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Maintenance of egg shell quality in hens drinking saline water

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by D. Balnave

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Researcher Contact Details
Associate Professor D. Balnave
Department of Animal Science
University of Sydney
Werombi Road
Camden NSW 2570

02 9351 1677
02 9351 1693
derickb@camden.usyd.edu.au

RIRDC Contact Details
Rural Industries Research and Development Corporation
Level 1, AMA House
42 Macquarie Street
BARTON ACT 2600
PO Box 4776
KINGSTON ACT 2604

Phone: 02 6272 4539
Fax: 02 6272 5877
Email: rirdc@rirdc.gov.au.
Website: http://www.rirdc.gov.au

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Foreword

Recent research in Australia using local strains of laying hens, as well as work conducted overseas, has shown that saline drinking water containing sodium chloride at concentrations similar to that in underground bore water has an adverse effect on egg shell quality while having little effect on food intake, egg production and egg weight. However, a few overseas studies have failed to observe effects on egg shell quality.

This publication reports a study to determine whether the new coloured overseas strains, as represented by the IsaBrown layer, are similarly, or less, sensitive than the older genotypes to saline drinking water.

In addition, the use of two prevention procedures, identified in earlier Australian studies, were examined. These involved the use of dietary supplements of ascorbic acid or zinc methionine.

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Peter Core
Managing Director
Rural Industries Research and Development Corporation

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Executive Summary

IsaBrown pullets were purchased from a commercial supplier at 16 weeks of age and kept at either a constant 18°C or a constant 30°C in temperature-controlled rooms. Four treatments were investigated. These were (i) a conventionally formulated 16% protein layer diet C with town drinking water, (ii) diet C with town drinking water containing 2 g sodium chloride (NaCl)/litre, (iii) diet C containing 200 mg ascorbic acid/kg with town drinking water containing 2 g NaCl/litre and (iv) diet C with 360 mg Zinpro 100 (zinc methionine)/kg with town drinking water containing 2 g NaCl/litre. The pullets received a continuous daily photoperiod of 16 hours from fluorescent lighting and production measures were made between 20 and 60 weeks of age.

Production and egg shell quality were significantly reduced at 30°C compared to 18°C but were not significantly affected by the dietary/water treatments. The results indicated that the IsaBrown hens were relatively insensitive to intakes of NaCl from the drinking water at concentrations of 2 g/litre. This lack of sensitivity contrasts with the majority of published reports including earlier work with local Australian layer strains.

Introduction

Studies conducted in Australia during the decade from 1985 showed that saline drinking water, including tap water containing sodium chloride (NaCl), supplied to mature laying hens at concentrations similar to those found in underground bore water, has an adverse effect on egg shell quality while having little effect on feed intake, egg production or egg weight (see Balnave, 1993). Similar effects of saline drinking water on egg shell quality were reported by Yoselewitz (1992) and Yoselewitz *et al*. (1993) in Israel, Pourreza *et al*. (1994, 2000) in Iran and Khalafalla and Bessei (1997) in Germany. However, studies in the USA by Maurice (1989) and by Damron (1998) failed to observe any adverse effects of saline drinking water on egg shell quality. The biochemical and physiological basis for this adverse response in egg shell quality was reported by Balnave and Yoselewitz (1989), Balnave *et al*. (1989), Roberts and Balnave (1992) and Brackpool *et al*. (1996).

Two preventive treatments were identified in the Australian studies (Balnave, 1993). These were the use of ascorbic acid supplements in the diet or drinking water and zinc methionine supplements in the diet. Although Khalafalla and Bessei (1997) confirmed the adverse egg shell quality responses to saline drinking water, they were unable to show any significantly beneficial effect of ascorbic acid. They related this difference in response to differences in the ambient temperature between their study (18-22°C) and the higher temperatures in the Australian studies (30, 20-35 and 18-30°C).

During the past decade egg producers in Australia have discarded established layer strains in favour of new coloured overseas genotypes. This may have influenced the sensitivity of current commercial layer flocks to saline drinking water.

Objectives

The present one year project was carried out to examine the sensitivity of one of the recently introduced overseas layer genotypes to saline drinking water and to evaluate the benefits, if any, of ascorbic acid and zinc methionine supplements for hens maintained at a constant 18°C and a constant 30°C.

Methodology

Beak-trimmed IsaBrown pullets were purchased from a commercial supplier at 16 weeks of age and placed in double bird cages in four temperature controlled rooms. Two rooms were kept at a constant 18°C and two at a constant 30°C. Each room contained 48 cages. Three adjacent cages comprised a replicate and in each room four replicates were randomly allocated to each of four treatments. The treatments consisted of (i) a conventionally formulated 16% protein layer diet and town drinking water, (ii) the conventionally formulated diet and town drinking water containing 2 g NaCl/litre, (iii) the conventionally formulated diet containing 200 mg ascorbic acid/kg and town drinking water containing 2g NaCl/litre, and (iv) the conventionally formulated diet with 360 mg Zinpro 100/kg (providing 36 mg zinc and 72 mg methionine/kg) and town drinking water containing 2 g NaCl/litre. The birds received a continuous daily photoperiod of 16 h from fluorescent lighting.

Production measures were made between 20 and 60 weeks of age. Egg numbers were recorded daily and summated each week. Feed intake per bird was determined every four weeks and all eggs laid on one day every four weeks were weighed. The mean egg production, feed intake and egg weight were calculated from the arithmetic mean of the respective measurement periods. All eggs laid at 40 and 60 weeks of age were used for the determination of egg shell breaking strength, shell thickness and percentage shell weight. Shell breaking strength was determined using the method described by Balnave *et al.*, 1992.

The data were analysed as a 2 x 4 factorial ANOVA with temperature and the dietary/drinking water treatments as main effects (Steel and Torrie, 1982).

Results

The results of this study failed to show significant adverse effects of saline drinking water on production. Significant (P<0.001) reductions in production were observed at 30°C compared to 18°C but these were consistent across all four treatments. The lack of any differences in production between hens receiving town water or saline water is in agreement with the majority of previous Australian studies (Balnave, 1993) and those reported by Pourreza *et al*. (1994, 2000), Khalafalla and Bessei (1997) and Damron (1998).

Egg shell quality responses on the different treatments

		Shell breaking strength		Shell weight		Shell thickness	
Treatment	Age (wk)	40	60	40	60	40	60
		(Newtons)		(%)		(μm)	
Temperature							
18°C		40.1	36.4	9.47	9.l2	389	382
30°C		37.5***	33.5***	9.02***	8.62***	376***	363***
SEM		0.5	0.5	0.08	0.09	2.1	2.0
Treatment							
Control (C)[1]		39.3	35.4	9.29	8.96	385	374
Saline water (S)[2]		37.8	34.1	9.17	8.77	379	369
S+ascorbic acid (AA)[3]		39.2	35.1	9.26	8.88	383	374
S+zinc methioine (ZM)[4]		39.0	35.3	9.25	8.74	383	373
SEM		0.6	0.7	0.11	0.13	2.9	2.9
Temperature	Treatment						
18°C	C	40.6	37.0	9.53	9.18	391	383
18°C	S	39.5	35.3	9.39	9.03	386	378
18°C	S+AA	40.4	36.9	9.48	9.14	390	384
18°C	S+ZM	40.0	36.6	9.48	9.13	390	383
30°C	C	38.0	33.9	9.05	8.73	379	364
30°C	S	36.1	32.9	8.95	8.51	372	360
30°C	S+AA	37.9	33.4	9.04	8.62	377	363
30°C	S+ZM	37.9	33.9	9.03	8.62	376	363
SEM		0.9	1.0	0.15	0.18	4.2	4.0

[1] Hens fed basal diet and town water.
[2] Hens fed basal diet and town water containing 2 g NaCl/litre.
[3] Hens fed basal diet supplemented with 200 mg ascorbic acid/kg diet and town water containing 2 g NaCl/litre.
[4] Hens fed basal diet supplemented with 360 mg Zinpro 100/kg diet and town water.
*** Significantly different from the 18°C temperature treatment at P<0.001.

Egg shell quality was significantly (P<0.001) reduced at 30°C compared to 18°C but was not significantly influenced by the dietary/drinking water treatments (see Table above). Nevertheless,

with all shell quality measures at both temperatures minimum values were obtained consistently with hens receiving the saline drinking water. The maximum reduction due to saline drinking water was 5 per cent, observed with shell breaking strength at 30°C at 40 weeks of age. Even with such small reductions all measures of egg shell quality were numerically improved by the ascorbic acid and zinc methionine supplements at both 18 and 30°C.

Discussion

The genotype used in these studies was relatively insensitive to intakes of NaCl from the drinking water at concentrations of 2 g/litre. The lack of sensitivity contrasts with the majority of reports (Balnave, 1993; Yoselewitz, 1992; Yoselewitz *et al*., 1993; Pourreza *et al*., 1994, 2000; Khalafalla and Bessei, 1997) but confirms similar reports by Maurice (1989) and Damron (1998). This raises the question of the cause of this variation.

White Leghorn x New Hampshire and White Leghorn x Australorp genotypes were used in the Australian studies that originally identified the adverse effect of saline drinking water on egg shell quality whereas Maurice (1989) and Damron (1998) used White Leghorns in their studies. However, Pourreza (1994, 2000) also used White Leghorns and observed an adverse effect of saline drinking water on egg shell quality. This suggests that some factor other than genotype may be involved. It appears from the present study that ambient temperature is not a relevant factor. A possible explanation for the different responses noted in Australia and the USA may relate to the fact that in Australia birds are generally selected and maintained on diets meeting minimum requirements for both sodium and chloride and, therefore, containing much lower concentrations of NaCl than diets formulated for birds in the USA. Supplementation levels of 0.17% of NaCl are typical of layer diets containing meat and bone meal in Australia, whereas supplementation levels up to 0.35% NaCl, with relatively high concentrations of chloride, are common in the USA (J. Brake, personal communication). Thus the older locally established strains of laying hens in Australia are likely to be more sensitive to the intake of NaCl from an external source, such as saline water, than hens in the USA which are selected on, and are accustomed to, much higher intakes of NaCl.

Implications

The results of this one year study with one genotype imply that the newly introduced overseas coloured layer strains are less sensitive in the immediate term to saline drinking water than were the local commercial strains available to Australian producers at the beginning of the 1990's. It is impossible to give accurate estimates of costs and benefits because of the variable sensitivities of the older local strains to saline drinking water. However, it would appear likely that the overall incidence of poor egg shell quality in commercial flocks should decline with the introduction of the new overseas strains. This is because a high proportion of commercial Australian flocks are exposed to saline drinking water through the use of underground bore water in commercial units. Losses due to poor egg shell quality with the older strains were estimated to approximate $20 million annually.

Recommendations

The sensitivity of this genotype to saline drinking water should be re-evaluated after further generations have been exposed to Australian bore water supplies.

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