Effect of Saline Drinking Water on Egg Shell Quality of Leghorn and Native Hens

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ABSTRACT

This experiment was carried out to study the effect of sodium chloride from drinking water and feed intake on the quality of egs from laying hens. Four hundred and twenty native and white leghorn laying hens ranging from 36 to 43 weeks of age were used. Seven experimental treatments containing different levels of salt supplied by feed and/or drinking water were compared. Increasing salt intake by the addition of NaCI to drinking water or feed intake reduced shell thickness, shell ash and increased, the number of damaged eggs. Shell calcium was not affected hy added salt, however, the addition of salt to the food reduced shell-breaking strength. Breed differences influenced the traits studied, except for shell percentage and shell calcium. Sodium chloride intake from drinking water was more effective in reducing shell quality than salt from food.

Keywords: Leghorn , Saline drinking water , Feed intake.

INTRODUCTION

The reduction in egg shell quality brought about by adding sodium chloride (NaCI) to the drinking water of laying hens has already been reported [3,4,12,13]. Concentrations of NaCI, ranging from 200 to 2000 mg/1, increased the incidence of egg shell defects when the intake of NaCI from drinking water was low compared with intake from the diet [13,14]. Short term use of saline drinking water, reduced egg shell quality at latter ages. The negative effect of saline drinking water on egg shell quality persisted even after the removal of saline drinking water [2].

Egg producers in many provinces use underground water as a source of drinking water for both fertile and egg producing flocks. These water resources may contain high concentrations of dissolved salts of which NaCI is a major constituent. This experiment was conducted to determine the effect of the source of NaCI on the incidence of egg shell defects and to evaluated whether any increase in sensitivity to the NaCI content of drinking water could be offset by altering the NaCI content of the diet. In addition, the effect of NaCI intake on different breeds was also evaluated.

MATERIALS AND METHODS

Four hundred and twenty laying hens (native and white Leghorn) ranging from 36 to 43 weeks of age were randomly divided into 42 groups of 10 hens each (210 hens from each breed). The hens from each breed were randomly selected from a flock of 1000

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hens before the commencement of the experiment. The egg production rate of each experimental group was nearly indentical. Before the experiment, all hens were maintained on a practical laying hen diet, containing 2900 kcal/kg ME, 16% protein, 0.2% salt and 3.5% calcium [11]. Analysis of the drinking water [1] showed that it contained 12 mg Na and 17 mg Cl per liter, respectively. The purity of NaCl used was about 95% .

During the eight weeks of the experiment, hens were given free access to food and water. The photopcriod was 14 h light/d. A basal diet was made (Table 1). In order to

Table 1. Composition of basal diet[a]

Ingredients (%)		
Yellow corn		60.75
Barley		10.00
Soybean meal (44%)		17.00
Fish meal (65%)		3.00
Oystershell		7.50
Dical-phosphate		1.20
Vit & min. supple.		0.50
DL-methionine		0.05
Total		100

Calculated analysis		
ME kcal/kg		28.75
Protein	*%*	15.8
Calcium	*%*	3.4
Avail. P	*%*	0.44
Lysine	%	0.76
Methionine	**%**	0.35
Cl	%	0.065
Na	**%**	0.047

[a] Adopted from Scott *et al.* [11]

obtain the seven experimental diets, various amounts of NaCl were added to either the basal diet (1 or 2 g NaCl/kg of diet) or the drinking water (0.5, 1 or 2 g NaCl/kg of water; Table 2). Each group of hens was

treated as a replicate. Food intake, egg production, number of damaged shells and shell quality measurements were recorded for each group. Eggs were collected and inspected manually for cracked, broken, deformed and soft-shelled eggs. Egg weight of three days

Table 2. Experimental treatments

Diet No.	Added NaCl	
	Feed mg/kg	Water mg/1
1	2000	0
2	1000	500
3	2000	500
4	0	1000
5	2000	1000
6	0	2000
7	2000	2000

accumulation of normal eggs for each group was determined per week. Water intake was determined twice a week.

Four weeks before the termination of the experiment, the collected eggs were transferred **to** the laboratory for shell quality determination. Shell thickness and shell percentage (as egg weight) were determined as described by pourreza *et al.* [9]. Shell ash precentage and calcium were measured using the method of AOAC [1|. An Instron testing instrument Model 1011 (Instron Corporation, Canton, MA 02021) was used to determine egg-breaking strength. Each individual egg was placed on its side on a flat surface and force was applied by a fleet cylindrical probe (base diameter of 3 cm) attached to a 5-50 kg load cell. The crosshead speed was 200 mm/min and egg-breaking strength was recorded in kilograms through a detector (5).

Analysis of Data

The least-squares method as outlined by Harvey [7| was used to analyze the data. For the percentage of shell, shell thickness, calcium content of the shell, percentage of shell ash,

egg-breaking strength and percentage of broken eggs, the constants were fitted for breed, treatment and the interaction between breed and treatment.

Pair-wise tests of significance for difference belween means were completed using Duncan's multiple range test [6| as modified by Kramer [8|. Standard errors of different means were calculated by the appropriate inverse elements of the varianee-covarianee matrix.

In order to estimate the adjusted regression coefficients of recorded traits on different levels and sources of salt intake, the regression of different measurements on a variety of levels and sources of salt intake was added to the analysis model referred to above.

Gross correlation coefficients were calculated without making any adjustment to the data. Also, the percentage of variation accounted for by regression was estimated by dividing the sum of squares accounted for regression coefficient by the total sum of squares.

RESULTS

Analysis of variance and least-squares means and standard errors for the considered traits arc shown in Tables 3 and 4. The incidence of damaged eggs was significantly (P<0.01) affected by breed and treatment.

Increasing the concentration of NaCI in the drinking water (diet 6) increased the percentage of damaged eggs. Shell thickness, shell ash and shell-breaking strength were also significantly (P<0.01) affected by breed and treatment. Interactions between breeds and treatments were significant (P<0.01) and followed the same manner for shell ash, shell-breaking strength and damaged eggs.

Shell calcium was not affected by breed or treatment (Table 4). Shell thickness and shell ash were decreased as the NaCI content of the water was increased. Increasing NaCI intake either from food or water decreased shell-breaking strength. This reduction was more pronounced with drinking water than food (Table 4). It is of interest to note that, as the concentration of NaCI in the water increases, egg shell quality decreases as well (Table 4).

The relationship between the different sources of added salt with the considered traits is shown in Tabcl 5. The correlation coefficients between NaCI from water and food with shell thickness, shell calcium, shell ash and damaged eggs were significant. Only the correlation coefficient between shell-breaking strength and dietary salt was significant (P<0.01). The coefficient for R square and V arc presented in Table 3. The

Table 3. Analysis of variance for the considered (raits (mean squares)

Source of variation	d.f.	Shell thickness mm %	Shell calcium %	Shell ash %	Breaking strength kg	Broken eggs %
Breed (B)	**1**	0.173	0.0096*'	1.20	1194.6**	16268**	22.73**
Treatment (T)	**6**	0.114	0.0020	5.295	19.6**	11779**	0.88**
B*T	**6**	0.143	'	2.92	20.2**	3770*	0.88**
Random	28	0.84	0.0006	3.79	1.7	1362	0.11
error		0.42	0.0009	0.32	0.97	0.74	0.91
CV		3.04	0.49 7.91	5.87	2.28	4.63	45.00

Significant at P<0.05.
Significant at P<0.0I.

Table 4. I.east-squares means and standard errors by breed and treatment and test of significance
for difference between means

Main factors	Subclass	Salt intake			N a of obs.	Shell %	Shell thickness mm	Shell calcium %	Shell ash %	Breaking strength g	Broken eggs %
		H₂O	Food	Total							
Overall mean		254	198	357	42[a]	9.53	0.388	33.2	56.6	797	0.736
Breed	Local	213	167	303	21	*9A7[b]a*	0.403a	33.4 a	61.9 a	777 a	0.000 a
	Exotic	292	226	411	21	9.60 a	0.372 b	33.0 a	51.2 b	816 b	1.471b
	1	0	211	211	6	9.53 ab	0.413 c	34.5 a	59.2 e	757 ab	0.563 a
	2	107	115	222	6	9.78 b	0.402 be	34.0 a	57.2 cd	834 cd	0.585 a
	3	118	212	310	6	9.45 ab	0.387 abc	33.0 a	58.3 de	798 be	0.582 a
Treatment	4	208	0	208	6	9.57 ab	0.397 abc	34.0 a	56.1 be	811 c	0.552 a
	5	213	222	435	6	9.57 ab	0.387 abc	32.2 a	54.7 ab	762 ab	0.657 a
	6	442	0	442	6	9.48 ab	0.367 ab	32.5 a	56.4 c	867 d	1.162b
	7	444	227	671	6	9.33 a	0.361 a	32.3 a	54.2 a	747 a	1.350 b
SE						0.12	0.012	0.80	0.53	15.1	0.14

Each observation is a mean of ten measurements. All means within a particular sub-class differ significantly
(P<0.05) except for those followed by the same letter.

Table 5. Relationship between different sources of added salt with considered traits"

Independent variable	Shell %	Shell thickness mm	Shell calcium %	Shell ash %	Breaking strength B	Broken eggs *%*
Added salt through the water						
r	-0.183	-0.542	-0.354	-0.360	0.151	0.487
b[b]	-0.378+0.31	-0.096+0.03**	-4.04±1.9**	-8.818+2.1**	60.52±55.8	1.54+43**
v%	3.54	18.1	10.7	5.3	2.5	5.6
Added salt through the feed						
r	-0.037	-0.085	-0.042	-0.187**	-0.446	0.223
b[b]	-0.350+0.53	-0.003+0.06	-0.925±3.3	0.212+4.5	-368 ±76	0.415 ±0.98
v%	1.09	0.006	0.2	0.001	33.37	0.17
Added salt through the water and feed						
r	-0.199	-0.573	-0.367	-0.457	-0.118	0.599
b[b]	-0.500±0.30	-0.097±0.03**	-4.321+1.8*	-8.394 ± 2.1**	-73.70±55.0	1.74+0.38**
v%	6.36	18.7	12.3	4.92	3.8	8.6

r = Gross correlation coefficients; b= Adjusted regression coefficient; v%= Percent of variation accounted for by
regression.

= The adjusted regression coefficients and standard errors should multiply by 1000. *
Significant at P<0.05. ** Significant at P<0.01.

highest R square was related to shell ash (0.97) and the lowest to shell calcium (0.32), which indicated that sources of variation other than those considered were effective on the calcium content of the shell.

DISCUSSION

The results obtained in this experiment indicate that increasing the amount of NaCl in the drinking water of laying hens reduces shell quality. Shell thickness decreased as NaCl intake increased. This reduction was more pronounced with drinking water than with food (Table 4). These findings confirm those obtained by others [11,14]. Reducing or eliminating dietary NaCl did not improve shell thickness which is in agreement with the finding of Yoselewitz and Balnave [14]. Although the total NaCl intake from diets 1, 2 and 4 were numerically similar, the shell thickness decreased severely when NaCl from drinking water was compared with that from the diets (Table 4). This finding shows that decreased shell thickness was not completely associated with decreased intakes of calcium or with increased egg output, because the feed intake and egg production were nearly similar in these treatments [10],

The correlation coefficients between shell-breaking strength and NaCl intake from the diet were significant; they showed that increasing NaCl intake from the diet decreases shell strength. Although these findings confirm those found by others [12, 13,15|, the difference in the means of intake (from food or water) is not in agreement with the findings of Yoselewitz and Balnave [13], they found that an increase in NaCl intake from drinking water rather than food decreased shell-breaking strength.

As NaCl intake increased, the percentage of the shell ash decreased. When shell calcium is compared with shell ash, it could be assumed that increasing NaCl intake may not only have a direct effect on the calcium content of the shell, but may also affect all components of shell structure.

Greater shell thickness and higher shell ash, as well as a lower number of damaged eggs found in native hens, may be related to lower egg weight and lower egg production as compared to the Leghorn breed in which the last two factors are relatively higher. In spite of greater shell thickness and higher shell ash associated with native hens as mentioned above, it is of interest to note that shell-breaking strength was lower in these breeds than in Leghorns. This could be related to the better shell structure of eggs from the Leghorn breed.

In conclusion, the results obtained under the conditions of this experiment show that there are breed differences in the measured criteria. These differences could be attributed to either afforded degree of sensitivity to NaCl intake or due to a genetic based factor, increasing NaCl intake reduced egg shell quality as measured by different parameters and reducing or eliminating the means of NaCl intake (by food) did not improve egg shell quality. Water analysis as well as breed identification are essential before the establishment of any laying or breeding flocks.

ACKNOWLEDGMENTS

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اثر آب آشامیدنی نمک‌دار بر کیفیت تخم‌مرغ
در مرغهای بومی ولگهورن

چکیده

این آزمایش به منظور مطالعه اثر نمک طعام از طریق آب و غذا بر کیفیت تخم‌مرغ در مرغهای تخمگذار انجام گرفت. چهارصدو بیست قطعه مرغ تخمگذار بومی و ولگهورن سفید از سن ۳۶ تا ۴۳ هفتگی مورد استفاده قرار گرفتند. هفت تیمار آزمایشی که حاوی مقادیر مختلف نمک از طریق آب و غذا بودند مقایسه گردیدند. افزایش مصرف نمک از طریق آب و غذا، ضخامت پوست و خاکستر پوسته را کاهش داد و تعداد تخم‌مرغهای شکسته افزایش یافت. کلسیم پوسته بوسیله نمک اضافه شده تحت تأثیر واقع نشد. ولی افزودن نمک به غذا مقاومت پوسته را کاهش داد. برای تمام صفات مورد مطالعه غیر از درصد پوسته و کلسیم پوسته اختلاف نژادی مشاهده گردید. اثر مصرف نمک از طریق آب در کاهش کیفیت پوسته بیشتر بود.