Body Weight, Carcass Yield, and Intestinal Contents of Broilers Having Sodium and Potassium Salts in the Drinking Water Twenty-Four Hours Before Processing

H. A. Gomes, S. L. Vieira,1 R. N. Reis, D. M. Freitas, R. Barros, F. V. F. Furtado, and P. X. Silva

Departamento de Zootecnia, Universidade Federal do Rio Grande do Sul, Av. Bento Gonçalves, 7712, Porto Alegre, RS 91540-000, Brazil

Primary Audience: Field Management Personnel, Nutritionists, Poultry Scientists, Processing Plant Personnel

SUMMARY

The purpose of this study was to investigate the effects of drinking water supplementation with graded increases of Na and K salts on the performance and gut contents of broilers before processing. Birds had no water, tap water, or water supplemented with sodium bicarbonate or potassium chloride in the concentrations of 0.15, 0.30, and 0.45% in the last 12 and 24 h before processing. The last 12 h coincided with preslaughter feed withdrawal. Cobb × Cobb 500 male broilers (46 d old) were set in a completely randomized experimental design with 8 treatments and 9 replications of 9 birds each. Birds were individually processed within a period of 12 h of feed withdrawal every 2 h. Individual weighing was followed with electrical stunning and removal of intestinal contents of the upper (crop through the gizzard) and lower segment (duodenum through cloaca). Water intake increased linearly with greater salt concentrations in the water ($P < 0.05$). Body weight loss increased linearly through the feed withdrawal; however, it was greater with birds without water access ($P < 0.0001$). There were no effects of treatments on the yields of carcass and cuts as well as on the intestinal contents at all evaluated times. Intestinal contents from upper and lower segments were decreased with time, but responses to the water treatments were not observed ($P > 0.05$). It is concluded that increasing water intake through the use of Na and K salts did not affect the rate of gut emptying before processing.

Key words: broiler, feed withdrawal, intestinal content, sodium, potassium, water intake

DESCRIPTION OF PROBLEM

Fasting before processing of commercial broiler chickens is done to decrease the waste of undigested feed and to decrease fecal contamination of the carcass during evisceration [1]. Effective feed withdrawal programs, however, should control losses due to carcass and cuts shrinkage while providing adequate evacuation of the digestive tract [2–7]. Feed withdrawal from 8 to 12 h has been shown to minimize gas-
trointestinal contents of broilers [8] and to maintain the sloughing of the intestinal mucosa and its overall fragility at a minimum [2]. Shorter or longer feed withdrawal times can lead to carcass contamination [9]. It has been estimated that broilers lose 0.353% of their noneviscerated carcass weight per hour after the first 4 h of fasting [4].

Feed withdrawal practices vary under commercial conditions, but in general, broilers have access to water during the on-farm period. Water intake is considered important to facilitate the emptying of feed from the crop and proventriculus [9, 10]. Therefore, factors stimulating water intake are expected to increase the rate of passage of digesta through the upper gastrointestinal tract. Many factors affect water intake in poultry, with electrolyte concentration being a strong one. For example, using commercially available sources of K and Na salts in the water has been shown to increase broiler water intake and in parallel helping to cope with heat stress [11–13].

Although the concept of feed withdrawal appears easy to implement, its application frequently results in unacceptable levels of contamination at processing plants. Part of this contamination may be related to inconsistent amounts of water consumed by broilers before transportation. Therefore, the objective of this study was to evaluate water supplementation with K and Na salts in the last 24 h before slaughter on intestinal contents and losses in the yield of carcass and commercial cuts.

**MATERIALS AND METHODS**

A total of 648 male Cobb × Cobb 500 broilers [14] were placed in 72 pens (1.6 × 1.7 m) having pine shavings as bedding. Each pen was equipped with an individual drinker system containing 3 nipples connected to a 20-L plastic tank and 1 tubular feeder. Birds were reared under typical commercial management conditions and fed a corn-soybean meal finisher diet (19.3% CP, 3,200 kcal of ME/kg, 0.90% Ca, 0.38% available P, 0.21% Na, 0.69% K). Light was provided on a continuous basis.

Birds placed in this study were first selected from a larger flock at 42 d of age. Selected birds had individual body weights within a range of the original flock average plus or minus 0.5 SD. Nine birds were individually identified with numbered bands placed on their legs and placed in each pen at 46 d of age.

Experimental treatments were composed of drinking water solutions having either potassium chloride or sodium bicarbonate in graded increases of 0.15, 0.30, and 0.45%. Water of each solution was prepared using tap water initially mixed in 200-L plastic tanks each. The study also had 2 other treatments: one exclusively with tap water and another without access to water. Each of the 8 treatments had 9 replicates of 9 birds each.

**Table 1. Cumulative water intake of broilers from drinking water having sodium bicarbonate or potassium chloride in graded increases in the 24-h period before slaughter (mL/bird)**

<table>
<thead>
<tr>
<th>Item</th>
<th>2</th>
<th>6</th>
<th>12</th>
<th>14</th>
<th>16</th>
<th>18</th>
<th>20</th>
<th>22</th>
<th>24</th>
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</thead>
<tbody>
<tr>
<td>Salt source</td>
<td></td>
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<td></td>
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<tr>
<td>NaHCO&lt;sub&gt;3&lt;/sub&gt;</td>
<td>67</td>
<td>139</td>
<td>235</td>
<td>281</td>
<td>308</td>
<td>347</td>
<td>375</td>
<td>396</td>
<td>407</td>
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<tr>
<td>KCl</td>
<td>61</td>
<td>126</td>
<td>224</td>
<td>272</td>
<td>301</td>
<td>332</td>
<td>361</td>
<td>382</td>
<td>400</td>
</tr>
<tr>
<td>Probability</td>
<td>0.4410</td>
<td>0.1329</td>
<td>0.3680</td>
<td>0.5358</td>
<td>0.6218</td>
<td>0.4322</td>
<td>0.4730</td>
<td>0.4868</td>
<td>0.7610</td>
</tr>
<tr>
<td>Salt level, %</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>0.15</td>
<td>67</td>
<td>129</td>
<td>215</td>
<td>253&lt;sup&gt;b&lt;/sup&gt;</td>
<td>274&lt;sup&gt;b&lt;/sup&gt;</td>
<td>309&lt;sup&gt;b&lt;/sup&gt;</td>
<td>339&lt;sup&gt;b&lt;/sup&gt;</td>
<td>363&lt;sup&gt;b&lt;/sup&gt;</td>
<td>373&lt;sup&gt;b&lt;/sup&gt;</td>
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<tr>
<td>0.30</td>
<td>61</td>
<td>133</td>
<td>223</td>
<td>276&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>304&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>334&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>366&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>378&lt;sup&gt;ab&lt;/sup&gt;</td>
<td>393&lt;sup&gt;ab&lt;/sup&gt;</td>
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<td>0.45</td>
<td>65</td>
<td>135</td>
<td>251</td>
<td>300&lt;sup&gt;a&lt;/sup&gt;</td>
<td>336&lt;sup&gt;a&lt;/sup&gt;</td>
<td>376&lt;sup&gt;a&lt;/sup&gt;</td>
<td>399&lt;sup&gt;a&lt;/sup&gt;</td>
<td>426&lt;sup&gt;a&lt;/sup&gt;</td>
<td>444&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Probability</td>
<td>0.7628</td>
<td>0.8216</td>
<td>0.0512</td>
<td>0.0351</td>
<td>0.0088</td>
<td>0.0159</td>
<td>0.0494</td>
<td>0.0477</td>
<td>0.0463</td>
</tr>
<tr>
<td>Mean</td>
<td>64.1</td>
<td>131.9</td>
<td>229.2</td>
<td>275.5</td>
<td>303.2</td>
<td>338.6</td>
<td>367.3</td>
<td>388.0</td>
<td>401.9</td>
</tr>
<tr>
<td>CV, %</td>
<td>33.6</td>
<td>21.5</td>
<td>16.7</td>
<td>16.3</td>
<td>16.2</td>
<td>17.0</td>
<td>16.4</td>
<td>17.1</td>
<td>18.5</td>
</tr>
</tbody>
</table>

<sup>a,b</sup>Means followed by different superscript letters in the same column are statistically different using Tukey at P ≤ 0.05.
Procedures with water and feed availability within the 24 h before processing were as follows: water was available ad libitum throughout the end with the exception of the birds in the treatment without water access, which had no water in the last 12 h; feed was provided ad libitum until 16 h before processing when it was removed for 3 h and then provided for 1 h as an attempt to standardize the amount of feed in the gastrointestinal tract for all birds. Feed was then withdrawn in the remaining 12 h. Broilers were sequentially slaughtered as 1 bird from each replication starting 2 h postwithdrawal and then every 2 h to the end of the 12-h feed withdrawal period. Slaughtering was conducted after birds were individually weighed using alternating current (AC) electrical stunning at 45 V. Manual evisceration followed with the collection of the upper segment (crop through the gizzard) and lower segment (duodenum through cloaca). Before removal from the abdominal cavity, the segments were isolated using a 2-mm waxed chord to tie the anterior and posterior junctions of crop to the gizzard segment and small and large intestine segment. Eviscerated carcasses without feet and heads were chilled in slush ice for 2 h, allowed to drip for 2 min, and then weighed. Carcasses were cut into commercial parts by trained processing plant personnel.

Crop, proventriculus, gizzard, and small and large intestines were weighed and had their contents removed through a manual gentle pressing. Contents were immediately placed in a freezer set at −18°C and kept for 3 d. Contents were then dried at 105°C until weight loss stability was reached, allowing calculation of their dry matter percentage.

The study was conducted in a completely randomized design with 8 treatments, 9 replicates of 9 birds each. A factorial analysis with 2 × 2 (salt type × salt concentration in the water) + 2 (no water or tap water) was conducted as well as a regression analysis using the graded increases of salts adjusted for each bird response. Responses considered significant (P < 0.05) were analyzed using Tukey test at 5% probability. Statistical analyses were conducted using SAS [15].

**RESULTS AND DISCUSSION**

Overall, there were no interactions between salt type and salt concentration in drinking water for all measured responses in this study (P > 0.05). Water intake increased as the concentration of both salts increased, regardless of salt source (Table 1). This response was linear (Figure 1), but it only became significant after water treatments had been available for more than 12 h (P < 0.05). Body weight loss and amounts of gastrointestinal contents were not affected by the type or concentration of salts in the drinking water (P > 0.05). Body weight loss was linearly

\[
y = 228.65x + 333.74 \\
R^2 = 0.21, P < 0.0012
\]
correlated with time \( (P < 0.05) \), with a greater rate of loss for birds without water access (Figure 2).

Gut contents were decreased with time throughout the feed withdrawal period (Figures 3 and 4). Differently from the body weight loss, there were no differences in terms of gastrointestinal clearance between birds with or without access to water as well as for salt type or concentration. Deriving the curves of Figures 3 and 4, it was possible to demonstrate that crop to gizzard contents were minimized after 9.3 h of fasting, whereas more than 10.2 h were needed to minimize contents in the small to large intestines.

After processing, birds did not show differences in the yield of the carcass or commercial cuts due to treatments \( (P > 0.05) \); data not presented). Reduction in weight of carcass and cuts occurred with time, but the yields of cuts as a proportion of the carcass remained similar within all feed withdrawal periods \( (P > 0.05) \).

Results demonstrating that broilers have increased water intake when it is provided with greater salinity have been published in the past [16–18]. This is an expected response to both Na and K and appears to be mediated by cells of the hypothalamus or nearby in the cerebral ventricles sensitive to osmoconcentration [19]. This physiological response has been used as a tool to alleviate birds under heat stress with the supplementation of diverse electrolytes in the water [20]. However, greater water intake with the increase of salts in the water has also been demonstrated under environmental temperatures below bird comfort [16]. Providing water for broilers during catching has been accepted as important to facilitate the clearance of feed from the crop and proventriculus [10]. However, the increased water intake obtained with the increases in Na and K in this study could not be associated with decreasing amounts of contents within the upper or lower gut at any feed withdrawal time as well as birds without water access in the last 12 h. Therefore, it is assumed that the greater water intake did not affect the rate of passage of contents through the upper and lower gut.

Reduction in body weight due to fasting is related to the elimination of excreta plus the loss due to catabolism of body tissues required in attending maintenance needs. Because energy required for basal metabolism is expected to remain the same throughout the time within the

![Figure 2. Cumulative body weight loss of broilers with or without access to water (%).](image-url)
Figure 3. As-is and dry matter contents of crop + proventriculus + gizzard during a 12-h feed withdrawal period (g).

Figure 4. As-is and dry matter contents of small + large intestines of broilers during a 12-h feed withdrawal period (g).
same age, a greater amount of body weight loss is expected at the beginning of fasting until the bulk of undigested feed is emptied from the intestines with further stabilization. In this study, loss of body weight was greater for broilers without water access similarly as has been shown by Zuids Hof et al. [21], and no effects were detected for the treatments that resulted in increased water intake. Increased urinary loss occurs in parallel with greater water intake, maintaining a close ratio between water intake and urinary excretion [20]. Therefore, birds without access to water are expected to dehydrate faster with an increased loss of body weight as moisture. This represents a body weight loss that adds up to those due to elimination of excreta and maintenance. Ambient temperature in this study ranged from a minimum of 25 to a maximum of 32°C and, therefore, evaporation from the respiratory tract is expected to have a greater effect in decreasing body weight with subsequent body dehydration for the birds without water access when compared with those with water ad libitum.

In this study, body weight reduction occurring during fasting was similar to former data that have shown reductions of 0.25%/h after 6 h of fasting without effects on carcass and cut yields [22]. In our study, yields of carcass and cuts did not change with time, but body weight loss was 0.20 and 0.36%/h after feed was removed, respectively, for broilers with and without access to water.

Gut contents were gradually decreased as with fasting time, reaching minimum amounts in the crop + proventriculus + gizzard and small + large intestines after 9 and 10 h, respectively. This finding is in accordance with former findings [2, 8, 9, 21]. Interestingly, a close relationship existed between the period of fasting that minimized the total contents and their dry matter within the gastrointestinal tract. Wabeck [8], using a subjective analysis, and Papa [6] actually measuring moisture of contents, observed a similar trend within a 12-h feed withdrawal, and extremely watery excreta have been found only with longer periods of withdrawal [7]. Our results point to the fact that current recommendations for feed withdrawals between 8 and 12 h lead to a minimization of intestinal contents without affecting their total moisture. Therefore, watery excreta elimination, probably from an accentuation of intestinal cell breakdown, occurs with longer periods of fasting.

CONCLUSIONS AND APPLICATIONS

1. Broilers had a linear increase in water intake as potassium chloride or sodium bicarbonate concentration was increased in the water to 0.45%.
2. Body weight reduction of broilers was linear during a 12-h feed withdrawal period; however, reduction was greater when birds were not allowed access to water.
3. Intestinal contents and dry matter percentage decreased with time and reached minimum values between 9 to 10 h after feed withdrawal. The lowest dry matter values were found at 9.3 h after fasting started for crop to gizzard contents when compared with 10.2 h for the contents in the small to large intestines.

REFERENCES AND NOTES


14. Cobb-Vantress Brasil Ltda, Guapiacu, Brazil.


