**The influence of a water quality supplement on growth performance, feed efficiency, and health of feedlot cattle1**

**Z. D. McFarlane‡2, S. L. Boerman‡, S. E. Dreyer‡ and L.G. Schneider**§

‡Animal Science Department, California Polytechnic State University, San Luis Obispo, CA 93407

§Department of Animal Science, University of Tennessee, Knoxville, TN, 37996;

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2 Corresponding author: zmcfarla@calpoly.edu

**ABSTRACT**

Water quality is rarely assessed in applied beef cattle studies. As an essential nutrient, water is imperative for growth performance and health of feedlot cattle. Thus, the objective of this study was to assess the influence of a water quality supplement on growth performance, feed efficiency, and health of feedlot cattle. Cattle (n = 80) were assigned to treatment in a randomized complete block design in two 90-d trials. Cattle were stratified by receiving body weight and blocked by weight class and randomly assigned to 1 of 2 of the following treatments: (1) control with no water quality treatment within pen (**CON**) or (2) an adjustment of water quality within pen (**TRT**). Cattle BW at receiving was similar (*P* = 0.95) between treatment groups. On days 14, 30, 60, and 90 of the trial, cattle BW did not differ (*P* ≥ 0.20) between CON and TRT cattle. Water quality treatment did not alter (*P* ≥ 0.59) average daily gain (ADG) from days 0 to 14, 14 to 30, and 60 to 90 of the trial. However, TRT cattle tended (*P* = 0.09) to outgain their CON counterparts from days 30 to 60 of the trial. Dry matter intake was not influenced by water quality treatment. In addition, feed:gain ratio (F:G) was not influenced on days 14 to 30 of the trial. Water quality treatment significantly lowered (*P* = 0.03) the F:G in TRT cattle from days 30 to 60 of the trial. Morbidity and mortality were not different (*P* ≥ 0.15) between treatment groups. Water quality treatment resulted in a $0.27 decrease in cost·kg of gain from days 30 to 60 of the trial. Hot carcass weights, carcass price, and quality grade were not impacted (*P* ≥ 0.52) by water treatment. Overall, water quality treatment seemed to influence cattle growth performance and feed efficiency from days 30 to 60 of the trial. These data indicate that supplementation of a water quality product may need to be provided strategically.

**INTRODUCTION**

Water is an essential nutrient that aids in growth, metabolism, digestion, and temperature regulation (NRC, 2016). In the United States, beef cattle consume approximately 760 billion liters of water per year (Beckett and Oltjen, 1993). However, the effects of water quality on cattle performance are rarely evaluated. Water intake may be reduced if water quality is decreased because cattle are sensitive to the taste and odor of water (Willms et al., 1996). Water intake, ADG, and DMI was improved in steers when consuming well water that used reverse osmosis to improve water quality (Sexson et al., 2010). Therefore, water quality may have potentially beneficial impacts on cattle growth, health, and overall performance. Newly received feedlot cattle typically have suppressed feed intake. The stressful events of transportation, comingling, and exposure to a foreign environment can exacerbate health- and performance-related issues. Receiving cattle when first arriving at a feedlot have reduced DMI and are particularly susceptible to disease because of reduced immune function (Duff and Galyean, 2007). Ultimately, water restriction reduces feed intake (Utley et al., 1970) and likely influences overall performance. Thus, alternative methods to increase water intake, and subsequently DMI, still need to be evaluated. Recent research has indicated that strategic water supplementation, such as providing a drench of crude glycerin, may be a valuable tool to improve the immune response (Carey et al., 2017) and energy intake (Lopez et al., 2018) of newly received feedlot cattle. Similarly, the addition of a water additive to adjust water quality and pH may influence feedlot cattle performance. Our hypothesis was that improving water quality would improve cattle growth performance, feed efficiency, and health. Therefore, our objectives were to assess feed intake, average daily gain, feed:gain ratio, and serum concentrations of metabolites.

**MATERIALS AND METHODS**

All animal handling and experimental procedures described were approved by the California Polytechnic State University, San Luis Obispo Institutional Animal Care and Use Committee (Protocol #1805). A total of 80 cattle (British and Holstein; 258.58 ± 53.18 kg) were transported approximately 210 km (3 h on a truck) from Overland Stockyards in Hanford, CA and/or the 101 Livestock Market in Aromas, CA to the Cal Poly Beef Cattle Evaluation Center in San Luis Obispo, CA. Cattle were shipped in 3 truckloads with 20 cattle per truckload. Cattle were housed in 8 soil-surfaced pens (7 × 35 m) with 5 cattle per pen and 7 m of feed bunk space. All pens were equipped with access to automatic water stations with 2 pens of cattle sharing 1 watering station. Cattle were fed the same ration (**Table 1**) twice daily at 0630 and 1630 h. Feed bunks were evaluated for unconsumed feed twice daily at 0630 and 1630. Feed refusals were weighed daily at 0600 h and random samples were collected weekly for quality analysis. Adjustments were made for feed delivery to allow trace amounts to no residual feed in bunks at 0630 h each day for the duration of the study (Lopez et al., 2018).

Cattle were immediately processed and vaccinated upon arrival (day 0) before access to feed or water. All cattle were individually weighed and provided an individual identification tag before randomly being assigned a pen and treatment. All cattle received four initial viral and bacterial vaccines at receiving including Ultra Choice 7 (Clostridium Chauvoei-Septicum-Novyi-Sordellii-Perfringens Types C and D Bacterin-Toxoid; Zoetis Inc. San Diego, CA), Inforce 3 (Bovine Rhinotracheitis-Parainfluenza; Zoetis), Bovi-Shield Gold One Shot BVD (Mannheimia Haemolytica; Zoetis) and a dose of insecticide pour-on Cydectin (Moxidectin; Bayer) before being sorted into appropriate treatment groups. On day 30 of the trial, both groups of cattle were treated with a dose of Cylence Pour-On Insecticide (Bayer) for fly control.

During the study, animal health was evaluated daily through visual inspection. Cattle observed displaying signs of morbidity based on the DART system (Lopez et al., 2018) were pulled from their pens and assessed to determine if further treatment was necessary. All cattle brought in for assessment had rectal temperatures recorded. During the first round of antibiotic treatment for BRD symptoms, Draxxin (Tulathromyicn; Zoetis) was administered. If a second round of treatment was required, Baytril 100 (Enrofloxacin; Bayer) was administered. For any respiratory illnesses, Nuflor (Florfenicol; Merk) injectable solution was administered. Pinkeye was treated with Bio-Mycin (Oxytetracylcline; Boehringer Ingelheim).

Ten cattle from each treatment group were harvested at a commercial abattoir (Central Valley Meats; Hanford, CA) at the end of the 90-day trial to evaluate the influence of water treatment on meat quality and quantity. Remaining cattle were sold at auction upon completion of the trial.

***Experimental Design and Sample Collection***

 Two 90-day feedlot trials were conducted as a randomized complete block design. Pens of cattle were utilized as the experimental unit. The study consisted of four blocks (weight class) and two experimental treatments. Within each block, cattle were stratified by receiving body weight and weight class and randomly allocated to 1 of 2 of the following treatments: (1) control with no water quality treatment or (2) an adjustment of water quality within pen. The initial group of cattle (n = 40) were blocked by weight class and randomly assigned to a pen (n = 4/per treatment) with 5 cattle per pen. The study was repeated with the same number of cattle (n = 40) and treatments (control versus water treatment). Replication of the trial resulted in 80 total head of cattle and experimental unit number of 8 pens/treatment. The duration of the entire study was 180 days. A basic economic analysis was performed to assess production economics. Average monthly feed prices for the 180-d trial (June to December) from the Cal Poly Animal Nutrition Center (San Luis Obispo, CA) were utilized to analyze production economics. Mean feed costs were $0.07 ± 0.001·kg for the duration of the study. The mean feed costs were used to analyze cost of gain between treatment groups.

Experimental treatment of water stations was conducted with the following methods: 1) Addition of a 4:1 solution to sanitize water stations (4 gallon H20:1 gallon of OB50 product), 2) Addition of OB50 product (PurOxi, Pure Water Global Inc., Deroche, British Columbia, Canada; 50% stabilized H2O2 solution) at 50 ppm with 0.5 lbs of CSP Dry [(NaPO3)6; PurOxi product] per gallon of OB50, 3) Addition of two water filters (10 and 5 micron), and 4) Addition of 50% H2SO4 to balance pH. Dissemination of the pH solution was accomplished by delivery at 1 second and 32%, while the OB50 product was delivered at 1 second and 64% through plastic tubing. The control treatment received no treatment of water. A water meter (pHep5, Hanna Instruments, Smithfield, RI) was utilized to measure pH of experimental water stations. In addition, evaluation of ppm of the OB50 product (PurOxi, Pure Water Global Inc., Deroche, British Columbia, Canada) in water stations were assessed using OB50 strips. Water stations that were treated for water quality resulted in a pH of 6.81 ± 0.01 and 60.26 ± 3.12 ppm of OB50 product. Non-treated water stations had a pH of 7.00 ± 0.01. Water intake was not monitored.

All sample collection was conducted at 0600 h for every sampling period prior to feed delivery. Body weight was assessed at d 14 of the study and again every 30 days during each 90-d trial. An initial blood sample was collected after a 2-week adaptation period to provide a baseline for serum analyses to be performed. Additional blood samples were collected every 30 days to determine cattle nutrient status. Ten cattle from each treatment group were harvested at the Cal Poly harvesting facility in order to assess the effects of water treatment on meat quality and food safety.

***Serum Metabolite Assays***

A blood sample (~ 9 mL; Corvac, Sherwood Medical, St. Louis, MO) was collected via coccygeal venipuncture prior to collecting BW data to determine nutritional status. Samples were immediately placed on ice and centrifuged at 2,000 × g at 4oC. Samples were then immediately stored at -20oC until analysis. Serum samples were analyzed for non-esterified fatty acids (NEFA), urea N (SUN), and glucose concentrations. Commercial kits were utilized to perform the analysis for NEFA (Wako Chemicals, Richmond, VA), SUN (Thermo Scientific, Middletown, VA), and glucose (enzymatic endpoint, Thermo Scientific, Middletown, VA). Inter- and intra-assay CV were less than 10%.

***Statistical Analysis***

Normality of data distribution and equality of variances of measurements were evaluated using PROC UNIVARIATE. Cattle growth performance, feed intake, and serum metabolite measurements were analyzed as a randomized complete block design using the GLIMMIX procedure (SAS Inst. Inc., Cary, NC, USA) and Kenward-Roger degrees of freedom. All data were analyzed with pen as the experimental unit. The model included the fixed effects of water treatment, weight class (treatment), sex and their interactions. The random variables utilized for all statistical analyses were trial and trial × weight class (treatment). Repeated measures was utilized for variables collected over time with sampling period as the repeated factor and compound symmetry as the covariance structure as determined by Akaike’s information criterion. Binomial data (morbidity and mortality) were analyzed with PROC GLIMMIX using a model that included the fixed effects of water treatment, sex, trial, and their interactions. The LSMEANS option was used to calculate treatment means and the PDIFF statement was utilized for the separation of main effects and any interactions. Least squares means were compared using Fisher’s LSD at a significance level of *P* < 0.05. Tendencies were determined at 0.10 ≥ *P >* 0.05. The main effect of trial was not discussed because trial effects do not meet study objectives. Data were presented as main effects if interactions were not determined to be statistically significant.

**RESULTS AND DISCUSSION**

Receiving BW was not different (*P* = 0.95; **Table 2**) for CON or TRT cattle. Body weight at d 14, 30, 60, and 90 was not different (*P* ≥ 0.20) between CON and TRT cattle. Average daily gain (ADG) from days 0 to 14 and days 14 to 30 was also not influenced (*P* ≥ 0.59) by water treatment. However, water treatment tended (*P* = 0.09) to influence ADG from d 30 to d 60 of the trial. Acclimation to a new foreign environment may have resulted in compensatory gain differences in the current study. From days 60 to 90, water treatment did not alter (*P* = 0.71) ADG in the current trial. Overall, ADG did not differ (*P* = 0.65) between treatment groups from days 0 to 90. Dry matter intake (DMI) was not altered (*P* ≥ 0.95) by water treatment throughout the entire study. In addition, F:G did not differ (*P* = 0.23) from days 14 to 30. From days 30 to 60, F:G was significantly lower (*P* = 0.03) in TRT cattle when compared with CON cattle. This may be attributed to the differences in ADG among treatment groups from days 30 to 60 of the trial. In addition, water treatment and balance of pH may positively influence rumen fermentation and resulted in greater feed efficiency in TRT cattle. Water stations for TRT cattle had a pH of 6.81 ± 0.01 while non-treated water stations had a pH of 7.00 ± 0.01. Rumen pH and microbial population can differ depending on dietary intake in feedlot cattle (Schwartzkopf-Genswein et al., 2003). In the current study, microbial populations of cattle may have been better acclimated to the feedlot diet through the potential buffering capacity of the water quality supplement. Cattle morbidity did not differ (*P* = 0.63) by treatment, nor was mortality altered (*P* = 0.15) by water treatment. However, mortality differences may be biologically relevant (10% CON versus 2.5% TRT). The lack of statistical difference may have been due to sample size limitation for binomial responses (Lopez et al., 2018). More research is warranted to assess the effects of water quality treatment on cattle health parameters.

Cattle receiving treated water were more feed efficient, resulting in a $0.27 decrease (**Table 3**) in cost·kg of gain. Steers consuming well water that used reverse osmosis to improve water quality increased DMI and ADG (Sexson et al., 2010). In the current study, the feed efficiency improvement from days 30 to 60 of the trial resulted in improved production and economic efficiency during this particular period of the trial. Hot carcass weight was not different (*P* = 0.55; **Table 4**) between CON and TRT cattle. In addition, quality grade and price were not impacted (*P* ≥ 0.52) by water treatment. Sexson et al. (2010) indicated a tendency for cattle that consumed water treated with reverse osmosis to have greater hot carcass weights than cattle consuming well water. We hypothesized that water treatment may influence carcass quality. However, water quality can be highly variable depending on location (Petersen et al., 2015). Sample size limitations may also attribute to the lack of statistical differences in the current study. Cattle respond to environmental conditions, particularly adverse conditions, in a highly variable and individualized manner (Arias and Mader, 2011). Thus, water intake and subsequent performance responses may be difficult to predict. Heat stress can have a profound influence on cattle health and performance in feedlots (Arias et al., 2011) and water intake typically suffers in response. In the current study, temperatures from June to December of 2018 averaged 22oC. Thus, heat stress was likely not a factor attributed to differences in performance in the current study.

**CONCLUSIONS**

These results indicate that supplementing a water quality product to newly received feedlot cattle may need to be applied strategically. Water quality treatment seems to have more of an influence once cattle are acclimated to their new environment. Evaluating this product in environmental conditions with an excessive heat load may be worthwhile. Further research is necessary to evaluate application techniques via drench application and (or) alternative methods. In addition, an evaluation of the effects of the water quality product on rumen fermentation parameters is warranted.

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**Table 1.** Composition of feedlot diet

|  |  |
| --- | --- |
|   |   |
| Item | DM basis |
| Ingredients, % |  |
|  Corn, steam flaked | 19.71 |
|  Almond hulls | 18.59 |
|  Distillers dried grains with solubles | 7.44 |
|  Mineral premix | 5.58 |
|  Molasses | 14.13 |
|  Oat Hay, suncured | 26.02 |
|  Alfalfa hay, suncured full-bloom 13 | 8.55 |

**Table 2.** Effects of water treatment on performance and health of newly received feedlot cattle

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   |   | Water Quality Treatment |   |   |   | P-value |
| Measurement |   | CON |   | TRT |   | SEM |   | TRT |
| BW, kg |  |  |  |  |  |  |  |  |
|  Day 0 |  | 260.76 |  | 269.26 |  | 6.00 |  | 0.16 |
|  Day 14 |  | 277.19 |  | 285.90 |  | 6.14 |  | 0.24 |
|  Day 30 |  | 291.12 |  | 303.24 |  | 8.52 |  | 0.52 |
|  Day 60 |  | 340.83 |  | 357.50 |  | 5.09 |  | 0.20 |
|  Day 90 |  | 362.71 |  | 377.41 |  | 9.80 |  | 0.47 |
| ADG, kg/d |  |  |  |  |  |  |  |  |
|  Days 0-14 |  | 1.16 |  | 1.19 |  | 0.19 |  | 0.92 |
|  Days 14-30 |  | 1.17 |  | 1.02 |  | 0.19 |  | 0.59 |
|  Days 30-60 |  | 1.01 |  | 1.26 |  | 0.10 |  | 0.09 |
|  Days 60-90 |  | 0.98 |  | 0.92 |  | 0.11 |  | 0.71 |
|  Days 0-90 |  | 1.12 |  | 1.09 |  | 0.06 |  | 0.65 |
| DMI, kg/d |  |  |  |  |  |  |  |  |
|  Days 14-30 |  | 36.70 |  | 36.50 |  | 6.90 |  | 0.97 |
|  Days 30-60 |  | 39.90 |  | 39.81 |  | 3.54 |  | 0.98 |
|  Days 60-90 |  | 46.57 |  | 46.77 |  | 5.43 |  | 0.97 |
|  Days 14-90 |  | 40.80 |  | 41.05 |  | 4.83 |  | 0.95 |
| F:G |  |  |  |  |  |  |  |  |
|  Days 14-30 |  | 3.70 |  | 2.92 |  | 0.41 |  | 0.23 |
|  Days 30-60 |  | 4.83 |  | 3.01 |  | 0.52 |  | 0.03 |
|  Days 60-90 |  | 4.75 |  | 4.28 |  | 0.60 |  | 0.59 |
|  Days 14-90 |  | 3.59 |  | 3.43 |  | 0.34 |  | 0.50 |
| Morbidity, % |  | 5 |  | 7.5 |  | -- |  | 0.63 |
| Mortality, % |   | 10 |   | 2.5 |   |  -- |   | 0.15 |

**Table 3.** The influence of water treatment on feed efficiency and production economics of feedlot cattle

|  |  |  |
| --- | --- | --- |
|   |   | Water Quality Treatment |
| Measurement |   | CON |   | TRT |
| DMI, $/kg/d |  |  |  |  |
|  Days 14-30 |  | 5.51 |  | 5.48 |
|  Days 30-60 |  | 6.00 |  | 5.98 |
|  Days 60-90 |  | 7.00 |  | 7.03 |
|  Days 14-90 |  | 6.13 |  | 6.17 |
| F:G, $/kg |  |  |  |  |
|  Days 14-30 |  | 0.56 |  | 0.44 |
|  Days 30-60 |  | 0.73 |  | 0.45 |
|  Days 60-90 |  | 0.71 |  | 0.64 |
|  Days 14-90 |   | 0.54 |   | 0.52 |

**Table 4.** The influence of water treatment on carcass characteristics and carcass price of feedlot cattle

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|   |   | Water Quality Treatment |   |   |   | P-value |
| Measurement |   | CON |   | TRT |   | SEM |   | TRT |
| *n =* |  | 9 |  | 10 |  |  |  |  |
| Hot Carcass Weight, kg |  | 276.46 |  | 287.14 |  | 13.93 |  | 0.52 |
| Carcass Price, $ |  | 746.84 |  | 781.04 |  | 68.60 |  | 0.72 |
| Quality Grade, % |  |  |  |  |  |  |  |  |
|  Choice |  | 56 |  | 50 |  | 0.26 |  | 0.52 |
|  Select |  | 33 |  | 30 |  | 0.26 |  | -- |
|  Standard |   | 11 |   | 20 |   | 0.26 |   |  -- |