Effect of different salinity levels in drinking water on growth of broiler chickens

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ABSTRACT

During breaks in supply of treated water, farmers turn to surface and underground sources, such as wells and boreholes. Though seemingly wholesome, such water usually contains dissolved salts of various kinds that may affect productivity in poultry and other farm livestock. Fifteen 2-week-old, imported broiler hybrid chicks were fed a common ration, but offered drinking water from one of three sources, for 21 days, to investigate any effects of water quality on productivity. Three treatments (water source), each with five replicates (individually penned birds) were tested, in a completely randomised designed experiment. The treatments were (i) water from the tap (TAP), (ii) water from a borehole (BH1), and (iii) water from a second borehole (BH2). Birds were raised in battery cages, given water and fed *ad libitum* and weighed weekly. Water samples from the three sources were analyzed weekly for quality (i.e. conductivity, salinity, dissolved oxygen, *p*H, and total dissolved solids). Mean water salinity level were 0.00, 0.07 and 3.80 per cent for TAP, BH1, and BH2, respectively. Water treatment had no significant effects ($P>0.05$) on feed intake (110.8, 95.3 and 106.1 g per bird per day), weight gain (45.0, 43.6 and 43.0 g per bird per day), feed conversion ratio (46.8, 50.0 and 47.2%), and final weight of birds after 21 days (1.33, 1.30 and 1.32 kg), for TAP, BH1, and BH2, respectively. However, water intake by birds was significantly ($P<0.05$) influenced by source of water (222.9, 184.6, and 250.4 cm^3 per bird per day) for TAP, BH1 and BH2, respectively. It is concluded that water from all the three sources, though different in quality, were acceptable to broilers over the short duration of the study. The need is to prolong the study to cover a normal broiler production period of 8 to 12 weeks to determine any long-term effects of salinity on productivity and health of broilers. The quality of water given to poultry, especially from underground sources (in place of tap water), should advisedly be analyzed for its quality and suitability.

RÉSUMÉ

ODOI, F. N. A., AFUTU, M. K. & LAMPTEY, S. : *Effet de différents niveaux de salinité d'eau potable sur la croissance de poulets à rôtir.* Pendants les coupures d' eau traitée, les agriculteurs se tournent vers les sources de surface et de nappe phréatique telles que les puits et les trous de sonde. Malgré qu'elle est apparemment saine, telle eau généralement contient de différents sortes de sels dissous qui pourraient modifier la productivité de volailles et d'autres animaux d'élevage. Quinze poussins ayant l'âge de deux semaines étant hybride de poulets à rôtir importés étaient nourris de ration commune, mais offerts l'eau potable de l'une de trois sources pour 21 jours, pour examiner l'effet quelconque de la qualité d'eau sur la productivité. Trois traitements (source d'eau), Chacune avec cinq répétitions (des oiseaux séparément parqués) étaient mis à l'essai dans une expérience de dessin complètement randomisée. Les traitements étaient : (i) L'eau de robinet (ROB), (ii) L' eau du trou de sonde (TS1), et (iii) L'eau du deuxième trou de sonde (TS2). Les oiseaux étaient élevés en batteries, offerts l'eau et nourris *ad libitum* et pesés chaque semaines. Les échantillons d'eau de trois sources étaient analysés chaque semaine pour vérifier la qualité (C.-à-d. conductivité, salinité, oxygène dissous, *p*H et solides totaux dissous). Les niveaux moyens de salinité d' eau étaient 0.00, 0.70 et 3.80% respectivement pour ROB, TS1 et TS2. Le traitement d'eau n' avait aucun effet considérable ($P > 0.05$) sur la consommation alimentaire (110.8, 95.3 et 106.1g par volaille par jour), le gain de poids (45.0, 43.6 et 43.0 g par volaille par pour), la proportion de conversion alimentaire (46.8, 50.0 et 47.2%) et le poids final de volailles après 21 jours (1.33, 1.30 et 1.32 kg), respectivement pour ROB, TS1 et TS2. La consommation d'eau par les oiseaux était, cependant, considérablement ($P < 0.05$) influencée par la source d' eau (222.9, 184.6 et 250.4 cm^3 par volaille par jour) respectivement pour ROB, TS1 et TS2. La conclusion est tirée que l'eau obtenu de toutes les trois sources quoique différentes en qualité, étaient acceptable aux poulets à rotir pendant la courte durée de l'étude. Il est nécessaire de prolonger la durée de l'étude pour couvrir la période normale de 8-12 semaines de la production de poulet à rôtir afin de déterminer l'effet quelconque à longue date de la salité sur la productivité et la santé de poulets à rôtir. La qualité d'eau offerte aux volailles, surtout de sources de la nappe phréatique (à la place de l'eau de robinet) doit être, en connaissance de cause, analysé pour sa qualité et son caractère approprié.

Original scientific paper. Received 04 Feb 04; revised 01 Feb 08.

Introduction

The broiler industry today is highly specialized, complex and competitive. Thus, any lapses in good management practice lead to high production and financial losses. Although much emphasis is usually placed on formulating the perfect ration for poultry, the value of good drinking water should not be overlooked, because water plays important roles in body composition, excretion of wastes, and in thermoregulation. Although much information is available on the way poultry react to water deprivation (Kellerup, Parker & Arscott, 1965), their response to saline water is not well documented. Generally, the response of farm animals, especially ruminants, to highly saline water has been to increase water consumption and reduce feed intake, thereby lowering productivity (Church, 1971). The aspects of water quality of interest include physical impurities, non-organic pollutants, and disease-causing organisms; their levels should be monitored when offering water to farm animals.

Water is classified as good if it contains less than 2500 mg l^{-1} of dissolved salts (Church & Pond, 1987), although most domestic farm animals do tolerate higher levels of dissolved solids. Underground water sources in particular normally contain more dissolved salts than treated water from the tap; carbonates, bicarbonates, sulphates, and chlorides of Ca, Mg, Na, and K, for example, are usually at higher concentrations (Church & Pond, 1987). During protracted breaks in supply of treated water, many households and farms turn to other sources, especially underground water from wells and boreholes. On such occasions, farmers have reported production losses in their poultry flocks, which they attribute to inability of birds to handle higher salinity levels in the underground water substitutes.

The objective of this study was to investigate the effects of water of higher salinity on feed and water intake, live weight gain, and feed conversion ratio of broiler chicks.

Materials and methods

Experimental design and management practices

The 21-day study used 15 2-week-old hybrid broiler chicks (initial weight, 250-300 g; mean weight for all treatments, 278 g), in a randomized complete block design; blocking was for initial live weight. The three treatments, based on salinity level of water offered, were (i) water from the tap (TAP), (ii) water from first borehole (B1), and (iii) water from second borehole (B2). Each of the three treatments had five replicates (chicks), with all chicks offering the same feed, *ad libitum*. Birds were held individually in battery cages equipped with removable feed and water troughs, and exposed to a 24-h lighting regimen.

Data collection and statistical analyses

Data were collected on feed and water intake (estimated by the difference between amounts offered and refused over a 24-h period). Birds were individually weighed at the start of the experiment, and at the end of every 7-day period (i.e. weekly). Samples of water from the three sources were analyzed weekly for quality (i.e. salinity, conductivity, dissolved oxygen, *p*H, and total dissolved solids), using an Automatic Water Quality Checker.

Data collected on the parameters measured were subjected to the ANOVA test; differences between treatment means were separated using the Duncan's Multiple Range Test (Steele & Torrie, 1980).

Results and discussion

Salinity and conductivity levels were highest in water from B2, which also had the highest level of dissolved solids in solution (Table 1). This reflected the fact that groundwater sources generally contain more salts in solution compared with tap water, which usually originates from surface water (Barrow, 1987).

Water intake (Table 2) reflected a significantly higher (P<0.05) consumption level by birds offered the most saline water (B2) compared with the others on either B1 or TAP; confirming observations by Smith & Teeter (1987) on differences between underground and surface water. Mineral salts have generally been found to increase water intake in poultry to assist in excreting the excess salt through the kidneys (Kare & Bieley, 1978; Church & Pond, 1987). Such birds, therefore, tend to drink water more frequently. Also, because salt is regarded as an additive that can improve palatability, its inclusion at certain levels can contribute to higher intake of water. Free water consumption is highly related to dry matter consumption by farm animals (McDonald, Edwards & Greenhalgh, 1981; Kesse, 1988), although marked differences are reported between species. The quality of water offered affects feed consumption, because water of poor quality is normally consumed to a lower extent (Church, 1971). However, the effects of varying salinity levels in water on general productivity are varied, depending on the actual concentrations of salts present. Most farm animals can tolerate salinity levels of between 1.3 and 1.7 per cent.

TABLE 1

Chemical Analysis of Three Water Sources Used

Parameter	*Source of water* Tap	B1	B2
Dissolved oxygen (%)	4.7	2.5	2.8
Salinity (%)	0.0	0.7	3.8
*p*h	7.1	8.3	8.4
Conductivity	0.15	0.22	0.71
Total dissolved solids (ppm)	120	680	1368

TABLE 2

Mean Weekly Intake of Water (cm^3 day^{-1}) on the Three Treatments

Week	*Source of water* Tap	B1	B2	*s.e.*
1	136.6^a	123.9^a	165.3^b	9.9
2	211.4^{ab}	183.9^a	248.7^b	15.3
3	320.7^{ab}	246.1^a	337.3^b	22.9
1-3	222.9	184.6	250.4	16.0

Means in a row with a common letter superscript not significantly different (P>0.05)

The tolerance level, again, often depends on the actual components of the dissolved solids (Church, 1971). Within the range of 0.05 to 0.50 per cent, salinity is observed to improve palatability of water. Subsequently, intake of water and feed usually increases. An improvement in growth rate and feed conversion ratio then often results (Smith & Teeter, 1987). However, a salinity level above 0.75 per cent lowers palatability, reducing growth rate and feed conversion efficiency.

In this study, only water in the B2 treatment significantly exceeded the threshold; and effect on feed intake was, thus, not very pronounced. The trend was for birds on tap water to consume more feed than others on more saline water. Birds on the treatment (B2) also consistently drank more water than those in the other two treatments. Some of the extra water taken in must have been used in excreting excess salt from the body (Church & Pond, 1987). The direct result is that the intake of feed is invariably lowered (Kellerup *et al.*, 1965).

Differences in weight gain of birds (Table 4) reflected the trend in differences in feed intake.

TABLE 3

Mean Weekly Intake of Feed (g day^{-1}) on the Three Treatments

	Source of water			
Week	*Tap*	*B1*	*B2*	*s.e.*
1	67.1	67.1	73.4	1.7
2	117.1	101.1	109.1	3.8
3	148.3b	117.7a	136.0ab	7.3
1-3	110.8	95.3	106.1	4.3

Means in a row with a common letter superscript not significantly different (P>0.05)

TABLE 4

Mean Weekly Weight Gain (g per bird per day) on the Three Treatments

	Source of water			
Week	*Tap*	*B1*	*B2*	*s.e.*
1	47.4	49.7	51.4	1.0
2	59.1	54.6	49.4	2.3
3	28.6	26.6	28.4	0.5
1-3	45.0	43.6	43.0	1.3

Means in a row with a common letter superscript not significantly different (P>0.05)

Birds on tap water that consumed more feed gained more weight than the others over the 3-week period. Again, the salinity level of water in the B2 treatment seemed not to be high enough to significantly depress feed intake and, therefore, weight gain, as argued by Church (1971).

Feed costs are estimated at about 60 per cent of total production costs in broiler enterprises (Buamah, 1992). High feed conversion efficiency (or low feed conversion ratio) is, thus, critical to a profitable broiler business. Over the 3-week period (Table 5), birds on tap water seemed to have the best feed conversion efficiency (i.e. the lowest feed conversion ratio) of the three treatments, although differences were not significant (P>0.05). This reflects birds on tap water eating more feed (Table 3), and gaining more weight over the period (Table 4) than birds on the other two treatments.

Thus, generally, higher salinity levels seemed to have stimulated intake of water, but lowered feed intake and feed conversion ratio. It has been argued that on highly saline water, birds have to excrete excess salts from their bodies, a phenomenon involving the use of some water (Church & Pond, 1987). Low concentration of salts may enhance water and feed intake, growth rate, and feed conversion ratio (Ross, 1977), because problems of salt toxicity are then less likely to occur. Thus, the effects of saline water on productivity in farm animals may vary, depending on the actual level as well as the specific salts present.

TABLE 5

Mean Feed Conversion Ratio (%) on the Three Treatments (per bird per week)

	Source of water			
Week	*Tap*	*B1*	*B2*	*s.e.*
1	70.6	74.3	70.0	1.1
2	50.4	53.9	45.3	2.1
3	19.3	22.6	26.4	1.7
1-3	46.8	50.0	47.2	1.6

Means in a row with a common letter superscript not significantly different (P>0.05)

Conclusion

Two-week-old chicks offered water of three different salinity levels, for 3 weeks, seemed to drink more of the saline water, especially at the highest salt level (B2). The trend was subsequently for feed intake, weight gain and feed conversion ratio to decline, as salinity levels in water increased. Therefore, in times of water shortage that necessitate a sudden change from using tap to underground water sources on the farm, it may be advisable for farmers to monitor salinity levels in water more closely to assess their suitability for broiler chickens.

Acknowledgement

The authors are grateful for the contributions and cooperation from the Teaching and Research Farm, and the Laboratories of the Animal Science Department, both of the University of Cape Coast; and the Ghana Water Company, Cape Coast.

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