell formation, the decrease in total plasma calcium across the uterus was greater than that when the uterus did not contain an egg with a shell being formed (Hunsaker and Sturkie; 1961). Also, positive correlation was found between serum calcium level and time of oviposition (Sloan *et al.*, 1974). Moreover, Nys *et al* (1986) showed that total calcium concentration in plasma decreased slightly throughout the ovulatory cycle. Plasma inorganic phosphorus levels were increased during the period of active shell formation (Prashed and Edwards, 1973). Also, shell quality could be assumed to become better for eggs from hens with lower rate of production than those from high production hens (Choi *et al.*, 1981). So, the present study was conducted to study intestinal calcium and phosphorus absorption (In vivo) during different stages of egg formation in the reproductive tract of high and low egg production laying hens.

MATERIALS AND METHODS

The present study was carried out at the El-Sabahia Poultry Research Station (Alexandria), Animal Production Research Institute, Agricultural Research center, Ministry of Agriculture. Ninty laying hens of Silver Montazah at 30 weeks of age were used in this study. All birds were housed in individual cages and fed on layer diets containing 16% crude protein, 2900 Kcal ME/Kg of diet, 3% calcium and 0.65% total phosphorus. Feed and water were given *ad libitum* and the daily photoperiod was 16L:8D. Egg number and egg weight were individually recorded daily for three months before studying the absorption. Hens were classified into two groups, high (73.27%) and low (32.29%) according to their egg production.

At 42 weeks of age, sixty experimental birds from groups were randomly chosen and weighed, these birds were used to estimate the calcium and phosphorus absorption in the small intestine (in vivo). Twenty birds were used at 9 a.m representing the absorption after the egg laying directly; twenty birds were used at 9 p.m. indicating the absorption during the period of calcification and the last twenty birds were used at 3 p.m. representing the absorption during the soft egg formation (ten birds for Ca and the other ten for P absorption in each stage). Blood samples were collected from wing vein of these hens at the different stages of estimation and kept at room temperature for one hour to clot. The samples were centrifuged at 3000 rpm for 15 minutes to separate clear serum, which were stored at -20 °C until analysis for calcium (Baginski *et al.*, 1973), inorganic phosphorus (Goodwin, 1970) and alkaline phosphatase (Bessey *et al.*, 1946) concentrations. Birds were fasted from feed only for 14-17 hrs for studying the absorption (in vivo) and then they were anaesthetized by ether. A longitudinal incision of about 3 cm was made through the abdominal skin and peritoneum, the small intestine was always an intact with blood supply.

Three ligated loops of the small intestine for each bird were performed duodenum, jejunum and ileum (3 loops X 5 birds X 3 stages X 2 production levels = 90 intestine ligated loops were offered for each absorption). $CaCl_2$ as a soluble calcium salt solution (8 mg Ca/mL) was infused in each isolated part according to its length. Thus 2 ml, 4 ml and 3 ml of $CaCl_2$ solutions were infused in the duodenum, jejunum and ileum respectively (about 1 ml for 10 cm of the intestine). The intestine was carefully replaced to its normal position, and the abdomen was closed with clips and the birds were left for one hour. After one hour (the absorption time) the birds were slaughtered then, the abdomen was opened and each isolated intestinal part was cut and picked out, washed by 100 ml warm physiological saline, the washable solution for each intestinal part was collected separately and filtrated. A sample was taken from each solution to determine Ca ions by EDTA titration as stated by Hawk's (1965). Calcium absorption was calculated by substracting the amount in each washed solution from that infused in each intestinal part (Khalil *et al.*, 1987). Calcium absorption was measured as a total calcium absorption (mg/hr); calcium absorption per each cm length of the intestine was calculated and the efficiency of calcium absorption expressed as the percentage of calcium absorption to the amount which was infused. The phosphorus absorption was determined by the same way. The infused solution was prepared from KH_2PO_4, after adjusting the pH to 7, each ml from this solution was contained 6.2 mg phosphorous. Thus 2 ml, 4 ml and 3 ml of KH_2PO_4 solutions were infused in the duodenum, jejunum and ileum respectively. Phosphorus was measured according to the method of Volasy and Szalio (1971). The same measurements of Ca were calculated for phosphorus.

After birds were slaughtered to determine calcium and phosphorus absorption, some measurements were obtained the length (cm) of each part of oviduct was recorded and largest ovarian follicle were weighed on electrical balance to the nearest milligram. The right tibia was removed, cleaned from muscle tissue and weighed, then its length was measured. The bones were dried and ashed at 550°C, the ash was dissolved in 5 ml. Conc. HCL and diluted to 100 ml with distilled water to determine its contents of calcium and phosphorus. (A.O.A.C., 1975). Also, at 42 weeks of age, ten eggs from each group were randomly taken for detection of shell quality traits including shell weight and thickness according to Johansson and Roedel (1968). The statistical analysis was computed using the General Linear Model for analysis of variance through the SAS programe (SAS Institute 1990). Means were compared for significant differences using Duncan's multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Tables 1 and 2 show that, calcium and phosphorus absorption in different intestinal parts had been affected by rate of lay and the different stages of egg formation. From the results of these tables, it can be observed that calcium and phosphorus absorption (either mg/hr, mg/cm and efficiency) in different intestinal parts in the high egg production hens was significantly ($P \leq 0.01$) higher than those of low egg production. These results of increasing calcium and phosphorus absorption with increasing of egg production are in agreement with the results of Radwan (1980) and Khalil *et al* (1987) indicated that, hens which had higher calcium absorption produced more eggs than those of lower calcium absorption. Khalil and Gad (1994) indicated that, calcium absorption in the ileum for the high egg producers was higher than the low egg producers in turkey hens. On the other hand, the calcium and phosphorus absorption in different intestinal parts at calcification time were significantly ($P \leq 0.01$) higher than those for the soft egg and after egg laying stages. These results pronounced that when the hens have a soft egg in the uterus, the calcium and phosphorus absorption increased and reached the maximum at the calcification time, after words it decreased, to the starting level when the hen had laid down the egg. These results are harmony with the results of Bar *et al.*, (1976) and Radwan (1980).

The efficiency of intestine to absorbe calcium and phosphorus varied from one region to another, therefore generally, the maximum absorption value's were obtained in the ileum while the minimum values were detected in the duodenum for both high and the low egg producers hen (Tables 1 and 2). These results are in agreement with previous reports either in vivo by El-Habbak and Radwan (1984), Khalil *et al.*, (1987) or in vitro by Radwan (1990) who showed that, the highest mean value of calcium and phosphorus absorption occured in the ileum while the lowest values were detected in the duodenum. Moreover, Khalil and Gad (1994) reported that duodenum had the lowest calcium absorption efficiency, while the jejunum and ileum had the highest ones in turkey hens.

Results in tables 3 and 4 show that the mean values of tibia length in the high and the low egg production were not significantly different at the different estimation stages of Ca and P in Silver Montazah laying hens. On the other hand, relative tibia weight; calcium and phosphorus in tibia and serum were significantly ($P \leq 0.01$) decreased for high egg production hens compared with low egg ones. These results are supported by Taylor (1956) who suggested that potentially high secretors of shell calcium are those which have a greater ability to lay down calcium on the bone during the period of low egg production and greater ability to remove it from the bone during the period of high production. Also Garlich *et al.*, (1984) showed that serum calcium and phosphorus of laying hens were influenced by egg production status. Mady and Ahmed (1998) showed that plasma calcium seems to follow an opposite trend as a result of increasing level of egg production in Japanese quail. The reverse results were obtained for the serum alkaline phosphatase value as it significantly ($P \leq 0.01$) increased for high egg production laying hens than the low ones in Silver Montazah strain. Mohamed (1997) found that serum alkaline phosphatase level was significantly higher in White Leghorn (high egg production) than Fayoumi (low egg production). Moreover, Savaliya *et al.*, (1997) showed that alkaline phosphatase enzyme is associated with calcium metabolism and egg production.

It can be observed from the comparison of egg formation stages that there were no significant differences in tibia length; relative tibia weight; calcium and phosphorus in tibia and serum. However phosphorus concentrations in tibia and serum were higher in calcification time comparing to those for after egg laying and soft egg stages. These results are in accordance with the results reported by Prashed and Edwards (1973) who showed that plasma inorganic phosphorus levels had increased during the period of active of shell formation. Moreover, Nys *et al.*, (1986) reported that the concentration of inorganic phosphorus in the plasma was increased in the laying hens during the period of shell formation and decreased when calcification was suppressed.

On the other hand, serum alkaline phosphatase concentration was highly significantly ($P \leq 0.01$) decreased in calcification time compared to those after laying and soft egg stages in Silver Montazah laying hens. The reported results herein could support the conclusion of Taylor and Williams (1964) who reported that alkaline phosphatase plays an important role in all metabolic processes as well as egg shell calcification, bone formation and calcium mobilization.

Tables 5 and 6 show that live body weight was significantly ($P \leq 0.05$) lower in the high egg production hens than in those for the low egg production group. These results do not support the results of Khalil and Gad (1994) who showed that the live body weight was not significantly affected when the hens were classified according to the rate of lay. Moreover, live body weight at after laying were significantly ($P \leq 0.01$) higher than the soft egg stage. On the other hand, largest foolicle weight and the length of the oviduct parts were significantly ($P \leq 0.01$) higher for the high egg production hens compared with the lower egg producers in Silver Montazah laying hens. While, no significant differences were observed in largest follicle weight and lengths of the oviduct parts during the egg formation stages.

Results obtained in table (7) showed that the egg weight; shell weight and relative shell weight were significantly ($P \leq 0.01$) decreased for the high egg production hens than the lower egg production ones, while no significant differences were observed between the two rates of egg production for shell thickness. These results are in agreement with Choi *et al.* (1981) who showed that shell quality could assumed to be better for eggs from hens with lower rate of production than those from high production hens.

From our results it can be concluded that the calcium and phosphorus absorption in the laying hens were different through the different stages of egg formation, since the absorption was increased during the calcification time compared to the other two stages of the egg formation. Moreover, the maximum absorption values were obtained in the ileum while the minimum values were detected in the duodenum for both high and low egg production hens. On the other hand, relative tibia weight, calcium and phosphorus in tibia and serum, egg weight, shell weight and relative shell weight were decreased for high egg production hens compared with low egg ones. While calcium and phosphorus absorption, serum alkaline phosphatase, largest follicle weight and the length of the oviduct parts were increased for the high egg production hens than the lower egg production ones.

Table (1): Calcium absorption per hour, per cm and efficiency (%) in the small intestine during the different stages of the egg formation in Silver Montazah hens.

Stages	Duodenum		Means	Jejunum		Means	Ileum		Means
	High egg prod.	Low egg prod.		High egg prod.	Low egg prod.		High egg prod.	Low egg prod.	
Calcium absorption (mg Ca/hr)									
After laying	5.24±0.42	3.54±0.36	4.39±0.38^{C}	10.84±0.24	9.90±0.13	10.37±0.20^{C}	11.00±0.54	9.16±0.42	10.08±0.45^{C}
Soft egg	8.06±0.18	6.46±0.42	7.26±0.34^{B}	11.70±0.31	10.82±0.28	11.26±0.24^{B}	13.28±0.44	12.60±0.59	12.94±0.36^{B}
Calcification time	11.30±0.19	10.38±0.41	10.84±0.26^{A}	13.38±0.56	12.20±0.46	12.79±0.39^{A}	16.32±0.22	15.04±0.39	15.68±0.30^{A}
Means	8.20±0.68^{A}	6.79±0.78^{B}		11.97±0.35^{A}	10.97±0.30^{B}		13.53±0.63^{A}	12.27±0.69^{B}	
Calcium absorption (mg Ca/cm)									
After laying	0.17±0.02	0.20±0.01	0.15±0.01^{C}	0.31±0.02	0.20±0.01	0.26±0.02^{C}	0.43±0.02	0.32±0.02	0.38±0.02^{C}
Soft egg	0.27±0.01	0.13±0.01	0.23±0.01^{B}	0.42±0.01	0.29±0.01	0.35±0.02^{B}	0.52±0.02	0.45±0.01	0.48±0.01^{B}
Calcification time	0.45±0.02	0.33±0.02	0.39±0.02^{A}	0.53±0.02	0.44±0.02	0.49±0.02^{A}	0.69±0.02	0.61±0.03	0.65±0.02^{A}
Means	0.29±0.03^{A}	0.22±0.02^{B}		0.42±0.03^{A}	0.31±0.03^{B}		0.55±0.03^{A}	0.46±0.03^{B}	
Calcium efficiency (%)									
After laying	20.26±0.57^{d}	13.14±0.84^{e}	16.70±1.28^{C}	31.96±0.99^{d}	20.22±0.71^{e}	26.09±2.04^{C}	41.08±2.49	25.96±1.36	33.52±2.85^{C}
Soft egg	31.80±0.51^{c}	20.68±0.85^{d}	26.24±1.91^{B}	44.14±0.94^{c}	31.02±0.46^{d}	37.58±2.24^{B}	55.22±1.56	43.92±1.57	49.57±2.15^{B}
Calcification time	52.22±0.96^{a}	46.78±1.34^{b}	49.50±1.19^{A}	68.78±0.74^{a}	53.98±2.04^{b}	61.38±2.67^{A}	84.14±2.43	66.42±2.29	75.28±3.35^{A}
Means	34.77±3.55^{A}	26.87±3.89^{B}		48.29±4.12^{A}	35.07±3.82^{B}		60.15±4.93^{A}	45.43±4.53^{B}	

A,b,c,d,e,f = Means having different letter exponents within rows in a main effect are significantly different at $P \leq 0.05$.

A,B,C = Means having different letter exponents within columns and rows in a main effect are significantly different at $P \leq 0.05$.

Table (2): Phosphorus absorption per hour, per cm and efficiency (%) in the small intestine during the different stages of the egg formation in Silver Montazah hens.

Stages	Duodenum			Jejunum			Ileum		
	High egg prod.	Low egg prod.	Means	High egg prod.	Low egg prod.	Means	High egg prod.	Low egg prod.	Means
phosphorus absorption (mg P/hr)									
After laying	3.02±0.11	1.98±0.17	$2.50±0.20^{C}$	5.42±0.19	4.18±0.33	$4.80±0.27^{C}$	$7.24±0.19^{c}$	$5.76±0.42^{d}$	$6.50±0.33^{C}$
Soft egg	4.08±0.37	2.84±0.14	$3.46±0.28^{B}$	8.52±0.21	5.80±0.25	$7.16±0.48^{B}$	$10.84±0.56^{ab}$	$7.06±0.09^{f}$	$8.95±0.68^{B}$
Calcification time	6.32±0.41	4.00±0.35	$5.16±0.46^{A}$	10.58±0.38	8.24±0.61	$9.41±0.52^{A}$	$11.82±0.14^{a}$	$9.90±0.38^{b}$	$10.86±0.37^{A}$
Means	$4.47±0.41^{A}$	$2.94±0.26^{B}$		$8.17±0.59^{A}$	$6.07±0.50^{B}$		$9.97±0.56^{A}$	$7.57±0.50^{B}$	
Phosphorus absorption (mg P/cm)									
After laying	$0.11±0.01^{bc}$	$0.10±0.01^{c}$	$0.11±0.01^{C}$	$0.13±0.01^{c}$	$0.11±0.01^{c}$	$0.12±0.01^{C}$	0.30±0.02	0.23±0.01	$0.27±0.02^{C}$
Soft egg	$0.13±0.01^{b}$	$0.13±0.01^{b}$	$0.13±0.01^{B}$	$0.20±0.01^{b}$	$0.18±0.02^{b}$	$0.19±0.01^{B}$	0.35±0.02	0.30±0.01	$0.32±0.01^{B}$
Calcification time	$0.20±0.01^{a}$	$0.15±0.02^{b}$	$0.17±0.01^{A}$	$0.31±0.01^{a}$	$0.22±0.02^{b}$	$0.26±0.02^{A}$	0.49±0.01	0.41±0.01	$0.45±0.02^{A}$
Means	$0.15±0.01^{A}$	$0.13±0.01^{B}$		$0.21±0.02^{A}$	$0.17±0.02^{B}$		$0.38±0.02^{A}$	$0.31±0.02^{B}$	
Phosphorus efficiency (%)									
After laying	$19.68±1.39^{d}$	$13.66±0.74^{e}$	$16.67±1.25^{C}$	44.68±1.82	29.72±1.08	$37.20±2.69^{C}$	63.16±0.98	50.32±2.53	$56.74±2.49^{C}$
Soft egg	$38.62±1.55^{b}$	$21.88±2.09^{d}$	$30.25±3.05^{B}$	47.52±5.59	41.80±3.20	$44.66±3.18^{B}$	72.50±1.19	63.16±1.95	$67.83±1.89^{B}$
Calcification time	$46.64±2.29^{a}$	$32.74±2.52^{c}$	$39.69±2.82^{A}$	59.72±2.69	51.96±2.49	$55.84±2.16^{A}$	82.64±0.81	69.82±1.24	$76.23±2.25^{A}$
Means	$34.98±3.17^{A}$	$22.76±2.33^{B}$		$50.64±2.65^{A}$	$41.16±2.75^{B}$		$72.77±2.19^{A}$	$61.10±2.41^{B}$	

A,b,c,d = Means having different letter exponents within rows in a main effect are significantly different at P≤0.05.

A,B,C = Means having different letter exponents within columns and rows in a main effect are significantly different at P≤0.05.

Table (3): Tibia length; relative tibia weight; tibia and serum calcium and inorganic phosphorus and serum alkaline phosphatase at the different estimation stages of calcium absorption in Silver Montazah laying hens.

Stages	High egg prod.	Low egg prod.	Means
Tibia length (cm)			
After laying	11.58±0.51	11.72±0.32	11.65±0.29
Soft egg	11.46±0.20	11.80±0.13	11.63±0.13
Calcification time	11.52±0.57	11.78±0.34	11.65±0.33
Means	11.52±0.24	11.77±0.15	
Relative tibia weight (%)			
After laying	0.742±0.020	0.802±0.016	0.772±0.016
Soft egg	0.722±0.009	0.812±0.022	0.767±0.019
Calcification time	0.748±0.026	0.806±0.009	0.777±0.016
Means	$0.737±0.011^{B}$	$0.807±0.009^{A}$	
Total tibia calcium (%)			
After laying	20.10±0.46	25.17±0.64	22.64±0.70
Soft egg	18.62±0.43	25.12±0.59	21.87±0.83
Calcification time	18.88±0.40	25.53±0.63	22.81±0.85
Means	$19.17±0.27^{B}$	$25.27±0.35^{A}$	
Total tibia phosphorus (%)			
After laying	9.51±0.65	12.50±0.56	11.01±0.54
Soft egg	9.70±0.65	12.64±0.55	11.17±0.53
Calcification time	9.52±0.38	13.29±0.43	11.41±0.52
Means	$9.58±0.32^{B}$	$12.81±0.29^{A}$	
Serum calcium (mg/dL)			
After laying	14.68±0.22	18.00±0.59	16.34±0.63
Soft egg	14.42±0.30	17.72±0.81	16.07±0.69
Calcification time	13.52±0.44	18.56±0.66	16.04±0.92
Means	$14.21±0.22^{B}$	$18.09±0.38^{A}$	
Serum phosphorus (mg/dL)			
After laying	$4.00±0.19^{c}$	$6.54±0.41^{a}$	5.27±0.47
Soft egg	$4.22±0.15^{c}$	$6.08±0.23^{b}$	5.15±0.34
Calcification time	$4.12±0.19^{c}$	$6.80±0.38^{a}$	5.46±0.49
Means	$4.11±0.10^{B}$	$6.44±0.22^{A}$	
Serum Alkaline phosphatase (IU/L)			
After laying	$117.48±1.16^{a}$	$109.10±2.67^{b}$	$115.63±0.90^{A}$
Soft egg	$116.88±1.07^{a}$	$114.38±1.32^{a}$	$113.29±1.96^{A}$
Calcification time	$117.94±0.80^{a}$	$94.76±1.00^{c}$	$106.35±3.91^{B}$
Means	$117.43±0.56^{A}$	$106.08±2.42^{B}$	

A,b,c = Means having different letter exponents within rows in a main effect are significantly different at P≤0.05.
A,B,C = Means having different letter exponents within columns and rows in a main effect are significantly different at P≤0.05.

Table (4): Tibia length; relative tibia weight; tibia and serum calcium and inorganic phosphorus and serum alkaline phosphatase at the different estimation stages of phosphorus absorption in Silver Montazah layins hens.

Stages	High egg prod.	Low egg prod.	Means
Tibia length (cm)			
After laying	11.70±0.31	11.96±0.14	11.83±0.17
Soft egg	11.72±0.07	11.86±0.20	11.79±0.10
Calcification time	12.04±0.15	12.18±0.33	12.11±0.17
Means	11.82±0.12	12.00±0.13	
Relative tibia weight (%)			
After laying	0.704±0.018	0.814±0.017	0.759±0.022
Soft egg	0.738±0.017	0.808±0.012	0.773±0.015
Calcification time	0.700±0.022	0.800±0.027	0.750±0.023
Means	$0.714±0.011^{B}$	$0.807±0.01^{A}$	
Total tibia calcium (%)			
After laying	20.08±0.65	23.80±1.45	21.94±0.97
Soft egg	18.06±0.64	24.30±0.90	21.18±1.16
Calcification time	18.72±0.63	26.02±1.27	22.37±1.39
Means	$18.95±0.41^{B}$	$24.71±0.71^{A}$	
Total tibia phosphorus (%)			
After laying	10.12±0.64	12.82±0.50	11.47±0.59
Soft egg	10.16±0.42	12.40±0.21	11.28±0.43
Calcification time	9.82±0.28	13.02±0.17	11.92±0.56
Means	$10.03±0.26^{B}$	$12.75±0.19^{A}$	
Serum calcium (mg/dL)			
After laying	13.80±0.20	17.66±0.71	15.73±0.73
Soft egg	14.26±0.68	17.24±0.68	15.75±0.67
Calcification time	13.16±0.30	17.92±0.48	15.54±0.84
Means	$13.74±0.27^{B}$	$17.61±0.35^{A}$	
Serum phosphorus (mg/dL)			
After laying	3.40±0.28	6.80±0.26	5.10±0.59
Soft egg	4.06±0.26	5.82±0.59	4.94±0.42
Calcification time	3.98±0.18	6.74±0.47	5.36±0.52
Means	$3.81±0.15^{B}$	$6.45±0.27^{A}$	
Serum Alkaline phosphatase (IU/L)			
After laying	$114.62±2.05^{ab}$	$108.22±3.22^{b}$	$111.42±2.13^{AB}$
Soft egg	$116.92±1.28^{a}$	$110.78±3.55^{b}$	$113.85±2.05^{A}$
Calcification time	$117.92±0.55^{a}$	$96.08±1.19^{c}$	$107.00±11.68^{B}$
Means	$116.49±0.85^{A}$	$105.03±2.31^{B}$	

A,b,c = Means having different letter exponents within rows in a main effect are significantly different at P≤0.05.

A,B,C = Means having different letter exponents within columns and rows in a main effect are significantly different at P≤0.05.

Table (5): Live body weight; largest follicle weight and length of oviduct parts at the different estimation stages of calcium absorption in silver Montazah laying hens.

Stages	High egg prod.	Low egg prod.	Means
Live body weight (g)			
After laying	1282±3.34	1290±14.60	1286±7.17^{A}
Soft egg	1238±10.16	1273±6.45	1255±8.07^{B}
Calcification time	1261±14.80	1288±7.17	1275±8.98^{AB}
Means	1261±7.41^{B}	1284±5.78^{A}	
Largest follicle weight (g)			
After laying	13.88±0.51	4.22±0.45	9.05±1.64
Soft egg	14.46±0.89	3.88±0.41	9.17±1.82
Calcification time	14.56±0.20	4.06±0.19	9.31±1.76
Means	14.30±0.33^{A}	4.05±0.20^{B}	
Infundibulum length (cm)			
After laying	8.34±0.09	4.52±0.32	6.43±0.66
Soft egg	8.64±0.30	4.42±0.38	6.53±0.74
Calcification time	8.50±0.49	4.72±0.34	6.61±0.69
Means	8.49±0.18^{A}	4.55±0.19^{B}	
Magnum length (cm)			
After laying	28.52±0.44	16.56±0.37	22.54±2.0
Soft egg	28.36±0.49	16.20±0.30	22.28±2.04
Calcification time	28.36±0.34	16.52±0.35	22.44±1.99
Means	28.41±0.23^{A}	16.43±0.18^{B}	
Isthmus length (cm)			
After laying	14.28±0.43	7.32±0.33	10.80±1.19
Soft egg	14.52±0.18	7.48±0.49	11.00±1.20
Calcification time	14.52±0.26	7.30±0.33	10.91±1.22
Means	14.44±0.17^{A}	7.37±0.21^{B}	
Uterus length (cm)			
After laying	6.32±0.33	5.40±0.38	5.86±0.28
Soft egg	6.66±0.22	5.26±0.33	5.96±0.30
Calcification time	6.62±0.32	5.30±0.34	5.96±0.31
Means	6.53±0.16^{A}	5.32±0.19^{B}	
Vagina length (cm)			
After laying	6.44±0.61	3.40±0.30	4.92±0.60
Soft egg	6.20±0.30	3.52±0.32	4.86±0.49
Calcification time	6.50±0.18	3.80±0.31	5.15±0.48
Means	6.38±0.22^{A}	3.57±0.17^{B}	

A,B = Means having different letter exponents within rows and columns in a main effect are significantly different at $P \leq 0.05$.

Table (6): Live body weight; largest follicle weight and length of oviduct parts at the different estimation stages of phosphorus absorption in Silver Montazah laying hens.

Stages	High egg prod.	Low egg prod.	Means
Live body weight (g)			
After laying	1251±18.47	1283±8.59	1267±11.00
Soft egg	1262±7.59	1275±4.71	1269±4.72
Calcification time	1271±8.47	1294±22.74	1282±12.10
Means	1261±7.03^{B}	1284±7.92^{A}	
Largest follicle weight (g)			
After laying	14.50±0.47	6.22±0.33	10.36±1.41
Soft egg	14.52±0.26	5.80±0.22	10.16±1.46
Calcification time	14.68±0.28	6.42±0.36	10.55±1.39
Means	14.57±1.9^{A}	6.15±0.18^{B}	
Infundibulum length (cm)			
After laying	8.50±0.62	5.44±0.35	6.97±0.61
Soft egg	7.52±0.35	5.60±0.38	6.56±0.40
Calcification time	8.52±0.35	5.38±0.30	6.95±0.57
Means	8.18±0.28^{A}	5.47±0.19^{B}	
Magnum length (cm)			
After laying	28.58±0.75	17.60±0.35	23.09±1.87
Soft egg	29.36±0.57	17.42±0.26	23.39±2.01
Calcification time	28.60±0.27	17.52±0.54	23.06±1.87
Means	28.85±0.32^{A}	17.51±0.22^{B}	
Isthmus length (cm)			
After laying	13.74±0.35	8.72±0.39	11.23±0.87
Soft egg	13.68±0.28	8.70±0.35	11.19±0.86
Calcification time	13.60±0.35	8.80±0.33	11.20±0.83
Means	13.67±0.18^{A}	8.74±0.19^{B}	
Uterus length (cm)			
After laying	6.24±0.34	5.52±0.34	5.88±0.26
Soft egg	6.34±0.24	5.44±0.37	5.89±0.26
Calcification time	6.40±0.34	5.54±0.32	5.97±0.26
Means	6.33±0.17^{A}	5.50±0.18^{B}	
Vagina length (cm)			
After laying	5.62±0.42	4.58±0.36	5.10±0.31
Soft egg	5.36±0.37	4.54±0.25	4.95±0.25
Calcification time	5.56±0.38	4.32±0.42	4.94±0.34
Means	5.51±0.21^{A}	4.48±0.19^{B}	

A.B = Means having different letter exponents within columns in a main effect are significantly different at $P \leq 0.05$.

Table (7): Egg production (%), egg weight (g) during the experimental period and shell quality at 42 weeks of age in Silver Montazah Laying hens.

Traits	Silver Montazah	
	High egg prod.	Low egg prod.
Egg production (%)	73.27±0.52[a]	32.29±0.45[b]
Egg weight (g)	46.36±0.36[b]	48.17±0.24[a]
Shell weight (g)	4.54±0.28[b]	5.59±0.27[a]
Relative shell weight (%)	9.18±0.33[b]	10.98±0. 57[a]
Shell thickness (mm)	0.400±0.008	0.422±0.012

a,b = Means having different letter exponents within columns in a main effect are significantly different at P≤0.05.

REFERENCES

A.O.A.C. (1975): *Official Methods of Analysis of Association of official agricultural chemists, 12th eds., Published by the A.O.A.C. Washington, D.C.*

Baginski, E.S.; Marie, S.S.; Clark, W.L. and Zak, B. (1973): *Direct microdetermination of serum calcium. Clin. Chim. Acta, 46: 49.*

Bar, A.; Dubrov, D.; Eisner, V. and Hurwitz, S. (1976): *Calcium-binding protein and calcium absorption in the laying quail (Coturnix Japonica) Poult. Sci. 55: 622-628.*

Bessey, O.A.; Loury, O.H. and Brock, M. (1946): *Rapid determination of alkaline phosphatase with 5 cubic millimeters of serum. J. Biol. Chemistry 164, 321.*

Choi, J.H.; Miles, R.D.; Arafa, A.S and Harms, R.H. (1981): *The influences of oviposition time on egg weight, shell quality and blood phosphorus. Poult. Sci, 60: 824-828.*

Duncan, D.B. (1955): *Multiple range and multiple F tests. Biometrics. 11: 1-42.*

El-Habbak, M.M.E. and Radwan, A.A. (1984): *An in vivo study of intestinal calcium absorption in different strains of laying hens. 1st Egyptian-British Conference on animal and poultry production. Zagazig, Egypt. PP. 172-181.*

Garlich, J.; Brake, J.; Parkiurst, C.R.; Tilaxton, J.P. and Morgan, G.W. (1984): *Physiological profile of caged layers during one production year. Molt and Postmole, Egg production, egg shell quality, liver femur, and blood parameter. Poult. Sci., 63: 339-343.*

Goodwin, J.F. (1970): Clin. Chem. 16(9): 776-780.

Hawk's (1965): *Physiological Chemistry. Edited by Bernard L. Determined of Calcium P. 1133-1137.*

Khalil, H.M. and Gad, H.A.M. (1994): *Calcium absorption rate relative to the histological intestinal villi characteristics and egg production of turkey hens. Egypt. Poult. Sci., Vol. 14: 161-190.*

Khalil, H.M.; Ibrahim, M.A.R.; Mahmoud, T.H.; Rizk, R.A and El-Bogdady, A.H. (1987): *Physiological studies of intestinal calcium and phosphorus absorption in different Egyptian strains of laying hens. Egypt. Poult. Sci., 7: 49-70.*

Mady, E.I. and Ahmed, H.A. (1998): *Oviposition time affecting egg shell quality and plasma calcium in Japanese Quail. Egypt. Poult. Sci., vol. 18(II) Aug: 399-412.*

Mohamed, A.S.A. (1997): *The physiological reactions of some environmental factors affecting egg laying in the layers. Ph.D. Thesis, Fac. Agric., Cairo Univ. Giza, Egypt.*

Nys, Y.; Guyen, T.M.N.; Williams, J and Etches, R.J. (1986): *Blood levels of ionized calcium, inorganic phosphorus, 1,25-dihydroxycholecalciferol and gonadal hormones in hens laying hard-shelled or shell less eggs. J. Endocr., III: 151-157.*

Prashed, D.N. and Edwards, N.A. (1973): *Renal excretion of calcium, phosphate and magnesium in the laying fowl. 4th European Poultry Conference, London, PP. 57-62.*

Radwan, A.A. (1980): *Study of calcium absorption and metabolism in poultry (Gallus domesticus). Ph.D. Thesis, Agric. Sci. Univ. Godollo-Hungary).*

Radwan, A.A. (1990): *In vitro study of intestinal calcium absorption in the chicken as influenced by dietary calcium, vitamin D_3 and protein levels. Egypt. Poult. Sci., 10: 309-323.*

SAS Institute (1990): *SAS/STAT Rusers Guide; Statistics. Version 6,4th Edition. SAS Institute Inc, Cary, NC.*

Savaliya, F.P.; Shukla, R.K.; Khanna, K. and Brahmkshtri, B.P. (1997): *Inheritance of serum alkaline phosphatase level and certain economic traits in pure and reciprocal crosses of White Leghorn Strains. Indian J. Anim. Sci., 67: 156.*

Sloan, D.R.; Roland, D.A. and Harms, R.H. (1974): *Circadian rhythms of serum calcium in hens and the relationship of serum calcium to shell quality. Poult. Sci., 53: 2003-2009.*

Taylor, T.G. and Williams, M. (1964): *Cycling changes in plasma acid and alkaline phosphatase concentration associated with egg shell calcification in the fowl. Biochem. J. 91: 21-22.*

Tylor, C. (1956): *Studies on egg shells. 4. The site of deposition of radioactive calcium and phosphorus. J. Sci. Food. Agric, 5: 335-339.*

Volasy G.Y. and Szalio, A. (1971): *Phosphorus meghatarozas Orvosi Herilap 3, 153.*

الملخص العربي

دراسة الامتصاص المعوى للكالسيوم والفوسفور (in vivo) خلال المراحل المختلفة لتكوين البيضة فى القناة التناسلية للدجاج المرتفع و المنخفض فى إنتاج البيض

مايسة مصطفى حنفي، علي محمد حسن الشيخ، هناء محمد خليل

قسم بحوث تربية الدواجن – معهد بحوث الإنتاج الحيواني – وزارة الزراعة – الجيزة – مصر

استخدم في هذه الدراسة ٩٠ دجاجة بياضة من المنتزة الفضي عمر ٣٠ أسبوع. كل الطيور سكنت فردياً في أقفاص و تم تسجيل عدد ووزن البيض الناتج لمدة ثلاثة شهور. قسمت الطيور الى مجموعتين عالية (٧٣,٢٧%) و منخفضة (٣٢,٢٩%) طبقاً لإنتاجها من البيض. عند عمر ٤٢ أسبوع استخدم ثلاثون طائر تجريبى لكل مجموعة لتقدير إمتصاص الكالسيوم والفوسفور فى الأمعاء الدقيقة (in vivo)، وقسمت الطيور كالآتي: استخدم ٢٠ طائر الساعة ٩ صباحاً و هذا يمثل الإمتصاص بعد وضع البيضة مباشرة كما أستخدم ٢٠ طائر الساعة ٩ مساءاً و نتيجة هذه المجموعة تمثل الإمتصاص خلال فترة التكلس (تكوين القشرة داخل الرحم) ثم أستخدم ٢٠ طائر الساعة ٣ مساءاً توضح الإمتصاص خلال تكوين البيضة (الطرية) ودخولها للرحم. وأوضحت نتائج هذه الدراسة ما يلي:

- إمتصاص الكالسيوم والفسفور مرتفع معنوياً في الإناث ذات إنتاج البيض العالي مقارنة بالإناث ذات إنتاج البيض المنخفض.
- إمتصاص الكالسيوم والفسفور خلال فترة التكلس مرتفع معنوياً مقارنة بمرحلتي تكوين البيضة الطرية عند دخولها إلى الرحم وكذلك بعد وضع البيضة.
- امتصاص الكالسيوم و الفوسفور يكون عالى فى اللفائفى بينما يكون منخفض فى الأثنى عشر خلال إنتاج البيض العالى و المنخفض فى دجاج المنتزة الفضى.
- انخفاض معنوى فى الوزن النسبي لعظام الساق وكذلك تركيز الكالسيوم و الفوسفور فى عظام الساق والسيرم بينما أرتفع معنوياً تركيز إنزيم الفوسفاتيز القاعدى فى السيرم فى المجموعة العالية فى انتاج البيض مقارنة بالمجموعة المنخفضة فى الإنتاج.

- ارتفاع تركيز الفسفور في عظام الساق والسيرم مع انخفاض معنوى لتركيز إنزيم الفوسـفاتيز القاعدي وقت التكلس مقارنة بالمراحل الأخرى خلال تكوين البيضة.
- انخفاض معنوي لوزن الجسم ووزن البيضة و القشرة و الوزن النسبى للقشرة مع ارتفـاع معنوى لوزن اكبر حويصلة و طول اجزاء قناه المبيض فى المجموعة العالية فـى انتـاج البيض مقارنة بالمجموعة المنخفضة فى الإنتاج بينما لم يلاحظ اى اختلافات معنويـة فـى سمك القشرة بين المجموعتين.