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Short communication

Early exposure to and subsequent beef cattle performance with saline water

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ABSTRACT

Two experiments were conducted to evaluate the impact of early life exposure to high salt water on later cattle performance with saline water. In Exp. 1, 24 cow/calf pairs were randomly assigned to one of two treatments: exposure to high salt water [HSW; 7478 mg/kg of total dissolved solids (TDS)] or to low salt water (LSW; 512 mg/kg TDS) when calves were 2 to 6 mo. old. Then all calves drank low salt water for 6 mo, and subsequently high salt water for 30 d. During the last period HSW tended to eat 10% less DM (DMI; $P=0.07$) and drank 22% less water than LSW (WI; $P<0.01$). Total tract DM digestibility (TTDMD; $P=0.92$), blood parameters (hemoglobin and hematocrit; $P>0.13$), plasma glucose ($P=0.18$), serum minerals ($P>0.08$) and weight gain (ADG; $P=0.85$) were not affected by treatment. In Exp. 2, 24 pregnant heifers in the last month of gestation were randomly assigned to either HSW (10827 mg/kg TDS) or LSW. The exposure period ended when calves were 3 month old. Then all calves drank low salt water for 95 d, and subsequently high salt water for 30 d. During the last period no significant differences between treatments were observed for DMI ($P=0.43$), WI ($P=0.61$), TTDMD ($P=0.92$), blood parameters ($P>0.42$), plasma rennin activity (PRA; $P=0.35$), and ADG ($P=0.16$). However, HSW drank less ($P<0.01$) high salt water than LSW during the first two hours of drinking water restoration after a water deprivation period of 20 h. Overall, in the conditions of our study we did not find evidence that early exposure to saline water induces tolerance and improves later performance of beef cattle with salty water. However, reduced water intake (Exp. 1) and increased thirst threshold (Exp. 2) of animals early exposed to saline water need further consideration.

1. Introduction

Adequate quality of drinking water for livestock is essential to maintain acceptable levels of productivity (NRC, 2000). However, in many parts of the world ruminants are faced with drinking water containing high concentrations of total dissolved solids (TDS; Basán Nickisch, 2007; FAO, 2007). Saline water causes reductions in water and food intake, jeopardizing cattle performance and health (Weeth and Hunter, 1971; Loneragan et al., 2001; Ward and Patterson, 2004; Grout et al., 2006). It has been suggested that neurological, physiological, and morphological processes are amenable to change early in life and can be altered so that animals can better adapt to the environment in which they are backgrounded (Provenza and Balph, 1990). If so, exposure to saline water early in life may induce tolerance and improve later performance of beef cattle with salt water, mainly through modification in kidney functions. Although nephrogenesis ends shortly after birth, newborn's kidney remains functionally primitive with respect to the capacity to concentrate urine (Little and McMahon, 2012).

Prior studies in rats and sheep have shown that high salt intake during pregnancy and the early postnatal period can reduce feed and water intake and salt balance in the offspring when they ingest the same diet later in life (Alves da Silva et al., 2003; Digby et al., 2010a). These authors suggested that these induced changes are linked to alterations in the renin-angiotensin system (RAS). Offspring from ewes that grazed saltbush (20% salt) excreted salt more rapidly and consumed less water compared with those from ewes that grazed pasture based on subterranean clover, which was attributed to lower rennin activity in the former (Chadwick et al., 2009a). Since the negative impact of poor quality water on animal performance depends largely on their water requirements

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(Patterson and Johnson, 2003), any permanent alteration in water intake may change the ability of animals to tolerate water with high salt content. We hypothesize that experience early in life with saline water improves cattle performance with salt water later in life. Our objective was to determine the effects of early life experience of calves with high salt water or low salt water on water and food intake, digestibility, blood parameters and weight gain when forced to drink high salt water later in life.

2. Materials and methods

For Experiment 1 and 2, we selected mother cows and calves with caving date between late December and early January from a commercial herd (Braford × Criollo Argentino; Instituto Nacional de Tecnología Agropecuaria [*INTA*] Santiago del Estero, Argentina). All cows were raised in the same environment, and none of them had previous experience with saline water. Animals were treated according the protocol approved by INTA for experimental animal care and use (INTA, 2013).

3. Experimental design

3.1. Experiment 1

The experiment was run with 24 cow-calf pairs. When calves averaged 2 mo of age and 78 ± 20 kg of BW (mean ± SD), 12 cow-calf pairs were randomly assigned to one of two treatments: early exposure to high salt water (HSW) or early exposure to low salt water (LSW). Total dissolved solids (TDS) in HSW were 7478 mg/kg, of which 3103 mg/kg were sulfates. The same values for LSW were 512 mg/kg TDS and 146 mg/kg TDS, respectively, and consisted of tap water. High salt water was made by mixing sodium chloride (NaCl) and sodium sulfate Na_2SO_4 salts in tap water until the target concentration was reached. The exposure period lasted 105 d; during the first 60 d calves were with their mothers. Thereafter, calves were weaned and the exposure period continued until d 105. All cow-calf pairs were fed alfalfa hay (*Medicago sativa*; 14% CP and 47% NDF) during lactation (first 60 d of the exposure period), and all weaned calves were fed a mixed ration (39% alfalfa, 40% corn and 21% roasted soybean; 15% CP and 40% NDF) during the last 45 d of the exposure period. Both groups, HSW and LSW, had *ad libitum* access to drinking water and food. Once the exposure period was completed, all calves grazed on rangeland and drank *ad libitum* tap water for 6 months (backgrounding period). During backgrounding, one calf per treatment was removed from the trial due to health problems. Immediately after the backgrounding period, 11 calves (169 ± 24 kg BW) from each treatment were assigned to individual pens (2 × 3.5 m), and fed a total mixed ration (14% CP; 50% NDF) composed of 65% alfalfa hay, 20.5% ground corn,13% roasted soybean plus 1.5% mineral mix (33% Limestone, 1.47% Copper sulfate, 0.04% Calcium Iodate, 0.014% Cobalt carbonate, 6.67% Magnesium Oxide, 7.20% Zinc sulfate, 0.014% Sodium selenite, 3.88% Iron sulfate, 2.67% Calcium carbonate).The diet was offered once daily (0800 h) at 130% of voluntary intake. Calves were allowed to adapt to the pens for 5 days, drinking tap water. Immediately after, we started an evaluation period, during which both groups were forced to drink high salt water (the same water quality that HSW calves had been exposed early in life) for 30 days. Feed and water intake of each calf were evaluated daily throughout the evaluation period, whereas feed digestibility was estimated in six calves from each group. Blood samples were extracted from all calves at the beginning (d 0) and at the end of the evaluation period (d 30), to evaluate concentrations of hemoglobin and hematocrit (hematological indicators), plasma glucose, and blood mineral profiles. Calves were weighed on d 0, 113, 294 and 331 of the experiment.

3.2. Experiment 2

Twenty four pregnant heifers were assigned to one of two treatments: LSW or HSW. Total dissolved solids in HSW were 10827 mg/kg TDS, of which 146 mg/kg were sulfates. The same values for LSW were 512 mg/kg and 146 mg/kg, respectively, and corresponded to tap water. High salt water was made by mixing NaCl salt in tap water until the target concentration was reached. The exposure period lasted 135 days: last 30 days of gestation and first 45 days of lactation, immediately followed by 60 days of exposure of calves alone. Pregnant and lactating cows were fed tropical grass hay (*Panicum maximum* , cv. Gatton; 7% CP and 78% NDF), whereas early weaned calves were fed a commercial feed specially formulated to fulfill young calf requirements plus alfalfa hay until the end of the exposure period. Both groups, HSW and LSW, had *ad libitum* access to drinking water and food. Once the exposure period was completed, all calves were fed a balanced ration (17% CP and 48% NDF) and they drank tap water for 95 d (backgrounding period). The diet was formulated with 60.5% alfalfa hay, 2% roasted soybean, 15% ground sorghum, 22% soybean meal, and 0.5% mineral mix (same composition as in Exp. 1). Immediately after the backgrounding period, calves from both treatments ($n=12$; 94 ± 17 kg BW) were assigned to individual pens (2 × 3.5 m) and fed the same ration as in the backgrounding period. Calves were allowed to adapt to the pens for 5 days, drinking tap water. Immediately after, we started an evaluation period, during which both groups were forced to drink high salt water (similar water quality that HSW calves had been exposed early in life; 12614 mg/kg TSD of which 480 mg/kg were sulfate) for 30 days. The day before the beginning of the evaluation period (d 0), calves were subject to a water deprivation period of 20 h. During d 1 of the evaluation period the rate of saline water intake was recorded at 1, 2, 6, 12 and 24 h post feeding. In this experiment, the level of thirst (motivation to drink) was regarded as the pattern of initial water intake after water deprivation. The diet was offered at the same time as in Exp. 1 (0800 h), once daily. Food and water intake, feed digestibility ($n=8$), and blood parameters were assessed as in Exp. 1. Calves were weighed on d 140, 231 and 265 of the experiment.

4. Measurements and sampling

In both experiments, during the evaluation period we measured forage and water intake, and collected samples for analyzes. Forage intake was calculated by subtracting DM refused from dietary DM offered daily, whereas water consumption was measured by the daily change in water depth in the water trough of each individual pen. In both experiments, forage and orts samples were collected just before feeding and composited on equal weight basis across days. Feed digestibility was determined by an external marker (LIPE®); fecal grab samples were collected from each calf ($n=6$ Exp. 1, $n=8$ Exp. 2) every 6 h from d 26 to d 29 of the evaluation period, advancing the sampling time 4 h each day in order to minimize concerns about diurnal variation in marker excretion. Fecal samples were composited across days within calf. In both trials, blood samples were taken from the jugular vein on d 0 and d 30 of the evaluation period. Immediately after collection, blood samples were placed into EDTA tubes to determinate hematological indicators, glucose and plasma renin activity analysis (PRA, Exp. 2 only), and in tubes without anticoagulant for the quantification of minerals. Measurements of BW on d 113 and d 331 (Exp. 1) and on d 140 and d 265 (Exp. 2) were performed once