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EFFECT OF DIFFERENT LEVELS OF CALCIUM WITHOUT OR WITH ZINC BACITRACIN ON BODY WEIGHT, EGG PRODUCTION, FEED UTILIZATION AND EGG QUALITY OF HEN LAYERS IN SINAI

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This experiment was carried out at Ras-Sudr Research Station, South Sinai to evaluate 3 levels of calcium (Ca), 3.5, 4.0 and 4.5% without or with Zinc bacitracin (ZBA) in layer diets during the summer months (June, July and August), and their effects on body weight, egg production, feed utilization, egg quality and some minerals in egg shell and blood plasma. Ninety hens Hy- Line (Brown –egg type) of 24 weeks of age were divided into 3 experimental groups, 30 hens each. Each treatment was divided into two sub treatment, 15 hens each, ZBA was added at a level of 100 mg/kg diet in three sub treatments.

The increase of Ca level in layer diets up to 4% with adding ZBA at a level of 100 mg/kg diet showed the best significant ($P<0.05$) improvements in final body weight (1848g) and weight gain (240.8g), when compared to the other experimental treatments. The highest value of egg production percentage throughout the interval periods and at the end of the experiment was noticed when hens fed on a diet with 4% Ca supplemented with ZBA. There were no significant effects on egg weight due to Ca levels without or with ZBA. Total egg mass recorded the best significant ($P<0.05$) value of 4.148 kg in the experimental group fed on 4% Ca supplementing with ZBA compared to the other experimental groups.

Hens fed on a diet containing 4% Ca and supplemented with ZBA appeared insignificant higher feed intake values at the interval periods and throughout the total experiment as well. Feed conversion values (kg feed/ kg eggs) behaved also the same trend, showing the best value of 2.46 for group fed on 4% Ca supplemented with ZBA.

The increasing of Ca level up to 4.0% and supplemented with ZBA followed by a significant ($P<0.05$) improvement in the absolute shell weight, shell weight per unit surface area (SWUSA), egg shell volume and shell thickness. Hens fed on 4.0% Ca supplemented with ZBA followed by those fed on 4.5% without or with ZBA, showed the best economical efficiency, respectively.

It could be recommended to feed hen layers during summer months on a diet with 4% Ca supplemented with ZBA at a level of 100 mg/kg diet. This could improve egg production performance, feed utilization and egg quality of hen layers

Keywords: Calcium levels, Zinc bacitracin, body weight, egg production, egg quality and feed utilization.

Body weight gain, feed intake, egg production, egg weight and egg shell quality are inversely related to high constant or cyclic environmental temperature. There are three fundamental factors involved in overcoming detrimental effects of heat stress such as controlling and improving the thermal environment, selection of breeds with better heat tolerance or dietary modifications (Bronsch *et al.*, 1991).

Ca requirements of laying hens are affected by production level, age of hens, Ca source and availability, and ambient temperature (Abou Egla, 1995). The National Research Council (1994) has suggested Ca level as 3.6% for Brown-egg layers. The importance of Ca as a limiting factor in egg production and egg shell quality may lead to excessive use of this element in layer diets, particularly during the summer months as one of diet modifications (Daghir, 1995) due to the lower feed intake under heat stress conditions.

Zinc bacitracin (ZBA) is an additive which is not absorbed from the gastro-intestinal tract. Small doses of it improve performance at high temperature and reduce heat stress effects (Kaemmerer and Kietzmann, 1980). Furthermore, Hay (1978) cleared that the mode of action of ZBA suggested to be due to various activities as nutrient sparing effect, better absorption of nutrients, a change in the microfloral population of gastrointestinal tract or a metabolic effect and suppression of organisms causing signs of disease.

Some of research work were carried out to use Zinc Bacitracin as a feed additive in diets. Engberg *et al.* (2000) used ZBA at a level of 20 mg, while El-Gendi *et al.* (2000) recommended it at a level of 50 mg in broiler diets. Rabbits were fed a diet with 100 mg ZBA without detrimental effects on performance (Soliman *et al.*, 2000). Bronsch *et al.* (1991) used 100 mg ZBA in layer diets and found an improvement in egg production and egg shell quality under a higher temperature of 34^0 C.

There is no data available on the interrelationship between calcium levels and ZBA during summer months. Hence, this article aimed to find the effect of different levels of calcium without or with ZBA as a feed additive on body weight changes, egg production, feed utilization, egg quality and some minerals content in egg shell and blood plasma in hen layers during summer months.

MATERIALS AND METHODS

This research work was carried out at Ras-Sudr Research Station, belonging to the Desert Research Center in order to evaluate 3 levels of calcium (3.5, 4 and 4.5%) without or with ZBA in layer diets during the summer months (June, July and August) and their effects on body weight changes, egg production, feed utilization, egg quality and some of mineral contents in blood and egg shell. Ninety hens Hy- Line (Brown –egg type) of 24 weeks of age raised in cages were divided into 3 experimental groups, 30 hens each. Each treatment was, in turns, divided into two sub treatment, 15 hens each, 3 replicates, 5 birds each. ZBA was added at a constant level of 100 mg per Kg of diet.

The birds were received a basal diet to be iso caloric and iso nitrogenous (2700 ME and 17% CP). Composition and calculated analysis of the experimental diet are shown in table (1). The birds were offered diets and water *ad lib.*

Body weight was recorded at the beginning of the experiment and monthly till the end of the experiment and the body weight gain was calculated as the difference between the initial and final body weight. Egg weight and egg number were recorded daily to calculate the egg production percentage and the egg mass in kg. Feed consumption were recorded biweekly and feed conversion values (kg feed/kg eggs) were calculated as the amount of feed consumed divided by egg mass.

Egg quality measurements were carried out by using 90 eggs (15 eggs from each treatment). These measurements involved yolk, albumen and shell weight percentage. Egg shell thickness was measured in μm by using a micrometer. Egg shape index was calculated according to Romanoff and Romanoff (1949) as an egg diameter divided by egg length. Yolk index calculated according to Funk, *et al.* (1958), as yolk height divided by yolk diameter. Haugh unit was calculated according to Eisen, *et al.* (1962) using the calculation chart for rapid conversion of egg weight and albumen height. Egg surface area (ESA) was calculated according to Paganelli *et al.* (1974) as $ESA = 4.835 * W^{0.662}$ Cm^2 where W= egg mass in grams. Shell weight per unit surface area (SWUSA) calculated as shell weight, mg/ ESA, Cm^2. Egg shell volume was estimated according to Rahn (1981) as ESA, Cm^2 X shell thickness. Some of minerals content like Ca, total P and Zn were determined in egg shell in the experimental treatments.

At the end of the experiment, 3 blood samples from each treatme were taken and centrifuged to obtain plasma which was stored at -20^0C ti analysis. In this respect, Ca, inorganic P and Zn, were measured by specifi diagnostic kits (Bio Merieux, France) according to guidelines an recommendation of Bogin and Keller (1987).

Data were statistically analyzed using the General Linear Mode Procedure (SAS, 1994). Duncan's multiple range test was used to test the significance (P< 0.05) of mean differences (Duncan, 1955). Some of correlation coefficients within the experimental groups were calculated.

TABLE (1). Composition and calculated analysis of the experimental diets

Ingredients%	Calcium levels%		
	3.5	4.0	4.5
Yellow corn	64.0	63.9	63.7
Soybean meal, 44%	13.70	13.7	13.4
Layer concentrate[1]	10.00	10.00	10.00
Wheat bran	4.0	2.80	2.00
Lime stone	6.3	7.60	8.90
Di Calcium P.	1.00	1.00	1.00
NaCl	0.50	0.50	0.50
Vit. & Min. premix[2]	0.50	0.50	0.50
Chemical composition			
ME, Kcal/Kg	2769	2764	2744
CP%	17.20	17.10	16.90
Ca%	3.55	4.10	4.56
Av. P%	0.70	0.70	0.72
M. + C.%	0.66	0.66	0.66
Lysine%	0.83	0.83	0.83
CF%	3.05	3.05	3.05

[1] Layer concentrate contains: 51% CP, 2500 Kcal ME/Kg, 8.0% Ca, 4% av. P., 2.0% Meth. and 3.19% Lysine.

[2] Vit. & Min. premix per Kg. of the diet contain: Vit. A 12.000 IU, Vit. D3 2000 IU, Vit. E 10 mg, Vit. K 2 mg, Vit. B1 1 mg, Vit. B2 4 mg, Vit. B6 1.5 mg, Vit. B12 10 mcg, Pantothenic 10 mg, Niacin 20 mg, Folic acid 1 mg, Biotin 50 mcg, Choline 500 mg, Iron 30 mg, Manganese 40 mg, Copper 3 mg, Iodine 0.3 mg, Cobalt 0.2 mg, Zinc 45 mg and Selenium 0.1 mg.

RESULTS AND DISCCUSION

Effect of calcium levels without or with ZBA on:

1-Body weight and egg production parameters

The effect of different levels of Calcium (Ca) without or with ZBA on body weight changes and egg production parameters are summarized in table (2). It could be stated that the increase of Ca level in layer diets up to 4% with adding ZBA at a level of 100 mg/kg diet showed the best significant (P<0.05) improvements in final body weight (1848 g) and weight gain (240.8 g) when compared to the other experimental treatments. On the other hand, 3.5% Ca without ZBA showed the lowest values in final body weight (1712.5 g) and body weight gain (106.2 g). It must be added that using ZBA with the different levels of Ca showed always a positive effect on body weight and weight gain.

The non significant effect of Ca levels on final body weight and weight gain and the significant effect (P<0.05) of which with adding ZBA could explain the important of this promoter at a level of 4% Ca in layer diet during summer months. The significant interaction (P<0.05) between Ca and ZBA could support this opinion.

Reviewing the literatures, there is no data on the effect of different levels of Ca with ZBA. However, some investigations were found on the effect of Ca or ZBA on one hand. The lack of a significant effect of dietary Ca levels on body weight and weight gain encountered in the present study was confirmed by Atteh and Leeson (1985), Hasb El-Napy (1989) who reported that dietary Ca level didn't affect body weight of Gimmaza laying hens. Moreover, Abou Egla (1995) reported that Ca level up to 4% in layer diet had no significant effect on final body weight.

The significant effect of ZBA on body weight and weight gain was previously confirmed by Manner and Wang (1991) who recorded a significant improvement in body weight and weight gain of hens when diet supplemented with 100 mg ZBA at 34^0 C. The same author added that feeding ZBA to hens housed under normal temperature conditions 20^0 C induced non significant effects on body weight performance of hens. This support the opinion that ZBA as one of the growth promoters is working better under stress conditions. These conditions include poor husbandry, sub optimal nutrition (poor quality diets) and environmental stress such as temperature (O'Connor, 1980).

The effect of Ca levels without or with ZBA on egg production percentage, egg weight and egg mass are shown in table (2). Analysis of variance revealed a significant (P<0.05) effect due to Ca levels, ZBA and also their interactions. The highest value of egg production percentage throughout the interval periods (Fig. 1) and at the end of the experiment was noticed when hens fed on a diet with 4% Ca supplemented with ZBA. Generally, egg production percentage insignificantly decreased with the increasing of dietary Ca more than 4%. However, 3.5% Ca without or with ZBA showed the lowest egg production percentage in contrast to the other experimental groups. Values of egg production percentage were 78.57, 78.87, 81.33, 85.22, 84.82 and 83.63 for groups fed on 3.5% Ca, 3.5% Ca +ZBA, 4.0% Ca, 4% Ca+ ZBA, 4.5% Ca and 4.5% Ca+ ZBA, respectively. The lower egg production percentage at a level of 4.5% Ca in diet could be interpreted that the increasing of dietary Ca may increase the Ca-binding protein over the blood free Ca ion concentration which in turns decline the egg production (Edwards *et al.*, 1992 and Esa and Hamdy, 2001). However, Scheideler (1994) recommended Ca intake up to 4.1 g during peak production of hen layers.

There were no significant effects on egg weight due to Ca levels without or with ZBA (Table 2). Abou Egla (1995) came also to the same conclusion. Total egg mass recorded the best significant (P<0.05) value of 4.148 kg in the experimental group fed on 4% Ca supplementing with ZBA (Fig. 2), while the lowest ones noticed in group fed on 3.5% Ca supplemented with ZBA. The interactions in this respect was also significant (Table 2).

The significant effect (P<0.05) of dietary Ca, ZBA and their interactions on egg production percentage and egg mass could explain the important role of increasing Ca level more than 3.5% and adding ZBA under the desert conditions during the summer months. It is well known that Ca is a limiting factor in egg production and the excessive use of this element to a certain extent may be taken as a mean to alleviate the harsh conditions through heat stress period. Also Ca is known to have intensity and specific interrelationships with a large number of nutritional and environmental factors (Gorman and Balnave, 1994). However, under the moderate conditions, the increasing of Ca levels in layer diets had no significant effect on egg performance (Sell *et al.*, 1987 and Cheng and Coon, 1990). The present results are also agreed with the finding s of Manner and Bronsch, (1987) and Manner and Wang (1991) who reported significant improvement in egg production performance when layer diets supplemented with ZBA during heat stress period (34^0C).

2- Feed consumption and feed conversion values

The effect of Ca levels without or with ZBA on feed utilization are shown in table (3). It is worth to note that hens fed on diet containing 4% Ca and supplemented with ZBA appeared insignificantly higher feed intake values at the interval periods and throughout the total experiment as well. However, the birds received 4.5% dietary Ca on one hand or supplemented with ZBA consumed to some extent more feed than those received 3.5% Ca without or with ZBA.

Feed conversion values (kg feed/ kg eggs) behaved also the same trend, showing the best value of 2.46 for group fed on 4% Ca and supplemented with ZBA. However, the lowest conversion values encountered when hens fed on diets having 3.5% Ca without or with ZBA. Values in this respect were 2.63 and 2.64 for the two groups in the same order, respectively.

The present results were partially confirmed by Abou Egla (1995) who noticed no significant effect on feed conversion in layer fed diets containing up to 4.0% Ca, while feed intake showed the lowest value at the same level of Ca.

It is well known that feed conversion values estimated depending mainly on feed consumption and egg mass. The highest value of egg mass in the present study was recorded in group fed on 4.0% Ca with adding ZBA (Table 2). Therefore, the same group appeared also the best value in feed conversion (Table 3). In an earlier study, Roush *et al.* (1986) found that Ca at a level of 3.75% improved feed efficiency of hen layers, while a 5% Ca level had not. However, not only the amount of Ca in feed but also the source of which, type of feed mixture and the environmental factors surrounding the birds must be taken into consideration. Radwan *et al.* (1985), for example, reported that the amount of Ca absorbed by an animal is a function of at least two factors; the amount and form of Ca eaten and the animal's capacity to absorb.

The effectiveness of ZBA in the current work concerning feed utilization was supported by Manner and Wang (1991) who reported that treated hens maintained at 34^0C and supplemented with ZBA consumed significantly more feed and showed better feed conversion compared to the untreated ones or those supplemented with ZBA under a moderate condition. ZBA acts to modify the intestinal flora as well as the gut wall structure (Boorman, 1987 and Bernsten, 1994). ZBA has also a nutrient sparing by inhibition of fermentative losses and from enhanced metabolizability in addition to its effect on nitrogen retention improvement (Huyghebaert and Groote, 1997). Another explanation for the important role of ZBA in layer diets during the summer months that ZBA reduces heat production which enables heat stressed hens to maintain a higher feed intake and, therefore, a better performance than untreated ones (Manner and Bronsch, 1987; Manner and Wang, 1991).

3- Egg quality measurements

Egg quality and egg shell parameters as affected by Ca levels without or with ZBA are reported in table (4 and 5). The interior egg quality measurements except those of shell weight% showed insignificant influence due to the different experimental groups. However, the increase of Ca level up to 4.5% showed insignificant increase in haugh units. This was previously confirmed by Mothur *et al.* (1982) and Abou Egla (1995), while Chah and Moran (1985) revealed that haugh units were not significantly influenced by dietary Ca levels in hen layer.

TABLE (2). Effect of Ca levels without or with ZBA[1] supplementation on body weight changes and egg production (Means ± SE).

Traits	Ca levels						Significance		
	3.5%	3.5% + ZBA	4%	4% + ZBA	4.5%	4.5% +ZBA	Ca	Ca+ZBA	Interaction
Initial body wt (gm)	1606.3±38.5	1612.5±33.7	1603.3±35.9	1607.5±32.4	1600.0±35.5	1614.9±32.4	N.S.	N.S	N.S.
Final body wt (gm)	1712.5^{b}±37.7	1724.5^{ab}±38.9	1770.9^{ab}±36.1	1848.3^{a}±43.7	1800.4^{ab}±49.0	1828.8^{ab}±37.2	N.S.	*	*
Body wt. changes (gm)	106.2^{b}±28.3	112.0^{b}±41.9	167.6^{ab}±35.7	240.8^{a}±31.2	200.4^{ab}±28.8	213.9^{a}±36.6	N.S.	*	*
Egg production %									
June	74.31b±2.01	74.74^{b}±1.63	78.08^{ab}±2.22	82.73^{a}±2.14	82.16^{a}±2.17	80.29^{ab}±2.07	*	*	*
July	80.01±2.20	79.98±2.20	82.03±1.90	84.03±1.80	83.9±2.10	84.30±1.80	N.S.	N.S.	N.S.
August	81.40^{b}±1.80	81.90^{b}±2.00	83.9^{ab}±2.00	88.9^{a}±2.20	86.8^{a}±2.1	86.3^{a}±2.30	*	*	*
Overall means	78.57^{b}±1.60	78.87^{b}±1.90	81.33^{ab}±2.00	85.22^{a}±1.80	84.82^{a}±2.30	83.63^{ab}±2.20	*	*	*
Egg wt. (gm)									
June	56.46±1.32	56.46±1.34	56.54±1.30	57.00±1.41	56.54±1.34	56.53±1.43	N.S.	N.S.	N.S.
July	58.65±1.40	57.95±1.44	58.08±1.39	58.38±1.25	57.96±1.29	58.74±1.36	N.S.	N.S.	N.S.
August	58.10±1.34	58.08±1.34	58.09±1.31	58.43±1.40	58.31±1.30	58.68±1.60	N.S.	N.S.	N.S.
									N.S.
Overall means	57.73±1.28	57.49±1.51	57.57±1.38	57.94±1.23	57.60±1.53	57.98±1.23	N.S.	N.S.	N.S.
Egg mass (Kg)									
June	1.175±0.08	1.182±0.07	1.236±0.06	1.320±0.06	1.3000±0.10	1.271±0.08	N.S.	N.S.	N.S.
July	1.314±0.10	1.298±0.08	1.334±0.06	1.374±0.09	1.361±0.11	1.386±0.11	N.S.	N.S.	N.S.
August	1.324±0.07	1.332±0.10	1.365±0.09	1.454±0.08	1.417±0.11	1.418±0.12	N.S.	N.S.	N.S.
Total	3.813^{c}±0.07	3.812^{c}±0.11	3.935^{bc}±0.10	4.148^{a}±0.07	4.078^{ab}±0.13	4.075^{ab}±0.13	*	*	*

[1] Added at a constant level (100 ppm/ kg diet)

[a,b,c] means within a row with different superscripts are significantly different (P< 0.05)

N.S. = non significance . * = (P< 0.05)

TABLE (3). Effect of Ca levels without or with ZBA supplentation on feed utilization (Means ± SE)

Traits	Ca levels					
	3.5%	3.5% + ZBA	4%	4% + ZBA	4.5%	4.5% +ZBA
Daily feed consumption, gm/hen						
June	108.12±2.30	109.00±2.00	107.9±1.70	110.3±1.93	108.1±1.56	108.50±1.63
July	111.80±1.90	111.7±2.20	112.5±2.00	113.8±2.00	112.8±1.50	112.0±1.70
August	114.3±2.41	114.9±1.86	115.0±2.30	116.8±2.33	115.1±2.30	115.5±1.90
Overall mean	111.41±2.55	111.87±2.30	111.8±1.99	113.63±2.17	112.00±2.00	112.00±2.10
Feed conversion, kg feed/ kg eggs						
June	2.76±0.10	2.77±0.12	2.62±0.11	2.51±0.08	2.49±0.07	2.56±0.09
July	2.55±0.11	2.58±0.10	2.53±0.10	2.48±0.09	2.48±0.09	2.42±0.08
August	2.59±0.12	2.58±0.09	2.53±0.10	2.41±0.10	2.44±0.10	2.44±0.10
Overall mean	2.63±0.10	2.64±0.08	2.56±0.09	2.46±0.10	2.47±0.11	2.47±0.10

TABLE (4) Effect of Ca levels without or with ZBA supplementation on egg quality measurements (Means ± SE)

Traits	Ca levels						Significance		
	3.5%	3.5% + ZBA	4%	4% + ZBA	4.5%	4.5% +ZBA	Ca	Ca+ZBA	Interaction
Egg weight, g	57.00±1.95	56.67±1.20	58.50±1.88	58.90±1.05	56.67±1.28	57.33±1.76	N.S.	N.S.	N.S.
Albumen wt., %	63.43±1.89	63.02±1.12	61.80±1.02	61.59±1.40	62.62±1.98	62.19±1.03	N.S.	N.S.	N.S.
Yolk wt., %	25.28±1.97	25.55±1.96	25.66±1.82	25.01±1.38	24.66±1.85	24.99±1.49	N.S.	N.S.	N.S.
Shell wt. %	11.29b±0.67	11.43b±0.66	12.54ab±0.40	13.40a±0.50	12.72ab±0.57	12.82ab±0.78	N.S.	*	*
Shape index	75.76±1.29	76.49±1.55	76.37±1.76	74.91±1.75	75.01±1.82	76.09±2.02	N.S.	N.S.	N.S.
Yolk index	47.21±1.89	45.80±2.41	47.29±1.90	47.54±2.09	47.53±1.96	45.86±1.84	N.S.	N.S.	N.S.
Haugh unit	76.55±4.50	73.71±3.99	74.12±4.90	75.68±3.30	77.30±4.90	78.01±4.60	N.S.	N.S.	N.S.

a, b means within a row with different superscripts are significantly different ($P< 0.05$)
N.S. = non significance. * = ($P< 0.05$)

TABLE (5). Egg shell parameters as affected by different levels of Ca without or with ZBA supplementation in layer diets measurements (Means ± SE)

Treatments	Egg shell wt., gm	Egg surface area (cm^2)	SWUSA (mg/cm^2)	Egg shell volume (cm^3)	Shell thickness (μm)
3.5%	$6.43^{b}\pm0.13$	70.27±1.37	$91.50^{c}\pm1.73$	$23.11^{ab}\pm1.35$	$318^{b}\pm10.42$
3.5% + ZBA	$6.48^{b}\pm0.12$	70.00±2.05	$92.57^{c}\pm1.25$	$22.33^{b}\pm1.17$	$315^{b}\pm12.48$
4%	$7.34^{ab}\pm0.15$	71.49±1.79	$102.67^{b}\pm2.00$	$24.23^{a}\pm1.10$	$339^{a}\pm12.76$
4% + ZBA	$7.89^{a}\pm0.17$	71.81±0.99	$109.87^{a}\pm1.97$	$24.77^{a}\pm0.96$	$345^{a}\pm11.27$
4.5%	$7.21^{ab}\pm0.11$	70.00±1.91	$103.00^{b}\pm1.65$	$21.07^{b}\pm1.07$	$330^{a}\pm13.92$
4.5% + ZBA	$7.35^{ab}\pm0.14$	70.54±2.11	$104.20^{b}\pm2.03$	$21.73^{b}\pm1.09$	$332^{a}\pm9.91$
Sig. Ca	N.S.	N.S.	*	N.S.	*
Sig. Ca +ZBA	*	N.S.	*	*	*
Sig. Interaction	*	N.S.	N.S.	N.S.	*

a,b,c means within a row with different superscripts are significantly different ($P< 0.05$)

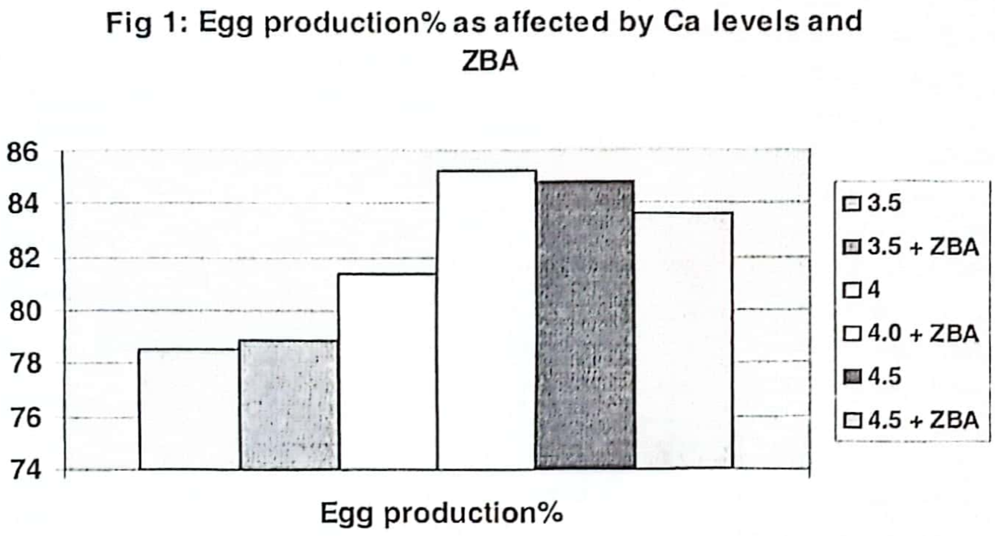
Sig. = significance   N.S. = non significance .   * = ($P< 0.05$)

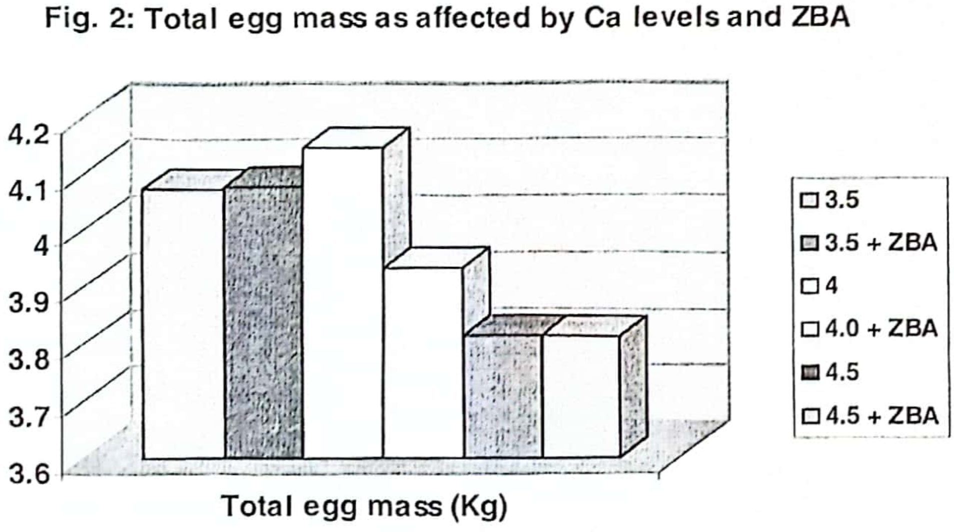
TABLE (6). Effect of Ca levels without or with ZBA supplementation on Ca, P and Zn of plasma and egg shell (Means ± SE)

Traits	Ca levels						Significance		
	3.5%	3.5% + ZBA	4%	4% + ZBA	4.5%	4.5% +ZBA	Ca	Ca+ZBA	Interaction
Minerals in blood samples									
Ca, mg/100 ml	$16.53^{b}\pm0.45$	$16.57^{b}\pm0.53$	$17.61^{a}\pm0.47$	$17.67^{a}\pm0.43$	$17.60^{a}\pm0.50$	$17.59^{a}\pm0.48$	*	N.S.	N.S.
InorganicP, mg/100 ml	5.37± 0.28	5.31± 0.27	5.03± 0.29	5.24 ± 0.28	4.87± 0.24	4.81 ± 0.23	N.S.	N.S.	N.S.
Ca: P ratio	3.08± 0.11	3.12± 0.10	3.50± 0.13	3.37 ± 0.10	3.61± 0.11	3.65 ± 0.12	N.S.	N.S.	N.S.
Zn mg/100 ml	0.60 ± 0.01	0.56 ± 0.01	0.55 ± 0.02	0.53 ± 0.01	0.51 ± 0.02	0.50 ± 0.02	N.S.	N.S.	N.S.
Minerals in egg shell									
Ca, mg/1 g	$352^{b}\pm8.31$	$359^{b}\pm9.1$	$377^{a}\pm10.13$	$384^{a}\pm12.0$	$380^{a}\pm10.1$	$381^{a}\pm11.3$	*	N.S.	N.S.
Total P, mg/1 g	1.40 ± 0.08	1.32 ± 0.06	1.21 ± 0.05	1.18 ± 0.07	1.13 ± 0.06	1.10 ± 0.07	N.S.	N.S.	N.S.
Zn μg/1 g	5.37 ± 0.28	5.31 ± 0.27	5.03 ± 0.29	5.24 ± 0.24	4.87 ± 0.23	4.81 ± 0.22	N.S.	N.S.	N.S.

a, b means within a row with different superscripts are significantly different ($P< 0.05$)

N.S. = non significance .   * = ($P< 0.05$)





It is worth to note that the increasing of dietary Ca level more than 3.5% followed by a significant ($P<0.05$) increase in shell weight%. This was obviously noticed in birds fed on 4% Ca and supplemented with ZBA. In this connection, shell weight% revealed values of 12.54, 13.40, 12.72 and 12.82% for groups fed on 4% Ca+ ZBA, 4.5% Ca and 4.5% Ca+ ZBA, respectively. On the other hand, shell weight% recorded values of 11.29 and 11.43% when birds received 3.5% Ca and 3.5% Ca+ ZBA. However, the significant ($P<0.05$) interaction between Ca levels and ZBA and the significant effect of ZBA on one hand could explain the importance of this growth promoter and its interfere with Ca level with regard to shell quality in layers.

Some of egg shell parameters as affected by the different Ca levels without or with ZBA supplementation are described in table (5). In the present study, there is an agreement that the increasing of Ca level up to 4.0% supplemented with ZBA followed by a significant ($P<0.05$) improvement in the absolute shell weight (Fig. 3), shell weight per unit surface area (SWUSA), egg shell volume and shell thickness (Fig. 4). These results agreed with the findings of Clunies *et al.* (1992), Attia (1993) and Abou Egla (1995) who cleared that the improvement in shell quality was presumable caused by the increase in the amount of Ca consumption and retained more Ca to be available for egg shell deposition, hence improve shell deformation.

It is well known that the egg shell of the laying hen is composed mostly of calcium carbonate (90-95%) with small amounts of tricalcium phosphate and magnesium carbonate (Labier and Leclercq, 1994). Therefore, the significant improvement of the shell weight, shell% and shell thickness may be logic as the increasing of dietary Ca to a certain extent may enhance the carbonate anhydrase. This enzyme is known as a main factor for shell formation (David and Roland, 1986).

Fig. 3: Egg shell wt. (gm) as affected by Ca levels and ZBA

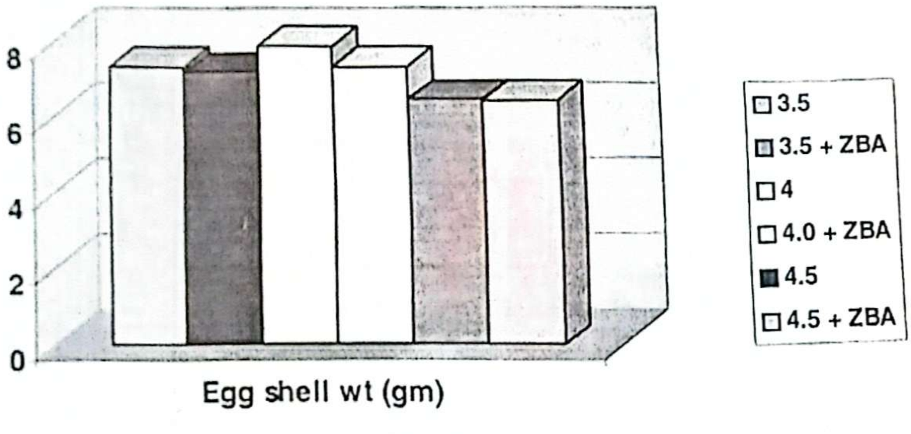
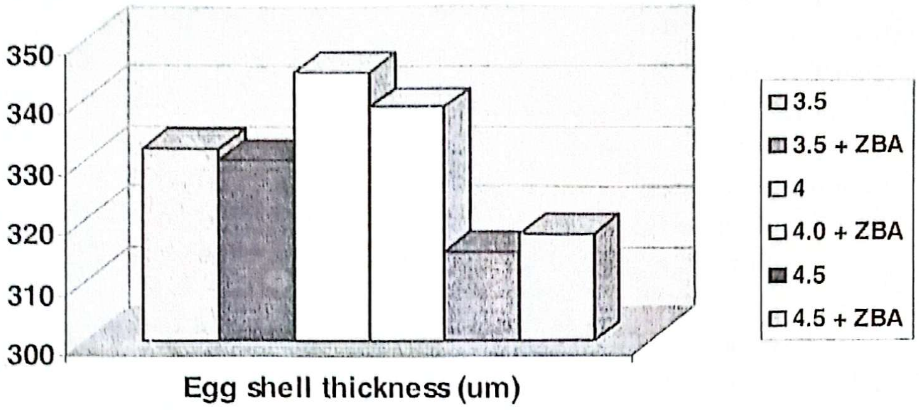


Fig. 4: Egg shell thickness (um) as affected by Ca levels and ZBA



The improved egg shell quality of heat stressed birds fed ZBA is possibly the result of respiratory alkalosis or at least a sparing effect on the buffer system involved. Furthermore, the effectiveness of ZBA in heat stress hens is clear in reducing fast heat production and heat production (Manner and Wang, 1991). ZBA appears to improve the postabsorptive metabolism in terms of egg quality and heat tolerance (Damron *et al.*, 1991). When birds are exposed to excessive temerature, hens increase respiration rate and blood concentration of CO_2 escalates. Respiratory alkalosis follows, which is rapidly counteracted by a massive renal excretions of bicarbonate, resulting in the buffering ability of the blood and as a consequence reducing egg shell synthesis (Labier and Leclercq, 1994). Hence, the increasing of dietary Ca level and adding ZBA in layer diet could ameliorate the deleterious effects of higher environmental temperature under the desert conditions.

4- Ca, P and Zn in blood plasma and egg shell

Some of mineral content (Ca, P and Zn) in blood plasma and egg shell as affected by Ca levels without or with ZBA supplementation are shown in table (6). There was an agreement that the increasing of Ca level in layer diet followed by a significant ($P<0.05$) increase in Ca level of blood plasma and egg shell as well. This was also previously confirmed by the positive improvement in some egg shell quality (shell weight and shell thickness, Table 5). However, the highest value of Ca in plasma and egg shell was encountered at 4% Ca level in of diet.

Phosphorus and Zn values in plasma and egg shell, on the other hand, insignificantly decreased at the higher level of Ca in diet. However, a major effect of high Ca concentration in poultry diets may reduce the bioavailability of other minerals. Diets high in Ca have been found to result in deficiencies of phosphorus (Shafey, 1988) and zinc (Roberson and Schaible, 1960).

5- Economical evaluations

Economical evaluation as affected by different levels of dietary Ca without or with ZBA supplementation are reported in table (7). It was noticed that the increasing of dietary Ca in hen layer diets without or with ZBA more than 3.5% showed gradually increase in relative economical efficiency. However, birds fed on 4.0% Ca supplemented with ZBA followed by those fed on 4.5% without or with ZBA, showed the best values, respectively. However, Abou Egla (1995) reported that cost of feeding decreased with increasing Ca level, resulted in higher economic efficiency for eggs.

In conclusion, this current work indicated the response of hen layers to a higher level of dietary Ca supplemented with ZBA supplementation in diet during summer months. This response was noticed in terms of an improvement in egg production performance, feed efficiency utilization and egg shell quality. Therefore, it could be recommended to feed hen layers on a diet with 4% Ca and added ZBA at a level of 100 mg/kg.

TABLE (7). Economical evaluation as affected by Ca levels without or with ZBA supplementation in hen layer diets.

Items	3.5%	3.5% + ZBA	4.0%	4.0% ZBA	4.5%	4.5% + ZBA
Total feed cost, LE.	9.89	9.87	9.76	9.92	9.78	9.78
Egg mass, Kg/hen	3.813	3.812	3.935	4.148	4.078	4.075
Price/Kg. Egg, LE	4.50	4.50	4.50	4.50	4.50	4.50
Total revenue	17.16	17.15	17.71	18.67	18.35	18.34
Net revenue	7.33	7.28	7.95	8.75	8.57	8.56
Economical efficiency	0.746	0.738	0.815	0.882	0.876	0.875
Relative economical efficiency	100	99	109	118	117	117

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تأثير مستويات مختلفة من الكالسيوم بدون أو مع إضافة الزنك باستراسين على وزن الجسم، إنتاج البيض، معدل الاستفادة من الغذاء وصفات البيض النوعية للدجاج البياض في سيناء

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أجريت هذه التجربة بمحطة بحوث رأس سدر بجنوب سيناء خلال أشهر الصيف وذلك لمعرفة تأثير استخدام مستويات مختلفة من الكالسيوم في علائق الدجاج البياض بدون أو بإضافة الزنك باستراسين وعلاقة ذلك بمعدل التغير في وزن الجسم، ، إنتاج البيض ونوعيته، الاستفادة من الغذاء وبعضا من محتوى الأملاح المعدنية في كل من البلازما وقشرة البيضة. استخدم في هذه التجربة ٩٠ دجاجة بياضة عمر ٢٤ أسبوع حيث قسمت إلى ٣ معاملات تجريبية بمعدل ٣٠ دجاجة لكل معاملة وكانت مستويات الكالسيوم في العليقة هي ٣,٥، ٤,٠ و ٤,٥%. قسمت كل معاملة تجريبية إلي مجموعتين(١٥ طائر/مجموعة) حيث حصلت المجموعة الأولى على مستوى الكالسيوم المقرر بينما حصلت المجموعة الأخرى على نفس مستوى الكالسيوم مضافا إليه الزنك باستراسين بمعدل ١٠٠ ملجم/كجم علف. أوضحت الدراسة أن زيادة مستوى الكالسيوم في العليقة مع إضافة الزنك باستراسين كان متبوعا بتحسن معنوي (عند مستوى ٥%) في وزن الجسم النهائي وأيضا معدل النمو. حققت أيضا صفات معدل إنتاج البيض وكذلك كتلة البيض الناتجة أفضل القيم عند مستوى ٤% كالسيوم مع إضافة الزنك باستراسين بينما لم يتأثر وزن البيض بأي من المعاملات التجريبية. كان هناك زيادة غير معنوية في كمية الغذاء المأكول ومعدل أفضل للتحويل الغذائي وذلك عند إضافة الزنك باستراسين إلى عليقة بها ٤% كالسيوم. كان هناك تحسنا معنويا في صفات البيض النوعية والمتمثلة في وزن القشرة ونسبتها وأيضا سمك القشرة حيث كانت أفضل نسب هذه الصفات في المجموعة التي غذيت على ٤% كالسيوم مدعوما بالزنك باستراسين. كانت أفضل قيم الكفاءة الاقتصادية للمجموعة المغذاة على ٤% كالسيوم مع الزنك باستراسين متبوعة بتلك التي حصلت على ٤,٥% كالسيوم بدون أو بإضافة الزنك باستراسين على التوالي.

مما سبق يمكن التوصية برفع معدل الكالسيوم في عليقة الدجاج البياض إلى ٤% مع إضافة الزنك باستراسين بمعدل ١٠٠ ملجم/ كجم عليقة خلال أشهر الصيف الحارة. الأمر الذي حسن من معدل استهلاك الغذاء، إنتاج البيض ونوعيته وأيضا الكفاءة الاقتصادية.