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Primary Audience: Flock Supervisors, Extension Specialists, Broiler Growers

SUMMARY

This study was conducted to determine what differences exist in average daily water consumption and water-to-feed ratios for 2010–2011 flocks as compared with flocks reared 10 and 20 yr ago at the University of Arkansas Applied Broiler Research Farm. Water is consistently overlooked as a vital nutrient for broilers though it is essential for metabolic processes within the bird and also accounts for a large majority of lean mass weight. Over the years, genetic advancement has continually pressed for improved intake, gain, and FE for the commercial broiler. However, it is also important to note how this has affected water consumption. Flocks were grown in commercial broiler houses with water consumption and feed input to the house recorded daily for the entirety of each flock. Daily water consumption and water-to-feed ratios were adjusted per 1,000 birds, with daily mortality taken into account, to standardize the data. Daily water consumption was significantly different between each group, with the 2010–2011 flocks consuming the greatest amount. Significant differences were also observed for daily water-to-feed ratios. Average daily gains were also evaluated and found to be significantly different. However, increased feed and water consumption does not seem to be the sole reason for increased average gain. Therefore, based on these results, water intake has increased over the years for the commercial broiler.

Key words: broiler water requirement, water consumption, water-to-feed ratio

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DESCRIPTION OF PROBLEM

Despite continued selection for increased weight gain and FE, water will always be a vital nutrient for the commercial broiler, as it is a required nutrient for the bird. Water plays a vital role in metabolic processes, the thermo-regulation process, and makes up 70 to 80% of lean body mass by weight in birds [1–3]. Additionally, water intake will vary depending on environmental temperature, RH, certain diet constituents [4], and rate of growth. Several on-farm issues can arise with water delivery that can alter water consumption. First, water quality can have a detrimental effect on water equipment, as poultry drinking water can contain several dissolved minerals and compounds [4–6]. Second, aqueous environments, such as on-farm water systems, are also susceptible to bacterial growth in the form of biofilms

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Dissolved solids and bacteria in poultry drinking water can both cause reduced bird performance [4, 8] as well as potentially decrease maximum allowable water flow [4]. In addition to possible water restrictions, on-farm water systems may not be sized to handle whole-farm water demand [6]. This may be a particular problem for older farms that split the main water line before reaching individual poultry houses. This water-system design immediately cuts the amount of water from the main line in half, potentially causing problems with water delivery, especially if cool cells are in use.

Farm management is also affected when birds consume more water, especially litter management. Birds release approximately 75% of the water they consume into the air and litter [9]. However, it is important to note that certain nutritional factors can elevate the amount of moisture released (i.e., high-protein diets), increasing litter moisture [10–14]. This addition of moisture can cause issues with in-house RH and wet litter. Proper ventilation is vital to help maintain litter moisture, RH, and the bird’s ability to thermoregulate through the evaporation of water off of the lungs. Wet litter can cause a greater occurrence of footpad dermatitis [15] and breast blisters, causing potential downgrades at the processing plant [16, 17]. Furthermore, wet litter is an excellent environment to harbor bacteria and leads to an increase in ammonia production, both which can result in reduced bird performance and livability [4, 16, 17].

Several sources can provide information on estimated predicted water consumption for broilers, including the NRC [18]. However, with an ever-changing industry and improving broiler lines, it is important to know that these sources are still viable options for producers. Therefore, this study was completed to determine if water consumption has changed for commercial flocks over a 20-yr period at the University of Arkansas Applied Broiler Research Farm (ABRF [19]), housed in 4 commercial broiler houses (40 × 400 ft). Detailed description of the farm for the 1991, 2000–2001, and 2010–2011 flocks housing styles are referenced by Liang et al. [20]. Brooding occurred in half of the house and each flock was grown out under commercial conditions. For this study, data was collected for flocks reared in 1991 (January–December 1991; n = 6), 2000–2001 (January, 2000–December, 2001; n = 11), and 2010–2011 (January, 2010–November, 2011; n = 10).

For the 1991 flocks, the 4 commercial broiler houses at ABRF were naturally ventilated with a closed water system and a Ziggity nipple drinker system with cups. During this period (January–December 1991), the average number of chicks placed per house was 18,800, creating an average stocking density of 0.85 birds/ft².

The 2000–2001 flocks were also housed at ABRF in 4 naturally ventilated commercial broiler houses. The water system was a complete closed Ziggity nipple drinker system without cups. During this period (January, 2000–December, 2001), the average number of chicks placed per house was 20,600, giving an average stocking density of 0.78 birds/ft².

Finally, the 2010–2011 flocks were grown out in tunnel-ventilated (houses were renovated in 2006) commercial broiler houses at ABRF. Again, the water system was a complete closed system with 2 houses using a Cumberland nipple drinker system and 2 houses using a Lubing nipple drinker system. During this period (January, 2010–November, 2011), the average number of chicks placed per house was 20,590, giving an average stocking density of 0.78 birds/ft².

Data Collection

Data were collected from old farm records of flocks previously grown at ABRF under commercial conditions (unpublished). Water consumption was recorded daily for the entirety of each flock from in-house water meters for poultry water lines. Daily feed consumption was recorded via digital scales on feed bins, verifying the amount of feed entering the house each day. Daily water consumption and water-to-feed ratios were adjusted per 1,000 birds, with daily mortality taken into account, to standardize

MATERIALS AND METHODS

Birds and Housing

All flocks for this study were Cobb strain, straight-run commercial flocks at the University of Arkansas Applied Broiler Research Farm and collect valuable water consumption data for the industry.
JAPR: Field Report

data across all flocks and alone for differences in placement numbers. Water-to-feed ratio was based on a per weight basis (1 gal of water = 8.34 lb). For daily water consumption, d 2 to 42 were assessed to match the shortest grow-out period of certain flocks. Days 0 and 1 were not included due to varying delivery times during d 0; likewise, flows during the first 48 h are not always accurately recorded by the meters due to low flow rates. Daily water-to-feed ratios were evaluated from d 7 to 42. Days 0 to 7 were excluded, as chicks were provided trays of supplemental feed, which is not completely consumed each day, so it is not possible to accurately measure daily feed consumption during this time. Average daily gains were also calculated using final average BW for each group.

Statistical Analysis

All recorded data were evaluated in SAS [21] using the GLM procedure. Flocks were grouped according to grow-out year and sorted via bird age. Differences were then assessed among the treatments for each bird age to d 42 for daily water consumption per 1,000 birds and water-to-feed ratio. Differences for ADG and interactions for ADG by average daily water consumption, average daily feed consumption, and average daily water-to-feed ratios were also calculated by SAS GLM. All statements of statistical significance are based on \( P \leq 0.05 \).

RESULTS AND DISCUSSION

Mean daily water consumption for flocks raised in 2010–2011, 2000–2001, and 1991 are summarized in Table 1 and Figure 1. On average, the 2010–2011 flocks consumed 50.32 gal of water/1,000 birds per day, which was significantly \( (P = 0.048) \) greater than the 42.41 gal/1,000 birds per day consumed by the broiler flocks in 2000–2001. In addition, the 2000–2001 flock water consumption was significantly greater \( (P = 0.042) \) than the 1991 flocks that consumed 37.07 gal/1,000 birds per day, on average. The only exception to these results occurred on d 22, when no significant difference \( (P = 0.143) \) was observed between the mean water level consumed of the 2000–2001 and 1991 flocks.

Average total water consumption by individual week of the grow-out period for each treatment is summarized in Figure 2. The 2010–2011 flocks consumed, on average, 71.12 gal/1,000 birds during wk 1, 192.20 gal/1,000 birds during wk 2, 301.66 gal/1,000 birds during wk 3, 405.82 gal/1,000 birds during wk 4, 503.85 gal/1,000 birds during wk 5, and 573.39 gal/1,000 birds during wk 6. When comparing average consumption per week, the 2010–2011 flocks is significantly greater \( (P = 0.0001) \) for each week than the 2000–2001 flocks, which averaged 51.52 gal/1,000 birds during wk 1, 151.04 gal/1,000 birds during wk 2, 243.81 gal/1,000 birds during wk 3, 337.43 gal/1,000 birds during wk 4, 440.99 gal/1,000 birds during wk 5, and 532.64 gal/1,000 birds during wk 6. Furthermore, the average weekly water consumption for the 2000–2001 flocks was significantly greater \( (P = 0.0001) \) than the 1991 flocks, which averaged 39.21 gal/1,000 birds during wk 1, 115.81 gal/1,000 birds during wk 2, 203.00 gal/1,000 birds during wk 3, 303.54 gal/1,000 birds during wk 4, 395.50 gal/1,000 birds during wk 5, and 468.12 gal/1,000 birds during wk 6.

Total cumulative water intake over the 42-d period was also evaluated for all treatments and summarized in Figure 3. The average cumulative intake for the 2010–2011 flocks was 2,048 gal/1,000 birds, which was significantly greater \( (P < 0.01) \) than the 2000–2001 average flock consumption of 1,757 gal/1,000 birds for 42 d. Additionally, the 2000–2001 flocks’ water intake was significantly greater \( (P < 0.01) \) than the 1991 flocks that averaged 1,525 gal/1,000 birds.

Percent change was evaluated between each of the treatments for average daily water intake by each day, average total water consumption by week, and average cumulative water intake for the 42-d period. When percent change was evaluated by day, the greatest change between flocks for water consumption occurred early in the grow-out periods and declined as age increased. The 2010–2011 flocks consumed 85% more water than the 2000–2001 flocks when comparing d 2 average daily water consumption between flocks (5.85 and 3.16 gal/1,000 birds, respectively), but only consumed 5.2% more water than the 2000–2001 flocks on d 42 (84.34 and 80.14 gal/1,000 birds, respectively). The 2000–2001 flocks had a 40% increase in
water consumption over the 1991 flocks when average daily water intake on d 2 for each treatment was compared (3.16 and 2.25 gal/1,000 birds, respectively), and only an 8.7% increase in water consumption on d 41 (78.16 and 71.85 gal/1,000 birds, respectively). Finally, the 2010–2011 flocks consumed 160% more water than the 1991 flocks for d 2 (5.85 and 2.25 gal/1,000 birds, respectively) and 17.6% more water on d 42 (84.34 and 71.72 gal/1,000 birds, respectively).

For percent change by week, the 2010–2011 flocks’ consumption during wk 1 (71.12 gal/1,000 birds) was 38% higher than the 2000–2001 flocks’ consumption during the same week of grow out (51.52 gal/1,000 birds), but only 7.6% more water was consumed by the 2010–2011 flocks during wk 6 when compared with the 2000–2001 flocks’ consumption for the same period (573.39 and 532.64 gal/1,000 birds, respectively). The 2000–2001 flocks had a 31.4% higher consumption rate than the 1991 flocks for wk 1 (51.52 and 39.21 gal/1,000 birds, respectively), and an 11.2% higher consumption rate than the 1991 flocks for wk 4 (337.43 and 303.54 gal/1,000 birds, respectively). Also, the 2010–2011 flocks had an 81% increase in water consumption versus the 1991 flocks for wk 1 (71.12 and 39.21 gal/1,000 birds, respectively), and a 22.5% increase in water consumption for wk 6 (573.39 and 468.12 gal/1,000 birds, respectively).

Finally, for percent change of total water consumed per 1,000 birds over the 42-d period, the 2010–2011 flocks consumed 16.5% more water when compared with the 2000–2001 flocks (2,048 and 1,757 gal/1,000 birds, respectively). The 2000–2001 flocks consumed 15% more water than the 1991 flocks (1,757 and 1,525 gal/1,000 birds, respectively), and, lastly, the 2010–2011 flocks consumed 34.3% more water over the 42-d period than the 1991 flocks (2,048 and 1,525 gal/1,000 birds, respectively).

Daily water-to-feed ratios were also evaluated and summarized in Figure 4. A decreased (P = 0.026) water-to-feed ratio was found for the flocks grown in 2010–2011 for d 16, 18 to 20, 31, 34 to 36, and 40 to 42 when compared with the 2000–2001 flocks and an increased (P = 0.007) ratio for d 7. When comparing the water-to-feed ratios for the 2010–2011 flocks to the 1991 flocks, a significantly (P = 0.047) increased ratio for the 2010–2011 flocks was found for d 7, 9, 10, 15, 16, 25, 26, 28, 29, 33, and 37 and a significantly (P = 0.002) decreased ratio was found for d 14 and 21. The 2000–2001 flocks, relative to the 1991 flocks, also had a
Figure 1. Average daily water consumption (gal/1,000 birds) for broiler flocks grown at the University of Arkansas Applied Broiler Research Farm [19] under commercial conditions in 2010–2011 (n = 10), 2000–2001 (n = 11), and 1991 (n = 6).

Figure 2. Average total water intake (gal/1,000 birds) by each individual week of grow out for broiler flocks grown at the University of Arkansas Applied Broiler Research Farm [19] under commercial conditions in 2010–2011 (n = 10), 2000–2001 (n = 11), and 1991 (n = 6). Bars with different letters (a–c) are significantly different ($P < 0.01$) within week.
significantly ($P = 0.035$) greater ratio for d 9, 11, 15 to 19, 25, 26, 28, 29, 31, 33, and 35 to 38 and a significantly ($P = 0.014$) decreased ratio for d 14 and 21 when compared with the 1991 flocks. However, when an average water-to-feed ratio was evaluated for each group across the 7- to 42-d period, the 2010–2011 flocks had a greater ($P < 0.05$) water-to-feed ratio than the 2000–2001 and 1991 flocks (2.02 vs. 1.98 and 1.90, respectively).

Average daily gain for the 2010–2011 flocks was 0.12 lb/d, which was significantly ($P < 0.001$) greater than the 2000–2001 flocks, which averaged 0.11 lb/d. Likewise, the 2000–2001 flock ADG was significantly ($P = 0.013$) greater than the 1991 flocks (0.10 lb/d). However, no interactions ($P \geq 0.1116$) were found for ADG by average daily water consumption, average daily feed consumption, or average daily water-to-feed ratio. The lack of a significant interaction signifies that ADG differences cannot be solely attributed to the differences in feed and water consumption. Thus, indicating that advances in broiler lines, nutrition, and management have led to more efficient commercial broilers, which is in agreement with Havenstein et al. [22].

Table 2. A comparison of average daily water consumption by week (gal/1,000 birds) for NRC [18] and broiler flocks grown at the University of Arkansas Applied Broiler Research Farm [19] under commercial conditions in 2010–2011 (n = 10), 2000–2001 (n = 11), and 1991 (n = 6)

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Finally, the data from each flock treatment was compared with NRC [18] guidelines and summarized in Table 2. The NRC guidelines are comparable to the 1991 flocks’ average daily water consumption through wk 5 of grow out. The 2000–2001 flocks are comparable to the NRC references through wk 3, but the average consumption for the 2000–2001 flocks becomes substantially more than the NRC recommendations from wk 4 through 6. Finally, the 2010–2011 flocks are comparable to the NRC guidelines through wk 2, but the water consumption for the 2010–2011 flocks is much greater for the final 4 wk of the compared information. This demonstrates how water consumption is dynamic, and that a current resource for water consumption is important for the industry.

CONCLUSIONS AND APPLICATIONS

1. A review of broiler flocks raised under commercial conditions in 2010–2011 consumed an average of 50.32 gallons/1,000 birds per day, which was significantly more than the average consumption by broiler flocks in 2000–2001 or 1991 (42.41 and 37.07 gal/1,000 birds per day, respectively).
2. It is important that farms are equipped to provide adequate water volume for optimal broiler development. The fact that bird water consumption has significantly increased over the past 10 and 20 yr is evidence that broiler farm water systems may need to be evaluated to ensure drinking systems have kept up with the changing water needs of the modern broiler.

REFERENCES AND NOTES

19. Arkansas Applied Broiler Research Farm, Fayetteville.