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Potassium chloride supplementation in drinking water of laying hens as a means to maintain high productivity under high ambient temperature

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Abstract

Voluntary water intake in laying hens is considered an important factor of adaptation to hot temperatures. This experiment was carried out to study the response of potassium chloride (KCL) in the drinking water on water intake, feed intake and productivity traits under heat challenge. A total of 48 hens were kept in climatic chambers and randomly allocated to three experimental groups of 16 hens each. These groups were given 0; .2 and .4 % KCL in the drinking water for seven consecutive days. The room temperature was cycled from 21±1°C (from 23 to 8 hrs) to 34±1°C (from 9 to 22 hrs). Water and feed intake, egg production and quality traits of the individual hens were recorded throughout the experimental period. Body temperature was recorded at days 1, 3; 5 and 7. Water intake was significantly higher in the hens receiving .2 vs. 0 % KCL supplementation. There was no significant difference between .2 and .4 % KCL. Feed intake in the control group was significantly higher in the KCL-supplemented groups at day seven. There was no effect of the treatments on egg shell strength, but shell thickness was significantly higher and the number of egg shell defects was lower in the KCl-treated hens. Body temperature was not affected by the treatments. The results show that KCL supplementation through the drinking water may be a means to avoid a reduction of egg production which usually occurs when the temperature in the layer house increases.

(Key words: Potassium chloride, egg quality, heat stress, water intake, feed intake)

Introduction

Voluntary water intake in laying hens is considered an important factor of adaptation to hot temperatures. The survival of chicken in hot environment is dependent upon the consumption of large volumes of water (Fox, 1951). May and Lott (1992) kept hens under cyclic ambient temperature (24-35-24°C) and under constant condition (24°C). At day one and day two of the cyclic temperature, water intake increased at the time of peak temperature and thereafter. At day three, the birds anticipated the heat stress by an increase of water intake prior to the raise of temperature. The peak of water intake and the lowest feed consumption occurred after the peak of heat stress. Laying hens which showed high rate consumption under an episodic heat period maintained high water intake for several weeks after the temperatures had returned to normal (Bessei et al., 1998). Under standard ambient temperatures, ab-libitum water intake is strongly associated with feed intake, but has no independent effect on growth rate. Under high ambient temperatures, water intake increases despite the reduction in feed intake. It was hypothesized that higher water intake under hot condition may improve broilers' tolerance to heat, with the effect being higher as potential growth rate of broilers increases in response to the continuous selection for rapid growth under normal condition (Deeb and Cahaner, 1998). Stimulation of water intake beyond the level of normal metabolic requirement may be a means to dissipate metabolic heat and thus, delay the depression of feed intake and growth under hot conditions. Addition of various salts to the drinking water has been reported to increase water intake in chicken.

Electrolytes are necessary to maintain physiological function during hot weather (Brake et al, 1994). Heat stress results in increased excretion of potassium through urine hence resulting in decreased plasma potassium (Arit-Boulahsen et al, 1989) there for sodium, chloride and potassium level should be increased for birds reared in heat stress environment. The recommended concentration of potassium chloride in broiler dietary level from 5-8 weeks of age is about 1.5-2% for maximum gain. This equals about 0.24-0.3% K in the form of KCL in drinking water (Smith and Teeter, 1987). Teeter (1994) reported that KCL supplementation (0.5%) in drinking water increased feed consumption, growth rate and water consumption (more than 29% as compared to the control group) when the temperature of the consumed water was lower than bird' body. Smith and Teeter (1986) observed that addition of 0.48% KCL to drinking water increased the growth rate of heat stressed broilers by 20 percent even though the blood had an alkaline pH, and blood CO_2 was depressed, indicating that factors other than blood CO_2 and pH are involved.

This experiment was carried out to study the response of potassium chloride (KCL) in the drinking water on water intake, feed intake, body temperature and productivity traits under heat challenge.

Materials and methods

The study was conducted in the research station of Hohenheim University, Stuttgart, Germany

A total of 48 hens were kept in individual laying cages in climatic chambers and were randomly allocated to three experimental groups of 16 hens each. These groups were given 0; .2 and .4 % KCL in the drinking water for seven consecutive days. Water and feed were provided ad libitum . The room temperature was cycled from 21±1°C (from 23 to 8 hrs) to 34±1°C (from 9 to 22 hrs). Water and feed intake, egg production and quality traits of the individual hens were recorded throughout the experimental period. Body temperature was recorded at days 1, 3; 5 and 7th of high temperature period.

Egg samples were collected on the 3rd, 5th and 7th day of heat stress. All eggs were identified by bird and brought on the same day of collection to the laboratory. The egg samples were stored overnight at 10 to 15^{0}C.

The egg quality parameters were determined in the egg quality laboratory of the Institut für Tierhaltung und Tierzuchtung, Universität Hohenheim.

The shell breaking strength was measured by the quasi-static compression test using Istron (Model 4301, Instron Ltd., Coronation Road, High Wycombe, Bucks HP 123 SY, England), where the eggs were compressed at a constant speed of 5.0 mm/min between the poles and the steel surfaces. Shell thickness (including the membranes) was measured on three pieces from the equator of each egg using an Ames thickness micrometer gauze. The shell thickness was determined after rinsing shells with distilled water and oven-dried at 100^{0}C for 4 hours.

The experimental data were analyzed by JMP 5.0.1 program (Sall et al, 1989)

The analysis of variance was performed by the ANOVA (procedure ANOVA analysis) and differences between means by Student's t-test.

Results and discussion

The effect of KCl solution on water, feed intake and water/feed ratio is shown on table 1. Water intake increased significantly with the KCl concentration (22-33% compared with control group). Water intake of birds receiving .2% and .4% KCl treatment was similar. This finding was similar to Ait-Boulahsen (1995) and Teeter (1994), Dayhim and Teeter (1995).

Drinking water with KCL had no effect on feed intake. This result is not in agreement with the study of Teeter (1994), who reported that KCL supplement (.5%) in drinking water increased feed consumption of broilers. There was, however, a tendency of lower feed intake with .4 % KCl supplementation .The establishment of a positive effect of KCl on feed intake, as reported by Ait-Boulahsen (1995), Teeter (1994) and Dayhim and Teeter (1995) may require some days of adaptation.

Water: feed ration increased with KCl supplementaion. This ratio was relatively constant over the experimental period at 0 and .2 % KCl. It declined from the second day to the 6th day of the experimental time at .4 % KCl. The latter effect was mainly due to the decrease of feed intake in these groups.

Body temperature of birds in high temperature (34±1°C) ranged from 41.16-41.38^{o}C, however, there was a tendency of lower body temperature with .4% KCL supplementation, especially in the 5th and 7th day. Drinking water with KCl did not affect body temperature (table 2). This result is in accordance with Ait-Boulahsen (1995), who reported that drinking water with .3% KCl did not affect body temperature response to heat stress. However KCl with .6% and .9% reduced the body heat gain during heat exposure.

Despite of the high temperature, egg weight of birds receiving .2% and .4% KCl was maintained. Egg weight in control birds decreased on 7th day of high temperature period, than the control on 7th day the weight of KCl treatment groups was significantly higher (table 4).

Eggshell defects are presented in the table 3. The data in this table shows that the average shell defects percent (14.6 and 14.9%) of two levels of KCl in drinking water (.2 and .4%) is lower than control (34.56%). It was shown that supplementation with KCl in drinking water reduced the negative effect of high temperature.

Eggshell thickness and eggshell strength were shown in table 4. The data indicate that the presence of KCl in drinking water did not affect the shell strength, but there is a finding of high thickness at .4 % KCl.

Table 1: The effect of KCL supplement in drinking water on water, feed intake and water/feed ratio

Group	Days of treatment						
Water intake (ml/bird/day)	1	2	3	4	5	6	7
0	289.43 ±75.81[b]	315.09 ±107.84[b]	311.25 ±120.31[b]	299.37 ±82.65[b]	296.41 ±80.36[b]	300.76 ±76.69[b]	290.52 ±64.74[b]
0.2	354.67 ±65.01[a]	379.27 ±60.49[a]	404.47 ±62.08[a]	397.80 ±80.28[a]	408.93 ±84.01[a]	407.67 ±93.02[a]	404.27 ±75.86[a]
0.4	345.19 ±71.98[a]	384.96 ±61.01[a]	395.83 ±65.99[a]	387.42 ±54.88[a]	398.96 ±68.09[a]	387.65 ±84.45[a]	398.47 ±67.81[a]
Feed intake (g/bird/day)							
0	103.11 ±16.94	111.26 ±21.66	107.23 ±23.10	103.96 ±16.59	116.07 ±17.93	119.15 ±36.06	99.40 ±26.63
0.2	106.73 ±20.42	106.13 ±17.47	103.87 ±21.38	113.27 ±18.65	111.00 ±18.50	116.73 ±20.91	111.93 ±15.58
0.4	105.49 ±21.92	99.77 ±21.31	102.95 ±17.50	106.86 ±17.03	111.07 ±21.07	107.16 ±22.78	99.92 ±19.59
Water/feed (ratio							
0	2.85 ±0.72[b]	2.81 ±0.69[b]	2.86 ±0.67[b]	2.90 ±0.69[b]	2.62 ±0.82[b]	2.77 ±1.20[b]	3.07 ±0.83[b]
0.2	3.38 ±0.65[a]	3.62 ±0.61[a]	4.05 ±1.03[a]	3.54 ±0.65[a]	3.73 ±0.76[a]	3.54 ±0.70[a]	3.67 ±0.79[ab]
0.4	3.31 ±0.61[ab]	4.04 ±1.23[a]	3.86 ±0.39[a]	3.66 ±0.16[a]	3.63 ±0.41[a]	3.64 ±0.40[a]	4.11 ±1.08[a]

*Means for the same parameter within same column with different letters are significantly different ($P<0.05$)

Table 2: The effect of KCL supplement in drinking water on body temperature (^{0}C)

Group	n	Days of treatment			
		1	3	5	7
0	16	41.33±0.19	41.33±0.19	41.25±0.23	41.28±0.24
0.2	16	41.37±0.21	41.38±0.21	41.24±0.28	41.28±0.21
0.4	16	41.31±0.22	41.31±0.22	41.19±0.29	41.16±0.27

Table 3: The effect of KCL supplement in drinking water on eggshell defects

Group	No of egg shell defects/week	Total eggs/week	% defects
0	28	81	34.56
0.2	13	89	14.6
0.4	13	87	14.9

Table 4: The effect of KCL supplement in drinking water on some egg production parameters

Group	Days of treatment					
	n	3	n	5	n	7
Egg weight (g)						
0	10	67.63±6.56	13	67.50±5.32	12	64.70±4.63 [b]
0.2	14	68.57±3.35	14	68.83±4.86	11	**68.96**±4.47 **[a]**
0.4	11	65.94±5.51	15	67.29±6.54	10	67.78±4.11 [ab]
Shell strength (N)						
0	4	28.83±5.39	8	30.50±4.58	10	31.80±7.26
0.2	10	31.17±7.48	12	29.21±5.23	8	27.03±7.86
0.4	10	30.55±4.94	13	30.25±7.73	13	31.09±9.39
Shell thickness (x0.01mm)						
0	10	34.85±4.61	13	34.18[b]±2.77	14	34.35±4.58
0.2	13	34.91±2.20	14	35.77[ab]±2.77	12	35.19±2.13
0.4	11	37.38±2.19	14	36.52[a]±2.37	14	36.02±2.91

*****Means for the same parameter within same column with different letters are significantly different ($P<0.05$)

Conclusions

In high temperature (34±1°C), supplementation .2 and .4% KCl in drinking water increased water intake from 22 to 33% and maintain egg weight, and decreased eggshell defects in comparison to control. Body temperature, eggshell thickness, eggshell strength was not affected by .2 and .4% KCl solution. The results show that KCL supplementation through the drinking water may be a means to avoid a reduction of egg production which usually occurs when the temperature in the layer house increases. However, higher concentration of KCl in drinking water for laying hen in high temperature should be further studied.

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