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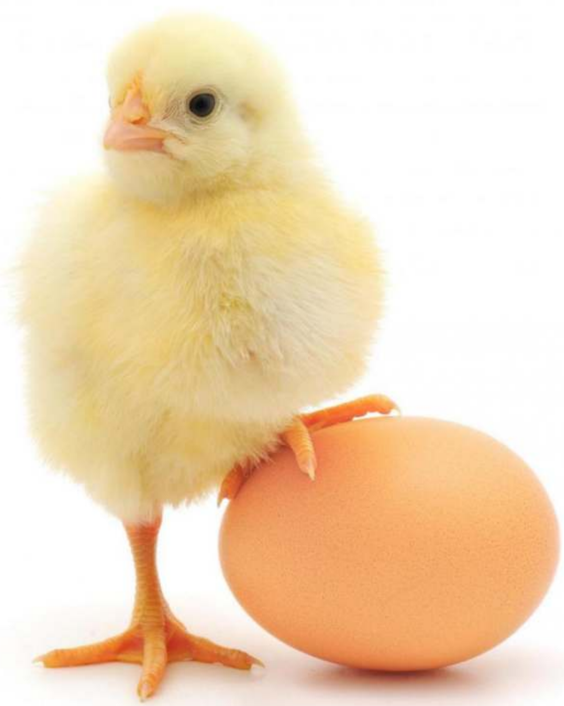

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Zinc Improves Egg Quality in Cobb500 Broiler Breeder Females

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Abstract: The aim of the present research was to, evaluate the effect of dietary supplementation with different levels of zinc (0, 50, 75, 100 mg/kg diet) on egg quality traits of Cobb 500 broiler breeder hens. The four experimental diets were as follows: T1 = the basal diet (control) without any addition (0 Zn). T2 = 50 mg Zn (pure zinc)/kg diet. T3 = 75 mg Zn (pure zinc)/kg diet T4 = 100 mg Zn(pure zinc)/kg diet. From the applied results which were selected a long the entire research period, we could be conclude the following: All of the egg quality traits and total mean of egg quality of broiler breeders hens were significantly affected by the different levels of dietary zinc supplementation except in both ESG and shell thickness. On the other hand, supplemental dietary zinc detected the highest ($p<0.05$) egg weight/week as compared to control group and had a significant effect ($p<0.05$) in accumulative egg weight.

Key words: Zinc, egg quality, broiler breeder production

INTRODUCTION

The Cobb commitment to genetic improvement continuous and increase the performance potential in all areas of broiler and broiler breeder production. However, to attain both genetic potential and consistent flock production, it is important that the flock manager has a good management program in place. The success of the Cobb broiler breeder worldwide has provided considerable experience of the breed in a wide range of situations, such as hot and cold climates, controlled environment and open housing (Cobb breeder management guide, 2008). Zinc is one of the essential elements for plant and animal life. Zinc deficiency in animals was not recognized until 1934. Today's farmer understands the importance of zinc in maintaining normal health and increased yields, especially in swine and poultry. In swine, a lack of zinc in the diet causes parakeratosis, characterized by dermatitis, diarrhea, vomiting, decreased appetite, severe weight loss and death. In poultry, zinc deficiency results in loss of appetite, growth retardation, blood disorders. Zinc sulfate is the optimum source of zinc in animal feeds as the nutritional source of zinc due to its biological availability (Old Bridge Chemicals, 1999). Kultu *et al.* (1998) observed that deficiency of zinc also decreases in egg production and reproductive performance problems in bone and skin development and mortality. Zinc is distributed throughout the body and participates in several reproductive functions (Savage, 1968). Activity of carbonic anhydrase, is an essential enzyme for egg shell formation (Pearson *et al.*, 1977). Inadequate intake of dietary zinc by hens adversely affects hatchability, embryonic development and poor chick quality (Supplee *et al.*, 1958; Turk *et al.*, 1959; Blamberg *et al.*, 1960; Kienholz *et al.*, 1961).

MATERIALS AND METHODS

This study was carried out at the Erbil Poultry Project, Erbil, Iraqi Kurdistan Region, Iraq during the period from 15th November 2008 to May 2009. A total number of (96) at 45 weeks old Cobb 500 broiler breeders were used. These birds were randomly distributed equally into four dietary treatments (T1 = the basal diet (control) without any addition (0 Zn). T2 = 50 mg Zn (pure zinc)/kg diet. T3 = 75 mg Zn (pure zinc)/kg diet T4 = 100 mg Zn (pure zinc)/kg diet) and each treatment was equally subdivided in to three replicates per group, each replicate constitutes 8 hens (24 females per group) on 12 floors pens. Birds were raised under similar environmental, managerial and veterinarian conditions. Birds were kept in a closed house; artificial lighting and drinking by nipples were provided through the experimental period (22 weeks). Commercial ration were provided for hen during experimental period. Birds were maintained for 16 hr light and 8 hr dark, also maintained hall temperature at 18-21°C during the study period Birds were fed standard diet (161 gm/day and then the diet was being decreased 1 gm per week from 45 week to 56 weeks of age, then fixed on 150 gm/day during the experimental period.

One type of zinc was used in the experiment: pure metal zinc. The imported zinc was obtained from Himedia-India, Himedia Laboratories. Ltd, Mumbai - India. By Abu-Wail office (Health Street, Babul Muadham, Baghdad, Iraq).

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Table 1: Effect of supplemental dietary zinc on egg weight of Cobb 500 broiler breeder hens at various ages

Item	Age week	T1 (0 mg Zn/kg diet)	T2 (50 mg Zn/kg diet)	T3 (75 mg Zn/kg diet)	T4 (100 mg Zn/kg diet)
Egg	51	61.39±0.44^{C}	62.94±3.92^{B}	67.47±2.50^{A}	63.34±3.18^{B}
weight	52	61.54±1.66^{C}	63.64±0.61^{B}	67.74±2.60^{A}	64.69±1.36^{B}
(gm)	53	61.73±2.11^{C}	63.94±3.10^{B}	67.96±1.10^{A}	65.14±0.90^{B}
	54	62.24±2.60^{C}	64.22±1.26^{B}	67.99±2.20^{A}	65.54±1.12^{B}
	55	62.44±2.01^{C}	64.64±1.33^{B}	68.14±2.16^{A}	66.34±0.96^{B}
	56	63.64±1.46^{C}	65.04±0.66^{B}	68.36±122^{A}	66.61±3.60^{B}
	57	64.01± 2.42^{C}	65.16±1.68^{BC}	68.42±2.61^{A}	66.64±1.16^{B}
	58	64.34±2.03^{C}	65.46±1.75^{BC}	68.53±2.01^{A}	66.69±0.99^{B}
	59	64.51±1.31^{C}	65.64±2.19^{BC}	68.64±1.88^{A}	66.93±2.00^{B}
	60	64.71±1.98^{C}	65.72±2.10^{BC}	68.82±1.60^{A}	67.18±1.76^{B}
	61	65.01±2.30^{C}	65.94±2.33^{BC}	68.90±1.04^{A}	67.44±2.06^{B}
	62	65.64±1.99^{C}	66.14±2.15^{BC}	69.11±1.63^{A}	67.71±1.86^{B}
	63	66.26±2.10^{B}	66.51±0.76^{B}	69.21±1.60^{A}	68.24±1.26^{B}
	64	65.36±2.11^{B}	66.64±0.60^{B}	68.46±1.43^{A}	66.85±2.18^{B}
	65	67.16±2.03^{B}	67.22±1.60^{B}	68.59±2.22^{A}	65.82±0.42^{B}
	66	67.42±2.39^{B}	68.13±0.97^{B}	69.53±2.33^{A}	69.67±1.24^{A}
	Mean	64.21±2.20^{C}	66.56±1.23^{B}	68.76±1.30^{A}	65.80±1.62^{B}

Means in a same row without common letter differ significantly ($p<0.05$)

Table 2: Effect of supplemental dietary zinc on egg quality traits of Cobb 500 broiler breeder hens at 54 week of age (Mean±SE)

	54 week of age				
	T1	T2	T3	T4	Sig. level
Albumin height (mm)	3.470±0.35^{B}	3.630±0.10^{B}	4.000±0.61^{A}	4.170±0.32^{A}	*
Yolk height (mm)	17.600±0.37^{B}	19.300±0.50^{A}	19.350±0.22^{A}	19.170±0.31^{A}	*
Yolk diameter (mm)	36.850±0.52^{B}	38.160±0.39^{A}	38.300±0.35^{A}	38.640±0.36^{A}	*
Yolk weight (gm)	18.700±0.37^{B}	19.870±0.45^{B}	22.100±0.35^{A}	21.240±0.73^{A}	*
Shell weight without member (gm)	5.550±0.22^{B}	5.770±0.08^{A}	5.700±0.40^{A}	5.720±0.08^{A}	*
Albumin weight (gm)	38.260±2.35^{B}	38.780±0.96^{B}	40.730±1.77^{A}	38.700±0.59^{B}	*
Shell thickness without membrane (mm)	0.375±0.006	0.366±0.009	0.352±0.007	0.361±0.158	NS
Specific Gravity of Egg (ESG)	1.081±0.001	1.080±0.002	1.077±0.01	1.079±0.001	NS
Haugh Unit (HU)	73.600±6.42^{B}	74.220±1.20^{B}	76.130±7.19^{A}	77.960±3.77^{A}	*

T1 = Control 0 mg zn/kg diet, T2 = 50 mg zn/kg diet, T3 = 65 mg zn/lkg diet, T4 = 100 mg zn/kg diet. Means in a same row without common letter differ significantly ($p<0.05$), NS = Non significant different within row. Sig. = Significant

Egg quality traits included in this study were egg weight, albumein height, yolk height, yolk diameter, yolk weight, shell weight, albumin weight, shell thickness, specific gravity of eggs, and Haugh unit. The data of this experiment were analyzed statistically using the General Linear Models procedure of SAS (2000). Significant differences between treatment means are separated using the Duncan's multiple range test with 5% and 1% probability.

RESULTS AND DISCUSSION

Egg weight: No significant differences were observed in Egg Weight (EW) between the dietary treatments T2 and T4 throughout the study period (Table 2), except at 63 and 66 wk of age, which T2 was significantly differ with T4, but a significant ($p<0.05$) increase in egg weight was noted between treatment groups (T2, T3 and T4) and control group (T1) at 51, 52, 53, 54, 55 and 56 weeks of age. Results also revealed the superiority ($p<0.05$) of T3 in EW with compare to other dietary treatments and control, except at 63 and 66 weeks of age which no significant differences were between T3 and T4 as well as between T1 and T2. However, the general increase in egg weight was noted throughout the experimental period. Significant differences were found between T2 and T3 and between T1 and T4 throughout the study period, Furthermore, data of egg weight (Table 2) showed that the T3 gave a higher value ($p<0.05$) in EW than the other experimental groups throughout the study and in total mean. The mean egg weight of birds consuming supplemental dietary zinc (T2 = 50 mg zn/kg diet and T4 = 100 mg zn/kg diet) was higher than that of control group (without supplemental dietary zinc). The data suggest that the increase in egg weight might directly be attributable to the increase in Zn concentration in the diet.

In a study by Kidd *et al.* (1992) with broiler parent stock, no effect of increasing Zn concentration on egg weight was found. The study involved the feeding of 41 week of old birds with Zn for 22 weeks. It is probable that the birds might not have enough time to respond to Zn supplementation in the study of Kidd *et al.* (1992). In a study by Durmus *et al.* (2004), significant differences were obtained with increase in zinc concentration in egg weight. However, the birds started receiving Zn supplementation as soon as they come out after

Table 3: Effect of supplemental dietary zinc on egg quality traits of Cobb 500 broiler breeder hens at 58 week of age (Mean±SE)

	58 week of age				
Treatments	T1	T2	T3	T4	Sig. level
Albumin height (mm)	3.250±0.60^{B}	3.320±0.21^{B}	4.660±0.13^{A}	4.600±0.05^{A}	*
Yolk height (mm)	18.090±0.55^{B}	19.190±0.22^{A}	19.770±14.89^{A}	19.890±0.26^{A}	*
Yolk diameter (mm)	40.350±1.31^{B}	46.440±0.45^{A}	48.500±1.09^{A}	48.640±0.44^{A}	*
Yolk weight (gm)	21.570±0.89^{C}	22.440±0.45^{B}	24.420±1.29^{A}	22.710±0.54^{B}	*
Shell weight without membrane (gm)	5.940±0.10^{B}	6.100±0.08^{A}	6.300±0.08^{A}	6.200±0.18^{A}	*
Albumin weight (gm)	36.340±3.01^{B}	37.370±1.95^{A}	37.400±1.92^{A}	37.100±0.14^{A}	
Shell thickness without membrane (mm)	0.344±0.009	0.337±0.006	0.336±0.003	0.335±0.004	NS
Specific Gravity of Egg (ESG)	1.077±0.001	1.079±0.001	1.069±0.002	1.061±0.001	NS
Haugh Unit (HU)	71.090±8.80^{B}	71.370±1.68^{B}	80.720±4.52^{A}	80.700±1.16^{A}	*

T1 = Control 0 mg zn/kg diet, T2 = 50 mg zn/kg diet, T3 = 65 mg zn/lkg diet, T4 = 100 mg zn/kg diet.
*Means in a same row without common letter differ significantly ($p<0.05$). NS - Refers non significant different within row

Table 4: Effect of supplemental dietary zinc on egg quality traits of Cobb 500 broiler breeder hens at 62 week of age (Mean±SE)

	62 week of age				
Treatments	T1	T2	T3	T4	Sig. level
Albumin height (mm)	2.650±0.25^{B}	3.300±0.38^{A}	3.190±0.23^{A}	3.150±0.42^{A}	*
Yolk height (mm)	15.690±0.36^{B}	16.010±0.36^{B}	16.940±0.46^{A}	16.700±0.15^{A}	*
Yolk diameter (mm)	47.810±1.29^{C}	50.040±0.43^{A}	50.200±1.32^{A}	49.880±0.35^{B}	*
Yolk weight (gm)	23.860±1.21^{B}	23.500±0.49^{B}	25.040±1.12^{A}	23.310±0.26^{B}	*
Shell weight without membrane (gm)	5.170±0.13^{C}	5.990±0.23^{B}	6.330±0.17^{A}	6.500±0.01^{A}	*
Albumin weight (gm)	36.350±1.57^{B}	36.450±3.88^{B}	37.580±3.31^{A}	37.520±3.12^{A}	*
Shell thickness without membrane (mm)	0.320±0.006	0.333±0.014	0.320±0.003	0.337±0.012	NS
Specific Gravity of Egg (ESG)	1.060±0.000	1.060±0.000	1.060±0.000	1.060±0.000	NS
Haugh Unit (HU)	62.290±4.04^{B}	71.020±7.85^{A}	69.250±3.02^{A}	69.29±5.75^{A}	*

*T1 = Control 0 mg zn/kg diet, T2 = 50 mg zn/kg diet, T3 = 65 mg zn/lkg diet, T4 = 100 mg zn/kg diet.
*Means in a same row without common letter differ significantly ($p<0.05$). NS - Refers non significant different within row

hatching and might have responded well to Zn supplementation throughout 62 weeks (from 1 day to 62 weeks). These findings in the present study were disagreement with those obtained by Kaya *et al.* (2001) who found that, adding zinc and / or vitamin-A to the hen's diet resulted in no significant differences in body weight, egg production, egg weight, feed intake and feed conversion among the groups of laying hens receiving experimental diets (0, 25, 50, 100, 200 mg ZnO/kg of diet).

Egg quality parameters: Data of Table 2 and 3 revealed that, yolk height, yolk diameter, shell weight, of broiler breeder hens at 54 and 58 weeks of age fed diets supplemented with 50 mg zn, 75 mg zn and 100 mg zn/kg diet were significantly affected compared with the control group and no significant differences were found among the dietary treatments (T2, T3 and T4) (50, 75 and 100 mg zn/kg diet) at the 54 and 58 week of ages in yolk height, yolk diameter and shell weight. While, diets supplemented with zinc were not significantly affected on shell thickness, Specific gravity of egg throughout the study, except at 66 wks of age which appeared significant differences between experimental groups (T2, T3 and T4) control group in shell thickness, also no significant differences were found between experimental groups and control at 66 wks of age in albumin weight. No significant difference between T3 and T4 in albumin height at 54, 58 and 66 week of ages, Whereas, the dietary treatments (T1 and T2) did not show significant difference ($p>0.05$) in albumin height and albumin weight at 54 and 62 weeks of age (Table 2 and 4).

Table 3, 4, 5, 6 also showed that the dietary treatments ameliorated ($p<0.05$) the Haugh unit values throughout the experimental periods than the control group, no significant differences were found between the dietary treatments (T3 and T4) in HU values at 54 and 58 wk which had higher ($p<0.05$) HU values than the control group and T2. Also, control group showed lower ($p<0.05$) HU values than the T2, T3 and T4 groups at 62 and 66 week of ages (62.29) versus (71.02, 69.25, 69.29) and (65.71) versus (77.5, 73.8, 70.32) respectively. As shown in Table 3, 4, 5, 6, higher total mean levels ($p<0.05$) of all egg quality parameters were recorded in experimental groups in comparison to control group after zinc supplementation of broiler breeder hens, except in ESG and shell thickness, which, shown the dietary treatments (T2, T3, T4) had no significant effects on the later traits. This phenomenon was observed at all weeks of age. While, all dietary treatments showed the highest value in shell thickness at 66 week of age compared with the control group. This finding disagree with (McDowell, 1992; El-Habbak *et al.*, 2005; Namra *et al.*, 2009) who deduced that reduction in shell weight may be related to the antagonism between the high level of both dietary Zn and Ca, with reference to

Table 5: Effect of supplemental dietary zinc on egg quality traits of Cobb 500 broiler breeder hens at 66 week of age (Mean±SE)

	66 week of age				
Treatments	T1	T2	T3	T4	Sig. level
Albumin height (mm)	2.750±1.83^{C}	4.190±0.19^{A}	3.750±0.41^{B}	3.330±0.30^{B}	*
Yolk height (mm)	15.290±0.09^{B}	16.160±0.25^{A}	15.550±0.36^{AB}	15.330±0.15^{B}	*
Yolk diameter (mm)	42.370±0.54^{B}	50.820±0.28^{A}	50.380±0.09^{A}	49.170±0.37^{A}	*
Yolk weight (gm)	24.380±0.52^{C}	25.460±0.49^{B}	26.860±1.06^{A}	25.780±0.84^{B}	*
Shell weight without membrane (gm)	5.780±0.10^{B}	6.460±0.31^{A}	6.380±0.50^{A}	6.530±0.20^{A}	*
Albumin weight (gm)	36.880±2.33	36.120±1.21	36.220±0.84	36.950±2.71	NS
Shell thickness without membrane (mm)	0.300±0.006^{C}	0.341±0.004^{A}	0.336±0.145^{A}	0.312±0.007^{B}	
Specific Gravity of Egg (ESG)	1.060±0.000	1.060±0.000	1.060±0.000	1.060±0.000	NS
Haugh Unit (HU)	65.710±2.75^{C}	77.500±3.72^{A}	73.830±7.54^{B}	70.320±3.16^{B}	*

T1 = Control 0 mg zn/kg diet, T2 = 50 mg zn/kg diet, T3 = 65 mg zn/lkg diet, T4 = 100 mg zn/kg diet. *Means in a same row without common letter differ significantly ($p<0.05$). NS - Refers to non significant difference within row or NS - Refers to non significant differences in a row

Table 6: Effect of supplemental dietary zinc on total means of egg quality traits of Cobb 500 broiler breeder hens at various ages (Mean±SE)

	Total means of egg quality				
Treatments	T1	T2	T3	T4	Sig. level
Albumin height (mm)	3.030±0.39^{B}	4.090±0.50^{A}	3.770±0.81^{A}	3.810±0.68^{A}	*
Yolk height (mm)	16.660±1.38^{B}	17.660±1.82^{A}	17.090±2.00^{A}	17.840±2.19^{A}	*
Yolk diameter (mm)	39.090±6.48^{B}	46.000±5.69^{A}	47.340±6.03^{A}	46.580±5.31^{A}	*
Yolk weight (gm)	22.120±0.674^{C}	22.800±1.36^{B}	24.600±1.85^{A}	23.260±0.70^{B}	*
Shell weight without membrane (gm)	5.610±0.567^{B}	6.080±0.32^{A}	6.170±0.167^{A}	6.230±0.215^{A}	*
Albumin weight (gm)	36.950±4.03^{B}	37.170±3.60^{B}	37.980±2.66^{A}	37.560±2.48^{A}	*
Shell thickness without membrane (mm)	0.334±0.032	0.344±0.014	0.336±0.013	0.336±0.020	NS
Specific Gravity of Egg (ESG)	1.069±0.011	1.069±0.011	1.069±0.010	1.068±0.010	NS
Haugh Unit (HU)	68.880±3.99^{B}	73.520±5.67^{A}	74.980±4.36^{A}	74.560±6.92^{A}	*

T1 = Control 0 mg zn/kg diet, T2 = 50 mg zn/kg diet, T3 = 65 mg zn/lkg diet, T4 = 100 mg zn/kg diet.
*Means in a same row without common letter differ significantly ($p<0.05$). NS - Refers non significant different within row

that, egg shell contain large amounts of calcium. Moreover, insignificant differences in shell weight were observed among the experimental groups except for control group throughout the experimental periods, which significantly detected the least shell weight value, as compared with T2, T3 and T4 groups The increase in albumin height, yolk diameter and yolk weight and albumin weight values of dietary treatment groups (T2, T3 and T4) may be due to that diets supplemented with different levels of zinc (50, 75, 100 mg/kg diet) caused rise in total protein of blood serum or plasma. Namra *et al.* (2009) and El-Habbak *et al.* (2005) deposed that, egg shell quality (egg shell weight and egg shell thickness) proved to be negatively affected by high dietary zinc level applied. Hudson *et al.* (2004) reported that supplemental zinc source did not alter egg shell breaking strength as measured at 50, 58 and 66 wk of age of broiler breeder hens. Also, these ameliorations in yolk and albumin egg quality may be attributed to the Zn roles on increment of estrogen concentration, which promoted vitellogenin synthesis and lipoprotein then transported it to ovary by blood stream (Sturkie, 1976).

As well as, Bacon *et al.* (1980) observed significant a positive correlation, between plasma estrogen concentration and neutral fats, lipoproteins free fatty acids and plasma protein in turkey hens.

It is possible that decrease of egg shell thickness throughout the study periods was caused by the decrease of calcium level in hens after long term (45-66 weeks) supplementation with Zn. On the other hand, no significant effect was observed in Egg Specific Gravity (ESG) between control group and the other experiment treatments. The increment of shell weight through the study may be attributed to the bone which might store calcium and phosphor and it might be mobilized to the blood stream (Weiser *et al.*, 1988) or may be due to the roles of zinc in boost of Vit. D_3 conversion to its active shape which led to increment of activate Protein Binding Calcium (PBC) in ileum then increase of calcium and phosphorus absorption and increase its levels in plasma which have a positive adverse on amelioration blood parameters and egg shell characteristics (Weiser *et al.*, 1990; El-Aroussi *et al.*, 1993; Mahmoud *et al.*, 1996), or may be due to the action of zinc on ALP activity increment, which this enzyme plays a major role on calcium metabolism (Tanabe and Wilcox, 1961; Rako *et al.*, 1964; Singh *et al.*, 1983). Moreover, Zinc deficiency has been shown to decrease Alkaline Phosphatase (ALP), resulting in depression in bone and egg shell formation (Brandae-Neto *et al.*, 1995; Nishi, 1996). The significant increase ($p<0.05$) in albumin quality in the present study, as measured by increased albumin weight (except at 54wk of age), albumen height and HU in the 54 wk, 58 wk and 62 wk and 66 wk of age is in agreement with the report of Sahin and Kucuk (2003) and Tabatabaie *et al.* (2007) who reported that zinc supplementation positively affected HU. A part from this effect, there were minimal differences in egg quality parameters between treatments. This may be due to the level of zinc in the basal diet (70 mg/kg) which was possibly insufficient for normal activity of carbonic anhydrase. Alternatively, the feeding period of 24 weeks may have been enough to allow the effects of zinc deficiency on other egg quality parameters to be expressed. On the other hand, HU will decrease with increasing bird age value with HU decreasing by around 1.5 to 2 units (Coutts and Wilson, 1990) for each month in lay. Doyon *et al.* (1986) (cited by Jones 2006) stated that HU decreased at a fairly constant rate of units per day of lay as the hen ages.

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