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SODIUM REQUIREMENT FOR BANDARA LOCAL LAYING HENS

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Abstract

The experiment was conducted to determine the effect of using different levels of dietary sodium chloride on productive performance and egg quality of developed local strain, Bandara.

One hundred and sixty hens (22 weeks old) divided into (5 groups x 8 replicates x 4 hens) were used in the experiment. Hens were fed on five experimental diets: a basal diet (without supplemental NaCl) and four basal diets supplemented with sodium chloride at levels of 0.15, 0.25,0.35 and 0.45%. The experiment extended for 12 weeks in 3 intervals, 4 weeks each. Egg production measurements and egg quality parameters were recorded at 4 weeks intervals. The multi- layer structure of the egg shell was studied using electron – micrography.

Main results obtained can be summarized as follows:

- Allover the experimental periods, hens fed on the basal diet (without NaCl supplementations) showed deteriorated egg production.

- The level of 0.20% Na (basal + supplemental) was sufficient level for maximum egg number, egg mass and the best feed conversion and shell quality.

- The level of 0.082% Na revealed maximum egg production and poor shell quality.

INTRODUCTION

Sodium (Na) and chloride (Cl) are essential for all animals. Dietary concentrations of salt generally used are those that will just support maximum growth or egg production, higher concentrations lead to excessive consumption of water and attendant problems with ventilation control and wet droppings (NRC, 1994).

Sodium and chloride have important metabolic effects on osmotic pressure regulation, acid base balance, nerve cells and monosaccharide and amino acid absorption. It is necessary to supply them in precise levels and adequate balance for optimum growth, bone development, egg production and good litter quality.

Because of physiological interactions of Na^+ and Cl^- with potassium (K^+), the relationship between these ions have been evaluated in poultry diets, (Hooge, 1998). He reported that the dietary electrolyte balance (DEB) is a principal factor in the acid-base balance regulation, which determines blood pH for better enzymatic efficiency, and thus, influences bird growth and performance.

Sodium chloride deficiency may occur among most all animals at some particular time, but each occurrence is likely to be under a variety of conditions (Church, 1971). Least- cost procedures for the formulation of poultry feeds often result in diets having excessive plant protein sources, essentially soyabean meal and corn, at the expense of animal protein sources, this method has heightened the risk of inadequate salt intake by poultry.

Several nutritionists (Dilworth *et al.*, 1972 a, Reid, 1977, Bertechini *et al.*, 1996, Pourreza *et al.*, 2000 and Chen and Balanve, 2001) have studied the effect of using various dietary sodium levels to determine the adequate level for layer hens to obtain optimum egg production under variety of conditions.

The present study was conducted to determine the response of the developed local strain, Bandara hens to various supplemental dietary sodium chloride levels.

MATERIALS AND METHODS

The present study was carried out at Seds research station, Animal Production Research Institute, Egypt. The study involved one experiment designed to determine the response of the developed local laying hens strain "Bandara" to different supplementary levels of sodium chloride (NaCl) in corn–soya diet.

One hundred and sixty developed local strain Bandara (White Cornish X Gimmizah) hens, 22 weeks old, were selected from the farm flocks of Bandara strain to be similar in weight, and distributed at random in 40 cages (4hens/cage). They were fed on 5 experimental treatments based on a basal corn-soya diet. Composition and chemical analysis of the basal diet (without supplemental NaCl) is presented in Table1.The experimental basal diet (T_1) was supplemented with NaCl at levels of 0.15 (T_2), 0.25 (T_3), 0.35 (T_4) and 0.45% (T_5). Layer hens were divided into 5 groups, 8 replicates / group, (4 hens/replicate). Hen's groups were given the 5 experimental diets at random and provided with feed and water *ad lib.*, for 16 hours photo periods. The experiment extended for 12 weeks in 3 intervals, 4 weeks each.

At the end of each 4 weeks interval, parameters of egg production as egg number (EN), egg weight, g. (EW), egg mass, kg. (EM), feed intake, kg. (FI) and feed conversion, kg egg / kg feed (FC) were determined. Also, egg quality parameters as shell weight%(SW), albumin weight % (AW), yolk weight% (YW) and shell thickness, mm (ST) were measured.

Table1. Composition and chemical analysis of the basal diet.

Ingredients		%
Yellow corn		71.165
Soybean meal 44%		19.00
Limestone		6.300
Bone meal		3.200
Vitamin & mineral mixture *		0.250
DL-methionine		0.053
L.Lysine		0.032
Salt (NaCl)		—
Total		100.00
Chemical analysis : **		
Crude protein	%	14.48
Metabolizable energy (Kcal/kg)		2808
Calcium	%	3.41
Available phosphorus	%	0.51
Methionine	%	0.32
Methionine + cystine	%	0.53
Lysine	%	0.76
Sodium	%	0.021
Chloride	%	0.039

* Each 2.5 kg contains: vit A,12000000 IU;Vit D3 2500000 IU; VitE, 12.5g; $Vitk_3$, 3g; B1, 1gm; B2, 5g; B6, 2g; B12,12mg; Niacin, 30g; Calcium pantothenate, 10g; Folic acid, 1.5g; Biotin, 50g; Choline, 250g; managanese, 80g; Copper, 10g; Iron, 30g; Zinc, 50g; Selenium, 150mg; Iodine, 400mg and Cobalt, 100mg.

** By calculation according to NRC, 1994.

The photomicrographs demonstrating the ultra– structure of the shell membrane were taken by electron microscope belonging to the National Research Centre, Dokki, Egypt.

Data obtained for egg production and egg quality were examined statistically using computerized analysis of variance and Duncan's multiple range test procedures within the statistical analysis system (SAS, 1996).

RESULTS AND DISCUSSION

Effect of sodium chloride supplementation on egg production

The effect of supplementing the basal diet with graded levels of sodium chloride (NaCl) on egg production is shown in Table2.

Results of the first experimental period showed that, hens fed on the basal diet consumed 108.21g feed daily/ hen which is equivalent to 25.52 mg sodium (Table 3). Hens gave 13.50, 45.38, 0.610 and 5.045 in EN,EW,EM and FC, respectively. According to variation in daily feed intake among treatments, the corresponding daily total sodium intake (dietary + supplementary) was calculated to be 92.85, 138.02, 183.06 and 228.13 mg/hen/day for the 0.15, 0.25, 0.35 and 0.45% NaCl levels of supplementation, respectively (Table 3).

Insignificant differences were found between hens fed on the basal diet and all treatments in EN, EW, EM and FC. However, differences between the basal diet and NaCl treatments in FI were significant. On the other hand, differences between treatments (T_2, T_3, T_4 and T_5) in the egg production parameters were insignificant.

Table 2. Effect of supplementing the basal diet with different levels of NaCl on egg production of local laying hens.

Item		T_1 0	T_2 0.15	T_3 0.25	T_4 0.35	T_5 0.45
First period:						
Egg number	(EN)	13.50^{a}	13.25^{a}	13.75^{a}	14.00^{a}	14.50^{a}
Egg weight	(EW)	45.38^{a}	46.33^{a}	46.48^{a}	46.75^{a}	47.20^{a}
Egg mass	(EM)	0.610^{a}	0.612^{a}	0.637^{a}	0.653^{a}	0.682^{a}
Feed intake	(FI)	3.030^{c}	3.150^{b}	3.172^{ab}	3.181^{a}	3.187^{a}
Feed conversion	(FC)	5.045^{a}	5.183^{a}	5.010^{a}	4.910^{a}	4.715^{a}
Second period:						
Egg number	(EN)	8.00^{b}	12.75^{a}	12.75^{a}	13.50^{a}	15.50^{a}
Egg weight	(EW)	42.58^{b}	48.28^{a}	48.53^{a}	49.20^{a}	49.38^{a}
Egg mass	(EM)	0.338^{c}	0.614^{b}	0.616^{b}	0.663^{ab}	0.762^{a}
Feed intake	(FI)	2.484^{c}	3.010^{b}	3.139^{a}	3.149^{a}	3.169^{a}
Feed conversion	(FC)	7.543^{a}	4.943^{b}	5.175^{b}	4.765^{b}	4.200^{b}
Third period:						
Egg number	(EN)	5.50^{c}	11.25^{b}	11.75^{b}	13.00^{ab}	15.75^{a}
Egg weight	(EW)	40.25^{b}	48.78^{a}	49.73^{a}	50.18^{a}	50.40^{a}
Egg mass	(EM)	0.220^{c}	0.547^{b}	0.581^{b}	0.650^{b}	0.792^{a}
Feed intake	(FI)	2.154^{d}	2.915^{c}	3.116^{b}	3.138^{ab}	3.156^{a}
Feed conversion	(FC)	10.085	5.443^{b}	5.455^{b}	4.868^{b}	4.000^{b}
Overall period:						
Egg number	(EN)	9.00^{c}	12.42^{b}	12.75^{b}	13.50^{ab}	15.25^{a}
Egg weight	(EW)	42.73^{b}	47.79^{a}	48.24^{a}	48.71^{a}	48.99^{a}
Egg mass	(EM)	0.389^{c}	0.591^{b}	0.611^{b}	0.655^{b}	0.745^{a}
Feed intake	(FI)	2.556^{c}	3.025^{b}	3.142^{a}	3.156^{a}	3.171^{a}
Feed conversion	(FC)	7.557^{a}	5.189^{b}	5.213^{b}	4.847^{b}	4.305^{b}

Means having different superscripts in the same row are significantly different ($P<0.05$).

Layer hens fed on the basal diet during the second period consumed 88.71g feed daily/hen, which is equivalent to 20.92 mg sodium. Hens gave 8.00, 42.58, 0.388 and 7.543 in EN, EW,EM and FC, respectively. It was noticed that, values of EN, EW, EM and FI for hens fed on the basal diet during the second period decreased by 40.74, 6.17, 44.59 and 18.02%, respectively, and that of FC deteriorated by 49.51% relative to those of the basal diet during the first period.

According to variation in daily feed intake/ hen, the corresponding daily total sodium intake (dietary + supplementary) were calculated to be 88.72, 136.58, 181.21 and 226.85 mg/hen/day for the 0.15, 0.25, 0.35 and 0.45% NaCl levels of supplementation, respectively (Table3). Differences between hens fed on the basal diet and the other treatments were significant in EN, EW, EM, FI and FC. but, the differences between T2, T3, T4 and T5 were insignificant in EN, EW and FC.

Supplementing the basal diet with 0.15% NaCL increased significantly EN, EW, EM and FI by 59.38, 13.39, 81.66 and 21.18%, respectively, and improved FC by 34.47% relative to the basal diet. Adding 0.25% NaCl to the basal diet caused an increase in En, EW, EM, and FI by 59.38, 13.97, 82.25 and 26.37%, respectively, and improved FC by 31.39%. Further increase in NaCl from 0.25 to 0.35% increased EN, EW, EM and FI by 68.75, 15.55, 96.15 and 26.77%, respectively, and improved FC by 36.83%. Values of EN, EW, EM and FI increased by 93.75, 15.97, 125.44 and 27.58%, respectively, and that of FC improved by 44.32% relative to those of the basal diet when 0.45% NaCl was added.

Table 3. Daily dietary sodium intake/hen during the three experimental periods.

Item	T_1 0	T_2 0.15	T_3 0.25	T_4 0.35	T_5 0.45
First period:					
g.feed/hen/day	108.21	112.5	113.29	113.61	113.82
mg. NaCl/hen/day	64.93	236.25	351.2	465.8	580.48
mg.Na/hen/day	25.52	92.85	138.02	183.06	228.13
Second period					
g.feed/hen/day	88.71	107.5	112.11	112.46	113.18
mg. NaCl/hen/day	53.23	225.75	347.54	461.09	577.22
mg. Na/hen/day	20.92	88.72	136.58	181.21	226.85
Third period:					
g.feed/hen/day	76.93	104.11	111.29	112.07	112.71
mg. NaCl /hen/day	46.16	218.63	344.99	459.49	574.82
mg.Na/hen/day	18.14	85.92	135.58	180.58	225.9
Overall period:					
g.feed/hen/day	91.29	108.04	112.21	112.71	113.25
mg. NaCl /hen/day	54.77	226.88	347.85	462.11	577.58
mg.Na/hen/day	21.52	89.16	136.71	181.61	226.99

Results of egg production during the second period showed that there were no significant differences between T_2, T_3, T_4 and T_5 in EN, EW and FC, also, for FI except T2 which showed significant decrease. The values of EM showed insignificant differences between T_2, T_3 and T_4, also, no significant difference between T_4 and T_5. The fifth treatment showed significantly higher EM as compared to T_2 and T_3.

Concerning the third period, results showed that, hens fed on the basal diet consumed 76.93 g feed daily/hen which is equivalent to 18.14 mg Na. Layer hens fed on the basal diet gave values of 5.50, 40.25,0.220 and 10.085 in EN, EW,EM and FC, respectively. There were significant differences between hens fed on the basal diet and all treatments in EN, EW, EM, FI and FC. Results showed more decrease in EN, EW, EM and FI of hens fed on the basal diet during the third period by 59.26, 11.30, 63.93 and 28.91%, respectively, and FC was worst by 99.9% as compared to the basal diet of the first period.

According to variation in daily feed intake / hen, the corresponding daily total sodium intake (dietary + supplementary) were calculated to be 85.92, 135.58, 180.58 and 225.90 mg/hen/day for the 0.15, 0.25, 0.35 and 0.45% NaCl levels of supplementation, respectively (Table 3). There were no significant differences between T2, T3, T4 and T5 in EW and FC. Also, insignificant differences were found between T2, T3 and T4 in EN and EM. Supplementing the basal diet with 0.15% NaCl caused an increase in EN, EW, EM and FI by 104.55, 21.19, 148.64 and 35.33%, respectively, and improved FC by 46.03% as compared to the basal diet. Adding of 0.25% NaCl to the basal diet caused 113.64, 23.55, 164.09 and 44.66% increase in EN,EW, EM and FI, respectively, and improved FC by 45.91% as compared to those of the basal diet. Supplementing the basal diet with 0.35% NaCl increased significantly EN, EW, EM and FI by 136.36, 24.67, 195.45 and 45.68%, respectively, and improved FC by 51.73% relative to basal diet. Also, supplying the basal diet with 0.45% NaCl increased EN, EW, EM and FI by 186.36, 25.22, 260.0 and 45.52%, respectively, and improved FC by 60.34% as compared to the basal diet.

The overall egg production results showed that hens fed on the basal diet consumed 91.29g feed daily/hen which is equivalent to 21.52mg Na. Hens gave 9.00, 42.73, 0.389 and 7.557 in EN, EW, EM and FC, respectively. According to variation in daily feed intake/ hen, the corresponding daily total sodium intake (dietary + supplementary) were calculated to be 89.16, 136.71, 181.61 and 226.99 mg/ hen/day for the 0.15, 0.25, 0.35 and 0.45% NaCl levels of supplementation, respectively (Table 3). Differences between the basal diet and the four supplemental levels of NaCl in EN, EW, EM, FI and FC were found to be significant.

Supplementing the basal diet with 0.15% NaCl caused an increase by 38.00, 11.84, 51.93 and 18.35% in EN, EW, EM and FI, respectively, and improved FC by

31.34% relative to the basal diet. Adding of 0.25% NaCl to the basal diet increased EN, EW, EM and FI by 41.67, 12.89, 57.07 and 22.93%, respectively, and improved FC by 31.02% as compared with the basal diet. Also, supplementing the basal diet with 0.35% NaCl caused 50.0, 13.99, 68.38 and 23.47% increase in EN, EW, EM and FI, respectively, and improved FC by 35.86%relative to the basal diet. Supplying the basal diet with 0.45% NaCl increased EN, EW, EM and FI by 69.44, 14.65, 19.52 and 24.06%, respectively, and improved FC by 43.03% relative to those of the basal diet.

Effect of sodium chloride supplementation on egg quality

The effect of sodium chloride (NaCl) supplementation on the egg quality parameters is shown in Table 4. Results of the first period showed that, layer hens fed on the basal diet gave values of 13.23, 54.64, 32.13 and 0.373 for SW, AW, YW and ST, respectively.

Insignificant differences were found between the basal diet (T_1) and T_2, T_3 and T_4 in SW, AW, YW and ST, Hens fed on the diet supplemented with 0.45% NaCl (T5) showed 13.40 and 9.30% significant increase in ST and 5.55% and 3.19% decrease in AW as compared to the basal diet and T2, respectively.

Results of the second period showed that, hens fed on the basal diet gave values of 12.52, 53.37, 34.11 and 0.342 for SW, AW, YW and ST, respectively. Insignificant differences were found between the basal diet (T_1), T_2, T_3 and T_4 in SW, AW and YW. Concerning ST, there were significant differences between the basal diet and T_3, T_4 and T_5. On the other hand ,T_5 showed a significant increase in ST as compared to other treatments.

Concerning the third period, results of the hens fed on the basal diet gave values of 11.81, 52.11, 36.09 and 0.310 in SW, AW, YW and ST, respectively. It can be noticed that ,the values of SW, and ST decreased by 10.73 and 16.89%, respectively, as compared to those of the first period. There were no significant differences between the basal diet and all treatments in AW and YW. Differences between the basal diet and T_2, T_3 and T_4 in SW were insignificant. There were insignificant differences between the basal diet and (T_2 andT_3) in ST. Hens fed on diet supplemented with 0.45% NaCl showed a significant increase by 9.48% in SW. Also, a significant increase was noticed for T4 and T5 by 9.68 and 16.13% in ST, respectively.

Table 4. Effect of supplementing the basal diet with different levels of NaCl on egg quality.

Item		T_1 0	T_2 0.15	T_3 0.25	T_4 0.35	T_5 0.45
First period:						
Shell weight %	(SW)	13.23^{ab}	13.24^{ab}	13.83^{ab}	12.26^{b}	12.17^{a}
Albumen weight %	(AW)	54.64^{ab}	53.31^{ab}	53.82^{ab}	56.09^{a}	51.61^{b}
Yolk weight %	(YW)	32.13^{a}	33.45^{a}	32.34^{a}	31.65^{a}	33.22^{a}
Shell thickness(mm.)	(ST)	0.373^{b}	0.387^{b}	0.397^{ab}	0.400^{ab}	0.423^{a}
Second period						
Shell weight %	(SW)	12.52^{b}	12.67^{b}	12.63^{b}	12.20^{b}	14.05^{a}
Albumen weight %	(AW)	53.37^{a}	52.66^{ab}	53.63^{a}	53.68^{a}	51.29^{b}
Yolk weight %	(YW)	34.11^{a}	34.67^{a}	33.74^{a}	34.12^{a}	34.66^{a}
Shell thickness(mm.)	(ST)	0.342^{c}	0.353^{bc}	0.363^{b}	0.370^{b}	0.392^{a}
Third period:						
Shell weight %	(SW)	11.81^{b}	12.09^{ab}	11.42^{b}	12.15^{ab}	12.93^{a}
Albumen weight %	(AW)	52.11^{a}	52.01^{a}	53.44^{a}	51.27^{a}	50.96^{a}
Yolk weight %	(YW)	36.09^{a}	35.90^{a}	35.14^{a}	36.58^{a}	36.11^{a}
Shell thickness(mm.)	(ST)	0.310^{c}	0.320^{bc}	0.330^{bc}	0.340^{ab}	0.360^{a}

Means having different superscripts in the same row are significantly different ($P<0.05$).

The effect of sodium chloride supplementation on the multistructure of the egg shell

Improvement of egg shell thickness was obviously found in the three periods of egg production as a result of the supplementing the basal diet with 0.45% NaCl. From the photomicrographs of the egg shell layers by the electron microscope, it was found that there was a positive effect on the thickness and density of each discriminated layer (cuticle, palaside, mammalian and shell membrane) at this level of supplementation.

Comparing the photomicrographs of (T_5) for the first period (Figure 2) and third period (Figure 4) with those of the basal diet for first period (Figure 1) and third period (Figure 3) they showed more dense, thicker and layers of (T_5). These findings could indicate that such type of supplementation may be an indication of greater strength of egg shell (Simons, 1971). In this respect, Vantoledo (1982) observed that, mammillary knob density was lower, and diameter was greater in eggs from high breaking strength lines of layers.

Allover the experimental periods, the results showed that the developed local strain, Bandara, fed on the corn-soya basal diet (without NaCl supplementation) showed deteriorated egg production and egg quality, especially, that of the shell thickness as compared to those supplemented treatments. Electron micrography for the multilayer structure of the egg shell confirmed these results (Figures 1and 3). This obviously indicated that the basal diet was extremely deficient in sodium (Na=0.021%).

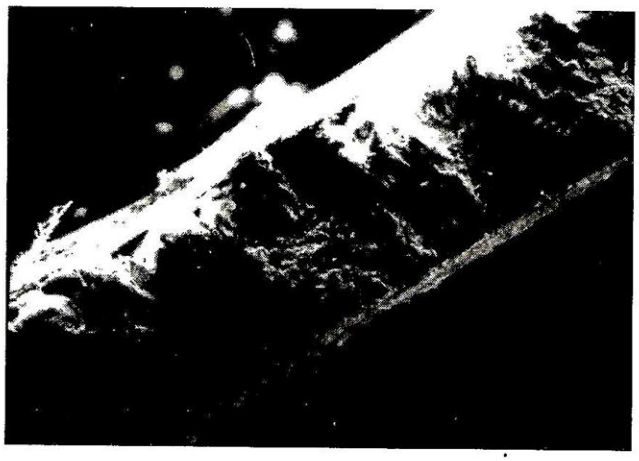

Figure 1. Egg shell photomicrograph of the basal diet for the first period

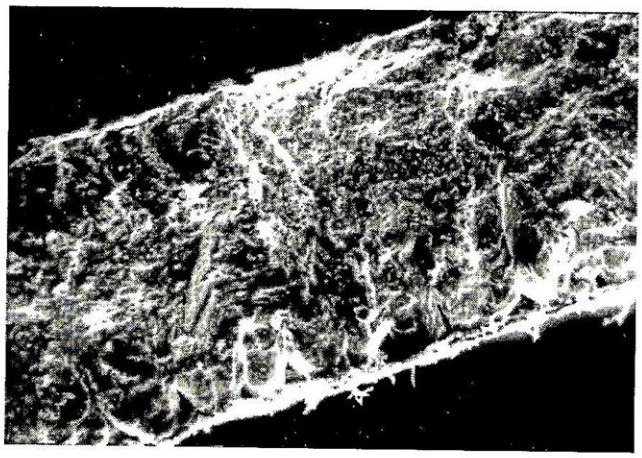

Figure 2. Egg shell photomicrograph of the basal diet plus 0.45 % Na Cl for the first period.

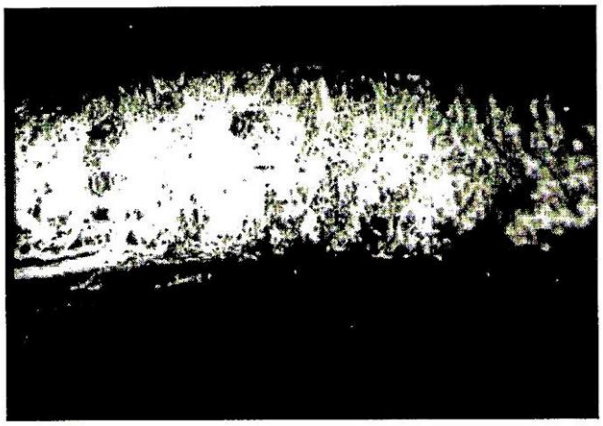

Figure 3. Egg shell photomicrograph of the basal diet for the third period

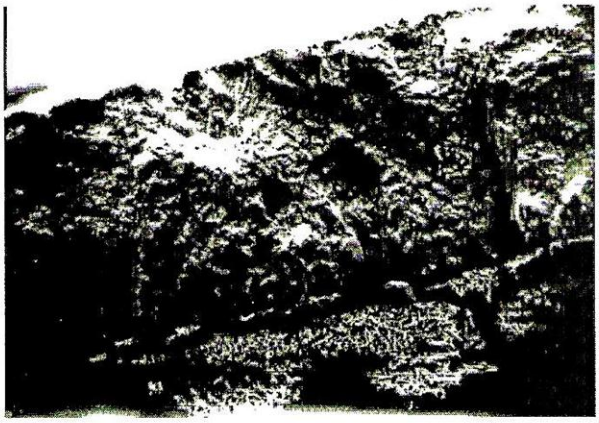

Figure 4. Egg shell photomicrograph of the basal diet plus 0.45 % NaCl for the third period

Results of feeding hens, the basal diet along the three subsequent experimental periods showed a numerical decrease in feed and Na daily intake from interval to interval and is accompanied by a similar decrease in egg production and shell quality. This finding may be due to that the basal diet was more deficient in Na in the latter interval than the former as compared to requirement.

Harms *et al.* (1995) reported that egg production was significantly reduced during week 4 when the hens had an intake of 35 mg Na/day. Also, They reported that egg production was reduced by week 7 when the diet was furnished by65 mg Na/hen/day.

The first period did not show any effect of supplemental level on egg production. The egg production trend in the second, third and the overall periods agreed with each other. The three subsequent intervals agreed with each other in the term of egg thickness. The 0.20% total dietary Na increased the value nearly 0.05 mm as compared to the basal diet. Assessing Na dietary level sufficient for maximum egg production values showed that it is 0.20%. In the term of FC the level was found to be 0.082% Na. Therefore, Na required could be from 0.082 to 0.20%depending on egg production parameters.

On the other hand, comparing 0.082% with 0.20% in the term of egg traits parameters, it was found that 0.20% Na gave the best shell thickness, 0.423 mm in the first interval, 0.392 mm in the second interval and 0.360 mm in the third interval.

Dorman *et al.* (1983) found that egg weights from hens receiving 0.36% NaCl were significantly heavier than those of birds consuming 0.12 and 0.24% NaCl, these findings were in agreement with the present results.

In conclusion, it was found that, level equivalent to 0.20% Na was a sufficient level which can maintain the EM, FC and shell thickness.

The level of 0.20% dietary Na was higher than that reported by Njoku and Sullivan (1978) and Dorman *et al.* (1983) (0.12% Na) and NRC (1994) (0.15% Na). In contrast, the level sufficient for maximum egg production without considering high quality shell thickness (0.082% Na) was found to be lower than that reported previously. Therefore, the low level of dietary Na could be suggested for producing hatchery eggs and the high level for table eggs production. Disagreement between results may be due to strain difference and purpose of egg production (Njoku and Sullivan, 1978). Also, it can be due to differences in feed intake as reported by Sloan and Harms, 1992 for commercial layers.

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الاحتياجات من الصوديوم للدجاج البياض المحلى من سلالة البندرة

مصطفى يوسف عطية

معهد بحوث الانتاج الحيوانى- مركز البحوث الزراعية - وزارة الزراعة- الدقى - الجيزة - مصر

تهدف الدراسة الى تقدير تأثير استخدام مستويات مختلفة من كلوريد الصوديوم فى علائق الدجاج البياض المحلى من سلالة البندرة على الأداء الانتاجى وجودة البيض.

تم استخدام ١٦٠ دجاجة بياضة من سلالة البندرة (عمر ٢٢ أسبوعا) ، تم تقسيمها الى ٥مجاميع (معاملات) ، كل مجموعة تتكون من ٨ مكررات (بكل مكرر ٤ دجاجات). وقد غذى الدجاج على ٥ علائق تجريبية: العليقة الأساسية (بدون إضافة كلوريد صوديوم) و٤علائق أضيف فيها الى العليقة الأساسية ٤ مستويات من كلوريد الصوديوم هى ٠,١٥ ، ٠,٢٥ ، ٠,٣٥ ، ٠,٤٥ ٪ استمرت التجربة لمدة ١٢ أسبوعا مقسمة الى ٣ فترات كل منها ٤ أسابيع. تم فى نهاية كل ٤ أسابيع أخذ قياسات انتاج البيض و صفات جودة البيض. كما تم دراسة التركيب المتعدد لقشرة البيض باستخدام الميكروسكوب الالكترونى.

أوضحت النتائج ما يلى

- حدث انخفاض معنوى لانتاج البيض للدجاج المغذى على العليقة الأساسية خلال الثلاث فترات التجريبية.
- أوضحت النتائج أن مستوى ٠,٢ ٪ صوديوم بالعليقة كاف لتحقيق أعلى انتاج للبيض وكتلة البيض و أحسن معدل تحويل غذائى و جودة قشرة البيض .
- وجد أن مستوى ٠,٠,٨٢ ٪ صوديوم بالعليقة كاف لتحقيق أعلى انتاج بيض بدون تحقيق أعلى جودة لقشرة البيض.