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Improving Egg Shell Strength During Late Production Period of Hens Fed Diets Supplemented with Different Vitamin D Forms and Levels.

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Abstract

EGG SHELL breakage causes an economic loss for egg producer, where 3% of the eggs laid produced with cracked shells or broken. This experiment was carried out to improve eggshell quality of eggs produced from aged chickens. Golden Montazah chickens that reached 11 month of age with average weight 1.45kg were randomly divided into nine groups . Groups one, two and three fed on control basal diets with zero levels of hydroxycholecaliferol (25-OHD3) and three levels from vitamin D3 (VD3) (2500, 3750 and 5000 IU) respectively , groups four, five and six fed on 0.04 mg/kg of hydroxycholecaliferol (25-OHD3) and three levels from vitamin D3 (VD3) (2500, 3750 and 5000 IU) respectively, groups seven , eight and nine fed on 0.08 mg/kg of hydroxycholecaliferol (25-OHD3) and three levels from vitamin D3 (VD3) (2500, 3750 and 5000 IU), respectively. The effect of supplemented layers diet with different forms and levels of vitamin D on mechanical, ultrastructure and chemical properties of eggshell during a late laying stage were tested. The results indicated that supplementing layer diets with 0.8 mg/kg hydroxycholecalciferol improved eggshell strength and ultrastructure of eggshell; moreover increased calcium contains eggshell and longer effective thickness (palsied layer) at the late stage of laying hens. The increasing total content of VD forms up to 0.13375 mg/kg diet causes an increase in the total amount of shell mass-produced by the hen, nevertheless other shell parameters didn't adversely affect. In contrast, increasing the total content of VD sources mg/kg diet than the previous limit did not attain desirable achievement. The results recommend that adding 25 hydroxycholecalciferol at 0.8 mg/kg to avoid the deteriorating quality of eggshells at late ages of laying hens and avoid loss economic due to poor eggshell quality.

Keywords: aged chicken, eggshell, ultrastructure, vitamin D.

Introduction

The high percentage of broken eggs and weakness of the eggshell are the most important problems at the late stage of egg production [1]. The problem of producing weakness eggshell leads to lost greatest money in poultry industry [2]. The calcium demand was increased with increasing egg production so, more attention must be directed to improve calcium utilization of layer diets [3]. Hence, eggshell quality is an important parameter that will affect incomes. Several factors influence quality of eggshells. Genetic factors such as species, breeds and genotypes while environmental factors such as environmental conditions and nutrition. Genetic improvement programs and feeding programs should work together to improve egg quality, particularly eggshell strength. Crossing between Golden Montazah and White Leghorn has improved egg quality and egg production [4]. Nutrition and genetic factors were considered major effected for eggshell quality; Nutrition factor included level, source and particle size of calcium in feed. While, hens getting older the egg size increase and the eggshell percentage decrease but the total calcium that reside in egg increase and this led to increase calcium requirements [5]. Vitamin D play major role in calcium metabolism of birds and utilization from calcium at late laying stage of -laying hens improved by increasing the combined different forms of VD3 and 25-hydroxyvitamin D3 (25-OHD) in diets [6].

The 25-OHD3 is an active metabolite of VD3, is a viable alternative to replace VD3 [7]. Youssef et al., 2019 recorded that the used combination from vitamin D3 (VD3) and 25-hydroxycholecalciferol (25-OHD3) in laying hens'

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diet at late stage of egg production was improved egg production and reproduction performance. Therefore, genetic improvement programs and nutrition programs work together simultaneously to improve productivity and the quality of eggshells, especially in the last stage of production. These experimental was targeted to evaluate effect feed on supplemented with different sources and levels of vitamin D for mechanical, ultrastructure and chemical properties of eggshell for Golden Montazah developed strain during a late laying stage.

The Egyptian native breeds were differentiating the high resistance of break eggshell due to the good ultrastructure of the eggshell [8-12]; But; the productive traits were lower compared to commercial strains. So, the selective breeding program and nutrition they should work together to improve production and quality eggs.

Youssef *et al.* [13] recorded that the used combination from vitamin D3 (VD3) and 25-hydroxycholecalciferol (25-OHD3) in laying hens' diet at late stage of egg production was improved egg production and reproduction performance. Therefore, these experimental was targeted to evaluate effect feed on supplemented with different sources and levels of vitamin D for mechanical, ultrastructure and chemical properties of eggshell for Golden Montazah developed strain during a late laying stage.

Material and Methods

The experiment was carried out at the Animal Production Research Institute, Agriculture Research Center (ARC) Egypt. with a collaboration with the Dept. of Poult. Prod., Fac. Of Agric., Ain Shams Univ. The Institutional Animal Care and Use Committee (IACUC (protocol number ARC-AHRI- 65-23 was achieved for the experiment.

Animals and study design:

One hundred and eighty-nine healthy Golden Montazah chickens that reached 11 months of age were chosen from a flock reared in Fayoum poultry research station and distributed randomly into 9 experimental groups. Each group constituted one experimental treat where each group composed from 21 chickens and distributed into 3 replicates with 7 chickens per each. Seven individual cages were used to household each group with three dimensional 30*30*30 cm where, feed and water were available *Ad libitum*. Three levels from vitamin D_3 (VD_3) (2500, 3750 and 5000 IU) interlocked with 3 levels from 25 hydroxycholecalciferol (25-OHD3) (zero, 0.04mg and 0.08mg/kg diet) to formulate 9 experimental diets (Table, one), The 1st diet acted as a control diet that composed to satisfy layer requirements according to NRC [14]. (Table Two), All birds in the treatments of these experimental were reared under similar management and hygienic conditions and continued for feeding the previous diets up to 14 months of age.

At the end of the 14th month of age, fifteen eggs from each treat were randomly taken to measure mechanical, ultrastructure and chemical properties of eggshell. The force required break eggs were estimated by the Instron device. The eggshell percentage was calculated by dividing the weight of the eggshell by the weight of the egg x 100. While the egg area was calculated using equation according to Nordstrom and Ousterhout [15]. Also, the thickness of the eggshell was measured in the medium region of the egg using a digital micrometer. Furthermore, the ultrastructure of eggshell was inspected by scanning electron microscope used methodology [10]. Calcium, Phosphorous, Magnesium, Zinc and Potassium were extracted and estimated used protocol described by Al-Obaidi *et al.* [16]. On the other hand, the organic matrix of eggshell was extraction used protocol described by Radwan [11]. Ovotransferrin, Ovalbumin and Ovocleidin-17 were measured concentration by using ELISA technique as the protocol described by Panheleux *et al.* [17].

Statistical analysis

The effect of a supplemented diet with different VD sources on mechanical, ultrastructure and chemical properties of eggshell were analyzed using two-way analysis, General linear model "univariate model" procedure of the statistical software package [18], version 16, the model statistic was used in these excremental as follows:
$Yij = \mu + Hi + Dj + (H \times D)\, ij + eij$

Where, Yij = dependent observation.

μ = overall mean.

Hi = effect of 25-OHD3 (i = I, II and III). Dj = effect of VD3 (j = 1, 2 and 3).

(Hi × D) ij = effect of interaction between 25-OHD3 and VD3.

eij = the residual error.

Significantly differ ($P \leq 0.05$)

Result and Discussion

The results of the mechanical eggshell quality from a developed Golden Montazah strain that was feeding on vitamin D and 25-OHD3 different levels and interaction between them are represented in Table Three. There was no significant effect of different vitamin D levels of shell strength, eggshell thickness, eggshell percentage and eggshell area at late laying period. The same way results in eggshell percentage, eggshell area and eggshell weight (SW) ⁄ eggshell area (SA) were no significant affected for different levels 25 hydroxycholecalciferol during late age egg production. While, the shell strength, shell thickness and eggshell weight per surface area were significantly affected for different levels of 25 hydroxycholecalciferol during late age egg production. On the other hand; there was no interaction between the levels of vitamin D and level of hydroxycholecalciferol expected for eggshell thickness. With progress, age hen occurs change endometrium morphology causing poor ultrastructure of eggshell reflected to decrease eggshell quality [19]. Supplementing layer diets of hydroxycholecalciferol was improved calcification eggshell information at 50 weeks of age by improved absorption and metabolism of calcium [20, 21].

Egg production parameters for 120 days (4 months) of the current experiment were published in separate paper) [13]. They reported that the average egg mass per hen per day for 4 months of the treatment groups 1to 9 were 24.04, 26.05, 28.38, 27.79, 28.97, 27.7, 29.97, 29.94, and 26.52 respectively. By multiplying average shell weight percent (Table 3) with egg mass per hen per day for 120 days so the total amount of shell mass that produced by the hen for treatments from 1 to 9 were 287.3, 321.0, 348.7, 347.45, 362.6, 343.7, 362.2, 359.6 and 322.4 grams respectively. This finding may be let authors postulate that increasing total content of VD sources mg/kg diet up to 0.13375 cause an increase in total amount of shell mass produced by hen, nevertheless other shell parameters didn't adversely affect. In contrast, increasing total content of VD sources mg/kg diet than previous limit did not attain desirable achievement.

Table (4) shows the results of mineral eggshell component (mg/100g) for the developed Golden Montazah strain that was feeding on vitamin D and 25 hydroxycholecalciferol different levels and interaction between them no significant Except for effected level vitamin D on concentration calcium in eggshell. Through the normal eggshell calcification is transferring over 2 g Ca through the intestine to the uterus or eggshell gland [22]. 25 hydroxycholecalciferol had affect level calcium in tissue and improved absorption feed calcium in tissue reflected level calcium in the eggshell gland and effected calcium precipitation rate in eggshell.

Table (5) appears that effect different level on vitamin D and 25 hydroxy-cholecalciferol of the organic matrix of eggshell on developed Golden Montazah strain during late age egg production. Ovotransferrin, Ovalbumin and Ovocleidin-17 no significant different concentrations in eggshell for the developed Golden Montazah strain that was feeding on vitamin D and 25 hydroxycholecalciferol different levels and interaction between them. Moreover, soluble protein (mg) /g total eggshell no significant different concentration for the developed Golden Montazah strain that was feeding on vitamin D different levels and interaction between them. But, soluble protein (mg) /g total eggshell significantly different concentrations for the developed Golden Montazah strain that was fed 25-hydroxy-cholecalciferol. The Ovotransferrin play major role in defense against bacterial penetration also killed bacteria by barring their growth due to forbidding bacteria of iron [17]. Moreover, they affect the calcification of eggshell by affected them on the morphology of calcite crystals grown. Moreover, they affect the calcification of eggshell by affected the morphology of calcite crystals. Yu *et al.* [23] recorded that increase concentration of ovotransferrin and ovalbumin during the late age of cycle laying hens compared to the beginning cycle of period laying hens due to increase number of glandular cells in the magnum.

Determined length eggshell layer by scanning electron microscopes (SEM) for developed Golden Montazah strain at 50 weeks of age appear that different level vitamin D no significant effect for length layer or percentage length of the eggshell (total length, palsied and mammillary). The seam trained results interaction effect between different level vitamin D and 25 hydroxy-cholecalciferol. But, palsied layer length for hens feeds 0.8 mg/kg diet Supplementing layer diets of hydroxy-cholecalciferol. Significantly longer compared to zero mg/kg hydroxycholecalciferol (control) and 0.4 mg/kg hydroxycholecalciferol.

Longer palsied layer reflected increase effective thickness of the eggshell [6, 9, 10, 12] recorded that the positive correlation among length palsied layer and stronger eggshell strength. The results consistent with Stefanello *et al.* [2]. reached that length palsied layer was the main factor affect force required eggshell broken.

Measurements of the eggshell ultrastructure Golden Montazah strain at 50 weeks week of age by SEM are depicted in Table six. Supplementation of vitamin D and 25 hydroxy-cholecalciferol and interaction between them in commercial diets of Golden Montazah strain, regardless of different levels of addition, did not affect the ultrastructure variability of eggshell mammillae. But, Supplementing layer diets of hydroxy-cholecalciferol add at 0.8 mg/kg was significantly decreased alignment, fusion and type B these results refer to good ultrastructure and high resistance eggshell for broken Table seven. Qiu *et al.* [24] decided that laying hens fed diet with low level of trace minerals conjugated with protein at late laying period was enhanced ultrastructure of eggshell and improved eggshell strength.

Conclusion

Supplementing layer diets of hydroxy-cholecalciferol add at 0.8 mg/kg was improved eggshell strength and ultrastructure of eggshell; moreover increased calcium contains eggshell and longer effective thickness (palsied layer) at the late age of cycle laying hens. The results recommend that hydroxycholecalciferol may be add at 0.8 mg/kg of older laying hens avoid the deteriorating quality of eggshells at the late ages of laying hens and avoid loss economic because poor eggshell quality at end cycle laying period.

Acknowledgement

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Conflict of interest

Despite of the difference between researcher specializations the researchers were in full cooperation. The researchers team include two researchers specialized in poultry physiology, three researchers specialized in poultry management, one researcher specialized in poultry nutrition and the last researcher specialized in poultry breeding. The trails include breeding specialization where eggs of local breed Golden Montazah were tested. The trails include either poultry management specialization where eggshell strength was investigated. Finally, the materials that supplemented in layer diets were different sources of Vit. D and this need the nutrition specialty. Therefore, the research benefited all researchers.

Funding statement

All costs were offered by the researchers' staff.

Ethical approval

The research was ethically sanctioned by the International Animal Care and Use Committee (ARC.IACUC), Agriculture Research Center, Egypt, resulting in the issuance of an ethical approval number, ARC.IACUC /65/23

TABLE 1. Total content of experimental diets from 25-OH-D_3 and VD_3 mg/kg diet.

Groups	Experimental diets	25-OH-D_3 mg + VD_3 mg/kg diet		Total content of VD sources mg/kg diet
		25-OH-D_3	VD_3	
1	I * 1	Zero	0.0625	0.0625
2	I * 2	Zero	0.09375	0.09375
3	I * 3	Zero	0.125	0.125
4	II * 1	0.04	0.0625	0.1025
5	II * 2	0.04	0.09375	0.13375
6	II * 3	0.04	0.125	0.165
7	III * 1	0.08	0.0625	0.1425
8	III * 2	0.08	0.09375	0.17375
9	III * 3	0.08	0.125	0.205

TABLE 2. Composition and calculated analysis of control diet.

Ingredients	Control diet	Calculated analysis	
Yellow corn	65.00	CP	15.14%
Soybean meal (44% CP)	5.30	ME.	2786.49 kcal
Corn gluten (60% CP)	9.00	Ca	3.45%
Wheat bran	12.00	Av.P	0.37%
Di-calcium phosphate	2.39	Lys.	0.70%
Lime stone	5.63	Met.	0.31%
Salt	0.37	SAA	0.61%
Premix	0.30	Na	0.17%
DL- methionine	0.01	Vtamin D_3	2500 IU
L-Arg	0		
Total	100		

Premix contain per 3kg vit A: 12 000 000, vit D3: 2500 000 IU, vit E: 50000mg, vit K3: 3000mg , vit B1: 2000mg, vit :B2 7500mg, vit B6 :3500 mg, vit B12: 15mg, Pantothenic acid :12000mg, Niacin: 30000mg, Biotin: 150mg, Folic acid: 1500mg, Choline: 300gm, Selenium: 300mg, Copper: 10000mg, Iron: 40000mg, Manganese: 80000mg, Zinc: 80000mg, Iodine: 2000mg, Cobalt: 250 mg and CaCO3 to 3000g.

TABLE 3. The mechanical eggshell quality for developed Golden Montazah strain that were feed on vitamin D and 25 hydroxycholecalciferol different levels and interaction between them.

Items	Factor	Shell strength (N)	Shell thickness	Shell%	Shell area (SA)	Sw/SA*
25HD	zero mg/kg diet (1)	26.51±0.12[b]	39.33±0.25[b]	10.16±0.08	65.09±0.16	80.87±0.65[b]
	0.4 mg/kg diet (2)	28.33±0.14[ab]	41.26±0.34[a]	10.40±0.11	64.43±0.31	83.28±0.54[a]
	0.8 mg/kg diet (3)	30.27±0.21[a]	41.09±0.19[a]	10.07±0.07	64.49±0.28	80.16±0.42[b]
	P. values	0.01	0.01	NS	NS	0.03
Vitamin D	2500 IU/kg diet (I)	29.62±0.11	40.20±0.21	10.15±0.06	65.35±0.43	80.80±0.52
	3750 IU/kg diet (II)	27.50±0.16	40.96±0.31	10.23±0.12	64.56±0.53	82.20±0.31
	5000 IU/kg diet (III)	28.11±0.18	40.52±0.43	10.24±0.10	64.10±0.29	81.34±0.37
	P. values	NS	NS	NS	NS	NS
Interaction	(I) * (1)	25.57±0.99	37.78±0.56	9.96±0.15	66.30±0.94	78.74±1.13
	(I) * (2)	26.27±1.24	39.61±0.59	10.27±0.16	64.11±0.53	82.16±1.21
	(I) * (3)	27.68±0.75	40.61±0.81	10.24±0.25	64.85±1.12	81.72±1.89
	(II) * (1)	29.40±1.17	41.72±0.88	10.42±0.20	64.37±0.75	83.22±1.53
	(II) * (2)	27.40±1.25	41.72±0.68	10.43±0.17	65.45±0.59	84.44±1.50
	(II) * (3)	28.18±1.19	40.33±0.51	10.34±0.15	63.47±0.56	82.19±1.14
	(III) * (1)	33.88±2.52	41.11±0.76	10.07±0.21	65.38±1.06	80.42±1.74
	(III) * (2)	28.83±1.65	41.56±0.65	10.01±0.20	64.11±0.60	79.99±1.49
	(III) * (3)	28.42±1.29	40.61±0.66	10.13±0.16	63.99±0.66	80.10±1.30
	P. values	NS	0.04	NS	NS	NS

* Eggshell weight (SW)/eggshell area (SA)

[a,b,..] Means within the same column and parameters with different superscripts are significantly differ ($P \leq 0.05$)

NS: not significant. HD: Hydroxycholecalciferol.

TABLE 4. Mineral eggshell component (mg/100g) for developed Golden Montazah strain that were feed on vitamin D and 25 hydroxycholecalciferol different levels and interaction between them.

Items	Factor	Calcium	Phosphorous	Magnesium	Zinc	Potassium
25HD	zero mg/kg diet (1)	2544.5±0.63[b]	140.2±0.34	250.6±0.65	0.94±0.01	82.5±0.52
	0.4 mg/kg diet (2)	2594.3±0.45[ab]	134.6±0.43	255.7±0.45	0.92±0.04	80.4±0.32
	0.8 mg/kg diet (3)	2657.1±0.54[a]	138.4±0.38	257.2±0.82	0.93±0.03	81.3±0.40
	P. values	0.02	NS	NS	NS	NS
Vitamin D	2500 IU/kg diet (I)	2610.2±0.39	144.8±0.54	256.1±0.49	0.92±0.05	81.7±0.76
	3750 IU/kg diet (II)	2599.1±0.72	136.7±0.29	254.3±0.52	0.90±0.03	82.1±0.53
	5000 IU/kg diet (III)	2621.4±0.58	142.5±0.33	258.4±0.44	0.93±0.02	83.4±0.39
	P. values	NS	NS	NS	NS	NS
Interaction	(I) * (1)	2577.4±0.85	142.5±0.75	253.4±0.50	0.93±0.01	82.1±0.61
	(I) * (2)	2602.3±0.89	139.7±0.69	255.9±0.37	0.92±0.05	81.1±0.47
	(I) * (3)	2633.7±0.79	141.6±0.73	256.7±0.29	0.93±0.04	81.5±0.53
	(II) * (1)	2597.8±0.37	138.5±0.86	252.5±0.41	0.92±0.03	82.3±0.71
	(II) * (2)	2596.7±0.65	135.7±0.59	255.0±0.43	0.91±0.02	81.3±0.27
	(II) * (3)	2628.1±0.71	137.6±0.44	255.8±0.39	0.92±0.06	81.7±0.32
	(III) * (1)	2582.9±0.88	141.6±0.40	254.5±0.62	0.94±0.03	82.9±0.50
	(III) * (2)	2607.9±0.98	137.6±0.59	257.1±0.43	0.93±0.07	81.9±0.43
	(III) * (3)	2639.3±0.90	140.5±0.63	257.8±0.51	0.93±0.05	82.4±0.36
	P. values	NS	NS	NS	NS	NS

[a,b,..] Means within the same column and parameters with different superscripts are significantly differ ($P \leq 0.05$)

NS: not significant. HD: Hydroxycholecalciferol

TABLE 5. Organic matrix of eggshell for developed Golden Montazah strain that were feed on vitamin D and 25 hydroxy-cholecalciferol different levels and interaction between them.

Items	Factor	Soluble protein (mg)/g total eggshell	Ovo-transferrin	Ova lbumin	Ovocleidin-17
25HD	Zero mg/kg diet (1)	265±0.31[c]	1.16±0.11	4.09±0.29	13.87±0.44[b]
	0.4 mg/kg diet (2)	283±0.42[b]	1.40±0.18	4.43±0.34	16.28±0.34[a]
	0.8 mg/kg diet (3)	302±0.23[a]	1.07±0.20	4.49±0.42	16.16±0.39[a]
	P. values	0.01	NS	NS	0.03
Vitamin D	2500 IU/kg diet (I)	296±0.11	1.15±0.17	4.35±0.43	13.80±0.61
	3750 IU/kg diet (II)	275±0.21	1.23±0.10	4.56±0.51	13.20±0.32
	5000 IU/kg diet (III)	281±0.48	1.24±0.14	4.10±0.39	13.34±0.29
	P. values	NS	NS	NS	NS
Interaction	(I) * (1)	281.7±0.99	1.16±0.15	4.22±0.94	13.84±0.93
	(I) * (2)	289.8±1.04	1.27±0.16	4.89±0.53	13.01±0.21
	(I) * (3)	299.5±0.75	1.11±0.25	4.92±0.72	13.49±0.89
	(II) * (1)	274.0±0.97	1.20±0.20	4.83±0.75	13.52±0.53
	(II) * (2)	279.0±0.55	1.33±0.17	4.50±0.59	13.74±0.50
	(II) * (3)	288.9±0.69	1.14±0.15	4.54±0.56	13.19±0.74
	(III) * (1)	273.8±0.52	1.20±0.21	4.60±0.36	13.12±0.74
	(III) * (2)	282.3±0.65	1.31±0.20	4.27±0.60	13.31±0.49
	(III) * (3)	292.0±0.69	1.16±0.16	4.29±0.66	13.77±0.60
	P. values	NS	NS	NS	NS

[a,b,..] Means within the same column and parameters with different superscripts are significantly differ ($P \leq 0.05$)
NS: not significant. HD: Hydroxycholecalciferol

TABLE 6. Cross-sectional length (mm) of individual eggshell layers (absolute or %) for developed Golden Montazah strain that were feed on vitamin D and 25 hydroxycholecalciferol different levels and interaction between them.

Items	Factor	Totall(µm)	Palisade(µm)	Mammillary (µm)	Palisade (%)	Mammillary (%)
25HD	zero mg/kg diet (1)	293.92±0.76[b]	229.15±0.45[b]	64.76±0.47	77.92±0.42	22.08±0.21
	0.4 mg/kg diet (2)	297.33±0.98[b]	232.68±0.76[b]	64.65±0.65	78.22±0.32	21.78±0.18
	0.8 mg/kg diet (3)	305.90±0.84[a]	239.92±0.67[a]	65.99±0.55	78.42±0.21	21.58±0.32
	P. values	0.001	0.003	NS	NS	NS
Vitamin D	2500 IU/kg diet (I)	300.16±0.66	234.28±0.39	65.88±0.63	78.05±0.58	21.95±0.20
	3750 IU/kg diet (II)	299.38±0.54	234.49±0.68	64.89±0.70	78.25±0.43	21.75±0.17
	5000 IU/kg diet (III)	297.61±0.69	232.98±0.75	64.63±0.44	78.26±0.21	21.74±0.21
	P. values	NS	NS	NS	NS	NS
Interaction	(I) * (1)	296.55±0.72	231.51±0.43	65.37±0.54	77.99±0.32	22.03±0.11
	(I) * (2)	298.67±0.87	233.58±0.49	65.27±0.62	78.09±0.55	21.83±0.32
	(I) * (3)	302.92±0.43	237.37±0.73	65.91±0.28	78.24±0.29	21.79±0.19
	(II) * (1)	296.69±0.53	231.82±0.71	64.84±0.47	78.11±0.40	21.93±0.33
	(II) * (2)	298.38±0.49	233.59±0.49	64.77±0.63	78.24±0.27	21.77±0.21
	(II) * (3)	303.11±0.54	237.25±0.92	65.44±0.65	78.36±0.46	21.67±0.46
	(III) * (1)	295.78±0.76	231.84±0.82	64.70±0.46	78.09±0.38	21.92±0.23
	(III) * (2)	297.47±0.83	232.88±0.64	64.64±0.38	78.24±0.32	21.77±0.46
	(III) * (3)	301.77±0.59	236.82±0.73	65.30±0.27	78.34±0.44	21.66±0.29
	P. values	NS	NS	NS	NS	NS

[a,b,..] Means within the same column and parameters with different superscripts are significantly differ ($P \leq 0.05$)
NS: not significant. HD: Hydroxycholecalciferol

TABLE 7. Ultrastructural variants of eggshell mammillae for developed Golden Montazah strain that were feed on vitamin D and 25 hydroxycholecalciferol different levels and interaction between them.

Items	Factor	Confluence	Fusion	Cuffing	Erosion	Depression	Cubics	Caps	Alignment	Type A	Type B	Aragonite	Changed membrane	Total score
25H D	zero mg/kg diet (1)	2.59	3.56[a]	3.56	1.04	1.06	1.44	3.11[a]	2.37[a]	1.26	1.59[a]	1.00	1.00	23.57[a]
	0.4 mg/kg diet (2)	2.56	3.11[ab]	3.04	1.00	1.04	1.37	2.41[b]	2.11[a]	1.15	1.30[ab]	1.00	1.00	21.07[b]
	0.8 mg/kg diet (3)	2.56	2.81[b]	3.11	1.04	1.00	1.37	2.14[b]	1.89[b]	1.19	1.14[b]	1.00	1.00	20.26[b]
	SE	0.10	0.09	0.11	0.03	0.04	0.07	0.06	0.10	0.08	0.07	0.04	0.02	0.25
	P. values	NS	0.01	NS	NS	NS	NS	0.03	0.01	NS	0.05	NS	NS	NS
Vitamin D	2500 IU/kg diet (I)	2.56	3.11	3.33	1.04	1.06	1.52	2.52	2.19	1.22	1.30	1.00	1.00	21.83
	3750 IU/kg diet (II)	2.52	3.26	3.26	1.00	1.02	1.37	2.60	2.15	1.19	1.37	1.00	1.00	21.72
	5000 IU/kg diet (III)	2.63	3.11	3.11	1.04	1.02	1.30	2.56	2.04	1.19	1.37	1.00	1.00	21.35
	SE	0.04	0.09	0.08	0.03	0.02	0.04	0.10	0.06	0.02	0.01	0.01	0.02	0.23
	P. values	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

	(I) * (1)	2.58	3.44	3.46	1.04	1.06	1.48	2.82	2.33^{a}	1.33	1.44	1.00	1.00	23.67^{a}
	(I) * (2)	2.56	3.11	3.19	1.02	1.05	1.45	2.47	2.44^{a}	1.22	1.56	1.00	1.00	23.50^{a}
	(I) * (3)	2.56	2.99	3.22	1.04	1.03	1.45	2.33	2.33^{a}	1.22	1.78	1.00	1.00	23.56^{a}
	(II) * (1)	2.57	3.41	3.41	1.02	1.04	1.41	2.86	2.22^{a}	1.11	1.33	1.00	1.00	21.61^{b}
	(II) * (2)	2.53	3.19	3.15	1.00	1.03	1.37	2.51	2.11^{a}	1.11	1.33	1.00	1.00	20.78^{b}
Interaction	(II) * (3)	2.54	3.04	3.19	1.02	1.01	1.37	2.37	2.00^{ab}	1.22	1.22	1.00	1.00	20.83^{b}
	(III) * (1)	2.61	3.34	3.34	1.04	1.04	1.37	2.84	2.00^{ab}	1.22	1.11	1.00	1.00	20.22^{b}
	(III) * (2)	2.60	3.11	3.09	1.02	1.03	1.34	2.49	1.89^{b}	1.22	1.22	1.00	1.00	20.89^{b}
	(III) * (3)	2.62	2.98	3.11	1.04	1.01	1.35	2.35	1.78^{b}	1.11	1.11	1.00	1.00	19.66^{b}
	SE	0.13	0.11	0.14	0.02	0.01	0.03	NS	0.07	0.04	0.02	0.01	0.01	0.26
	P. values	NS	NS	NS	NS	NS	NS	0.03	0.05	NS	NS	NS	NS	0.03

[a,b,..] Means within the same column and parameters with different superscripts are significantly differ ($P \leq 0.05$)
NS: not significant. HD: Hydroxycholecalciferol.

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تحسين قوة قشرة البيض خلال فترة الإنتاج المتأخرة للدجاج المغذى على عليقه تحتوى على انواع ومستويات مختلفة من فيتامين د

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الملخص

يتسبب كسر قشر البيض في خسارة اقتصادية لمنتج البيض، حيث أن 3% من البيض الذي يتم وضعه يكون بقشرة متشققة أو مكسورة. أجريت هذه التجربة لتحسين جودة قشر البيض المنتج من الدجاج النتقدم بالعمر. تم تقسيم دجاج المنتزه الذهبي الذي بلغ عمر 11 شهر بمتوسط وزن 1.45 كجم عشوائياً إلى تسع مجموعات غذيت على علائق أساسية تختلف فقط في محتواها من 25 هيدروكسي كوليكالسيفيرول وفيتامين د3 ملجم/كجم من العليقة. تم اختبار تأثير العليقة المكملة بأشكال ومستويات مختلفة من فيتامين د على الخواص الميكانيكية والبنية التحتية والكيميائية لقشر البيض خلال مرحلة وضع متأخرة. أشارت النتائج إلى أن إضافة 0.8 ملجم/كجم من هيدروكسي كوليكالسيفيرول إلى النظام الغذائي أدى إلى تحسين قوة قشر البيض والبنية التحتية لقشر البيض؛ علاوة على ذلك، زيادة محتوى الكالسيوم فى قشر البيض و تأثرسمك القشره على المدى البعيد في مرحلة الانتاج المتأخرة للدجاج البياض. ادي المحتوى الإجمالي المتزايد من انواع فيتامين د إلى 0.13375 ملجم / كجم من العلف إلى زيادة في إجمالي كتله القشرة التي تنتجها الدجاجة ، على الرغم من أن مكونات قشره البيضه الأخرى لم تتأثر سلبياً. بينما، زيادة المحتوى الإجمالي لمصادر فيتامين د ملجم/كجم من النظام الغذائي عن الحد السابق لم يحقق الهدف المرجو منه. أوصت النتائج بإضافة 25 هيدروكسي كوليكالسيفيرول بمعدل 0.8 ملجم/كجم لتجنب تدهور جودة قشر البيض في الأعمار المتأخرة للدجاج البياض وتجنب الخسارة الاقتصادية بسبب سوء جودة قشر البيض.

الكلمات الدالة: الدجاج المتقدم بالعمر- قشرة البيض- البنية الاساسية لقشره البيض- فيتامين د.