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Frequent Changing and Rinsing of Drinking Water Buckets Improved Performance of Hutch-Reared Holstein Calves

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Abstract

There is often great variation in the cleanliness of drinking water provided to hutch-raised calves. Due to the relationship between dry matter intake and water intake, low water quality in the calf hutch could reduce feed intake and daily gain, and possibly affect health status of the calves. The objective of this study was to compare the performance of hutch-reared calves when drinking water containers were changed/rinsed with decreasing frequency. For three consecutive years, 24 Holstein bull calves (2-7 days of age) were purchased each year from a single commercial dairy. Calves were purchased in four sets of six calves each in September, December, March and June of each year. Calves remained in the hutches for 60 days, receiving milk replacer twice daily. A concentrate mix was available at all times. Of the six calves in each set, two had their drinking water buckets rinsed daily, two were rinsed at 7-day intervals and two at 14-day intervals. Average daily gain (ADG) of calves was measured during the 60-day period while in hutches, and through a subsequent 100 to 110-day post-weaning feeding period.

The frequency of changing/rinsing drinking water buckets affected ADG of calves while in the hutches: daily, 1.55 lb (0.70 kg)/day; 7-day, 1.48 lb (0.67 kg)/day; 14-day, 1.40 lb (0.64 kg)/day. All means were different ($P < 0.05$). These differences in ADG carried over through the post-weaning period: daily, 3.12 lb (1.42 kg)/day; 7-day, 3.01 lb (1.37 kg)/day; 14-day, 2.90 lb (1.32 kg)/day. The daily and 14-day treatments were different ($P < 0.05$), while the 7-day treatment was intermediate. Calves assigned to the daily and 7-day changing/rinsing regimen required a similar number (1.25) of medical treatments while in the hutches ($P > 0.05$). When drinking water buckets were changed/rinsed at 14-day intervals, calves required 1.75 medical treatments, an increase of 40%. Calves on the 14-day regimen were 2.48 (95% CI: range 1.32 to 4.68) times more likely ($P < 0.01$) to receive more than one treatment, compared to calves on daily and 7-day changing/rinsing regimens. Thus, a seemingly minor management practice such as frequency of changing/rinsing drinking water buckets in calf hutches can have an impact on calf performance and health.

Résumé

La propreté de l'eau potable servie aux veaux logés en hutte semble très variable. En raison du lien existant entre l'ingestion de matière sèche et la quantité d'eau consommée, la qualité moindre de l'eau potable disponible dans les huttes de veaux pourrait réduire la prise alimentaire et le gain quotidien et même influencer la santé des veaux. L'objectif de cette étude était de comparer la performance des veaux logés en hutte lorsque les seaux d'eau potable étaient rincés plus ou moins fréquemment. Lors de trois années consécutives, 24 veaux mâles de race Holstein (2-7 jours d'âge) ont été achetés d'une ferme laitière commerciale. À chaque année, les veaux étaient achetés en groupe de six à quatre reprises, soit en Septembre, Décembre, Mars et Juin. Les veaux étaient logés dans les huttes pendant 60 jours et recevaient un substitut de lait deux fois par jour. Un mélange de concentrés était disponible en tout temps. Parmi les six veaux de chaque groupe, il y en avait deux dont le seau d'eau était rincé quotidiennement, deux dont le seau était rincé à la semaine et enfin deux dont le seau était rincé aux deux semaines. Le gain moyen quotidien (GMQ) des veaux était mesuré pendant la période de 60 jours dans la hutte et ensuite pendant une période de 100 à 110 jours d'alimentation suivant le sevrage. Le nombre d'intervention médicale était noté pour chaque veau. La fréquence du rinçage du seau avait un impact sur le GMQ des veaux logés en hutte : rinçage journalier : 1.55 lb (0.70 kg)/jour, rinçage à la semaine : 1.48 lb (0.67 kg)/jour, rinçage aux deux semaines : 1.40 lb (0.64 kg)/jour. Toutes ces moyennes différaient statistiquement ($P < 0.05$). Ces différences se sont maintenues durant la

période d'alimentation suivant le sevrage : rinçage journalier : 3.12 lb (1.42 kg)/jour, rinçage à la semaine : 3.01 lb (1.37 kg)/jour, rinçage aux deux semaines : 2.90 lb (1.32 kg)/jour. Il y avait une différence au niveau du GMQ avec le rinçage quotidien et le rinçage aux deux semaines ($P < 0.05$) alors que le rinçage à la semaine occupait une position intermédiaire. Le nombre d'intervention médicale était le même pour les veaux dont le seau était rincé quotidiennement ou à la semaine, soit 1.25 ($P > 0.05$). Toutefois, ce nombre était de 1.75, un accroissement de près de 40%, chez les veaux dont le seau était rincé aux deux semaines. Les veaux dans le traitement aux deux semaines avaient 2.48 fois plus de risque (I. C. 95% : 1.32-4.68) de nécessiter plus qu'une intervention médicale ($P < 0.01$) que les veaux dans le traitement journalier ou à la semaine. Un changement de gestion d'apparence anodine au niveau de la fréquence de changement et de rinçage de l'eau potable dans les seaux peut avoir un impact sur la performance et la santé des veaux logés en hutte.

Introduction

A positive correlation between drinking water intake, dry matter consumption and animal performance has been observed.[12] Poor drinking water quality can reduce water intake, with concomitant reductions in feed consumption and performance.[11] Animal health can also be compromised by poor drinking water quality.[8] Researchers from several locations in the US and Canada have reported decreased daily gain, decreased gain:feed ratio and increased incidence of polioencephalomalacia in feedlot cattle when drinking water exceeded 0.3% sulfate.[3,4,5,6,10] Investigators reported a 0.33 lb (0.15 kg) increase in average daily gain of steers when the quality of water from dugouts was improved via aeration and coagulation.[14] The popular press also attests to the importance of drinking water quality on livestock production and health. Hot, dry weather and drought conditions not only concentrate dissolved solids in drinking water, but can also result in lethal algae blooms.[13]

Individual hutches have gained favor for raising and management of dairy calves from birth to about 60 days of age. Hutches are usually equipped with separate containers or buckets for feed and water. Water containers can easily become contaminated with feed particles, insects, algae, debris and fermentation by-products if not changed/rinsed frequently. It has been our observation that water quality in these containers is often poor, even on otherwise well-managed dairies. The objective of this study was to determine if the frequency of changing/rinsing of drinking water containers in individual calf hutches would affect the health and performance of Holstein bull calves.

Materials and Methods

The study was conducted at the Utah Agricultural Experiment Station near Logan in northern Utah at an elevation of 4535 ft. The average daily temperature for the four major seasons are: fall, 42°F (5.6°C); winter, 25°F (-3.9°C); spring, 41°F (5.0°C); and summer, 64°F (17.8°C). Twenty-four Holstein bull calves, aged two to seven days, were purchased from a single commercial dairy for three consecutive years (72 calves total). All calves received three to four full feedings of high-quality colostrum prior to purchase. Calves were purchased each year, in four sets of six calves each, during the first week of September, December, March and June. Individual polyethylene hutches[a] (36" wide x 66" long x 44" high; 91 x 168 x 112 cm) were used to house the calves from purchase until 60 days of age. A wire panel enclosure (40" wide x 78" long x 48" high; 102 x 198 x 122 cm) was attached to the front of each hutch, allowing calves access to the outside environment. Two 5-quart (4.7 L) capacity polyethylene buckets were attached to the front of the enclosures, one for feed and one for drinking water. Hutches were initially heavily bedded with wood shavings. Small amounts of shavings were added thereafter as needed to keep the calves clean and comfortable.

Upon arrival, calves were immediately weighed and placed in the hutches. A commercial milk replacer[b] (20% protein, 20% fat, 36 mg lasalocid/lb) was offered at levels recommended by the manufacturer at 0500 and 1700 daily (0.5 lb [.23 kg] powder/feeding). Calf starter ration was available at all times in one of the buckets attached to the enclosure. The starter ration was based on dry-rolled barley supplemented with soybean meal, and fortified with commercial pre-mixes such that all recommended concentrations of macro- and micronutrients were achieved.[9] The calf starter ration was changed each seven days or immediately upon becoming wet with rain or fouled with fecal material. Drinking water was available in each hutch at all times in one of the buckets attached to the enclosure. Drinking water was managed using one of three methods: 1) bucket kept full of water but rinsed and water replaced daily, 2) bucket kept full of water but rinsed once each seven days, or 3) bucket kept full of water but rinsed each 14 days. Drinking water was from a 150 ft (45 m) deep well, and was of high quality. Any bucket fouled with fecal material was immediately rinsed and cleaned. Two calves in each group of six calves were randomly assigned to one of these three drinking water management treatments.

If calves developed diarrhea while in hutches, electrolyte solution[c] was given at 1200 (noon) for four consecutive days, evenly spaced between the two feedings of milk replacer. If the rectal temperature was elevated

(≥ 103°F; 39.4°C) along with the diarrhea, Penicillin G[d] was administered at manufacturer's recommended dosage. Calves showing signs of respiratory distress and an elevated temperature were treated with oxytetracycline[e] at label dosage. Detailed medical records were kept for each calf.

Seven days prior to weaning, at approximately 53 days of age, calves were vaccinated with a clostridial bacterin-toxoid[f] and an inactivated combination respiratory vaccine.[g] Booster vaccinations were given as recommended by the manufacturer. Castration was accomplished using elastrator bands, and a hot-iron was used for dehorning. During this 7-day preweaning period, milk replacer feeding was reduced to once daily at 0500 to initiate the weaning process. At the end of this period, milk replacer was withdrawn completely and the calves were weighed. Calves remained in the hutches for 14 days after milk replacer was withdrawn to complete weaning. During this period, a post-weaning ration (concentrate mix) was available *ad libitum,* and small amounts of alfalfa hay was offered. Drinking water buckets were rinsed daily during this period. Calf housing and care met or exceeded criterion established by the GUIDE for the Care and Use of Agricultural Animals in Agricultural Research and Teaching.[1]

At the end of the 14-day post-weaning period in the hutches, all six calves in each group were placed in a common pen (12' x 24'; 3.7 x 7.3 m) with a covered loafing area bedded with wood shavings and a feeder with concrete apron. Drinking water was available *ad libitum* in a 50 gallon (190 L) polyethylene tank that was rinsed each seven days. While in these pens, calves had free-choice access to a post-weaning ration (concentrate mix) and alfalfa hay (18.0% crude protein, 48% neutral detergent fiber, 0.595 Mcal NE_m/lb, dry matter basis). This concentrate mix contained dry-rolled barley supplemented with soybean meal and was fortified with commercial premixes. The proportions were adjusted to match the nutrient requirements of weaned calves.[9] Calves remained in these pens until approximately 160 to 170 days of age, at which time they were weighed and then marketed at a local livestock auction.

Data were analyzed using the Proc Mixed procedure of SAS (SAS Inst. Inc, 1996, Cary, NC) with average daily gain as the dependent variable and water treatment, season and medical treatment by season interaction as the independent variables. Odds ratios for medical treatment between water treatment regimens were determined using logistic regression. Season and year at enrollment were included as potential confounding variables in the original model. Year effect was not included as part of the model, since there were no differences. Multiple comparisons were made with *P*-values adjusted using Tukey's procedure. Statistical significance was considered at $P < 0.05$.

Results and Discussion

The effect of drinking water bucket management and season of year on the daily gain of hutch-reared Holstein bull calves from birth to weaning is presented in Table 1. Both drinking water bucket management and season affected the daily gain of the calves during the hutch-rearing phase ($P < 0.05$). However, the interaction of drinking water bucket treatment by season was not statistically significant ($P > 0.05$). Thus, more frequent drinking water bucket management improved calf daily gain, regardless of season.

Table 1. Average daily gain of hutch-reared Holstein bull calves from birth to weaning (60 days) as affected by frequency of changing/rinsing of drinking water buckets and season.

	Frequency of changing/rinsing drinking water buckets				
	Daily gain, lb				
Season started	Daily	7-days	14-days	Mean	Weaning weight, lb
Summer (June)	1.43	1.41	1.34	1.39[z]	171[z]
Fall (September)	1.65	1.55	1.43	1.55[x]	183[x]
Winter (December)	1.49	1.43	1.41	1.46[y]	175[y]
Spring (March)	1.64	1.54	1.41	1.53[xy]	182[xy]
Mean	1.55[a]	1.48[b]	1.40[c]		
Weaning weight, lb	183[a]	179[b]	174[c]		

[a,b,c] Column effects, frequency of changing/rinsing drinking water buckets. Means in the same row with different superscripts differ, $P < 0.05$.

[x,y,z] Row effects, season. Means in the same column with different superscripts differ, $P < 0.05$.

In general, the daily gain of calves in this study is consistent with expectations. The average body weight of the calves during the hutch phase was about 134 lb (60 kg). The NRC lists daily gains from 0 to 1.76 lb (800 g)/day for dairy calves of this weight.[9] Daily changing/rinsing of drinking water buckets during the hutch phase of the study increased mean daily gain of calves by 4.7 and 10.7% (0.07 and 0.15 lb [0.032 and 0.07 kg] per day) compared to when buckets were changed/rinsed at 7-day and 14-day intervals, respectively ($P < 0.05$). These differences in daily gain resulted in 4 lb (1.82 kg) and 9 lb (4.09 kg) differences in body weight when weaned at 60 days. While this magnitude of difference may not seem large, it accounts for 3.0 and 6.7% of total body weight, respectively, when the average body weight of the calves is 134 lb.

There was an effect on calf daily gain during the hutch phase due to season (Table 1). Lowest daily gain and 60-day weaning weights were in calves started in the summer, which was likely due to heat stress, higher drinking water temperature and pests such as flies. Calves started in the fall and spring gained about 0.15 lb (0.07 kg) more per day and weighed about 12 lb (5.45 kg) more at weaning compared to those started in the summer. Calves started in the winter showed intermediate performance, gaining 0.07 lb (0.032 kg) more per day and weaning 4.0 lb (1.82 kg) heavier than calves started in the summer.

Frequency of changing water and rinsing buckets had an effect on the number of times calves required medical treatment during the hutch phase (Table 2). Calves on the 14-day regimen were 2.48 (95% CI: range 1.32 to 4.68) times more likely ($P = 0.005$) to receive more than one treatment, compared to calves on daily or 7-day changing/rinsing regimens (Table 3). Treatments included oral electrolyte solutions and/or antibiotics as previously described. Number of times treated indicates treatment for separate medical events, rather than consecutive days treated. Of the 72 calves on the study, 44 required only one medical treatment while 26 required two separate medical treatment regimens during the 60-day hutch phase. Only two calves required three medical treatments, and no calves died during the study. These treatment rates are not uncommon. Data from a national survey reported a mortality rate of 10.8% in dairy heifers from birth to weaning; 75% was due to diarrhea and respiratory problems.[7]

Kertz *et al* studied the importance of drinking water availability for hutch-reared dairy calves and reported a 45% increase in concentrate consumption when supplemental drinking water was available.[2] They reported that 40 of the 41 calves assigned to the study experienced diarrhea, with an average duration of about five days. Changing/rinsing drinking water buckets either on a daily basis or at 7-day intervals in our study decreased the risk of treatment by 2.48 times, compared to changing/rinsing drinking water buckets at 14-day intervals (Table 3). In addition to the cost of medication associated with treatment of calves, reduced daily weight gain while calves were ill also increased production cost.

The effect of drinking water management during the hutch phase on post-weaning weight gain is presented in Table 4. These calves were 160 to 170 days of age when marketed. The daily gain of the steer calves in this study was higher than recommended for Holstein heifer calves. The National Research Council (NRC) recommends that heifer calves gain about 1.94 lb (0.88 kg)/day during this period.[9] The steer calves in this study were being raised for beef purposes, therefore a higher rate of gain was desirable. Calves had free-choice access to good quality alfalfa hay and a balanced concentrate mix; they selected a diet that was approximately 70% concentrate mix and 30% alfalfa hay. Based on these dietary proportions, the NE_m and NE_g concen-

Table 2. Number of medical treatments for hutch-reared Holstein bull calves from birth to weaning (60 days) as affected by frequency of changing/rinsing drinking water buckets.

Number of separate medical treatments	Frequency of changing/rinsing drinking water buckets in hutches			Total
	Daily	7-days	14-days	
	Number of calves per 24 requiring 1, 2 or 3 treatments			
1	18	18	8	44
2	6	6	14	26
3	0	0	2	2
Mean	1.25[a]	1.25[a]	1.75[b]	

[a,b] Means in the same row with different superscripts differ, $P < 0.05$.

Table 3. Final likelihood ratio modeling the odds that hutch-reared Holstein bull calves will be treated more than one time from birth to weaning (60 days) as affected by frequency of changing/rinsing drinking water buckets.

Variable	Coefficient	Standard Error	Odds Ratio	95% Confidence Interval	*P*-value
Water treatment	—	—	—	—	0.005
14-days	0.91	0.32	2.48	1.32-4.68	—
Daily and 7-days	0	0	1	—	—

Table 4. Average daily gain of Holstein steer calves from weaning (60 days) until sale weight (160-170 days) as affected by frequency of changing/rinsing of drinking water buckets during the hutch-rearing phase and season.

	Frequency of changing/rinsing drinking water buckets				
	Daily gain, lb				
Season started	Daily	7-days	14-days	Mean	Sale weight, lb
Summer (June)	3.01	2.73	2.57	2.77^{z}	458^{z}
Fall (September)	3.30	3.19	3.10	3.19^{x}	512^{x}
Winter (December)	2.97	3.06	2.99	2.99^{y}	484^{y}
Spring (March)	2.21	3.08	2.93	3.08^{xy}	505^{x}
Mean	3.12^{a}	3.01^{a,b}	2.90^{b}		
Sale weight, lb	506^{a}	491^{a}	476^{b}		

^{a,b} Column effects, means in the same row with different superscripts differ, $P < 0.05$.
^{x,y,z} Row effects, means in the same column with different superscripts differ, $P < 0.05$.

trations of the diet were about 0.80 Mcal and 0.52 Mcal/lb dry matter, respectively. The NRC suggests that a diet with this energy density should sustain a daily gain of about 3.15 lb (1.43 kg)/day in Holstein steer calves of this size and maturity. The overall average daily gain of calves during the post-weaning period in this study was 3.01 lb (1.37 kg)/day, indicating relative agreement between predicted and actual daily gain.

Although management of each group of calves was identical for the last 100 to 110 days, differences in drinking water bucket management during the hutch phase resulted in differences in daily gain and sale weight. Only minor numerical differences ($P > 0.05$) were detected in post-weaning gain and sale weight between calves whose drinking water buckets were changed/rinsed daily or at 7-day intervals during the hutch phase. However, when the changing/rinsing interval was increased to 14 days during the hutch phase, post-weaning daily gain and sale weight were reduced. Calves whose drinking water buckets were changed/rinsed at 14-day intervals weighed 30 lb (13.6 kg) less at the end of the study compared to calves from other treatment groups (Table 5). This difference in sale weight was not simply a carryover of the weight difference incurred during the hutch phase, which was only 9 lb (4.09 kg; Table 4). Thus, drinking water bucket management during the hutch-rearing phase affected the performance of these calves during the subsequent 100 to 110 day post-weaning period. Reduced water intake resulting from stagnant, contaminated water in the buckets changed/rinsed at 14-day intervals may have resulted in lower starter ration intake, impeded gastrointestinal tract development, and/or health issues that reduced daily gain during the post-weaning period.

Calves started in the summer were in the hutches from June through July, thus weaned during the hottest part of the summer. The lowest daily gains were exhibited by calves started in the summer (Table 4). This was likely associated with heat stress, drinking water temperature and insect pests. Calves started in the fall and spring had the highest daily gain and sale weights, possibly due to a more thermoneutral environment. Calves started in the winter showed intermediate performance, possibly due to cold stress.

Conclusions

These data clearly show that changing/rinsing of

Table 5. Average daily gain of Holstein steer calves from birth to sale weight (160-170 days) as affected by frequency of changing/rinsing of drinking water buckets during the hutch-rearing phase.

	Frequency of changing/rinsing drinking water buckets				
	Daily gain, lb				
Season started	Daily	7-days	14-days	Mean	Sale weight, lb
Summer (June)	2.35	2.24	2.13	2.24[z]	458[z]
Fall (September)	2.68	2.57	2.49	2.57[x]	512[x]
Winter (December)	2.40	2.42	2.40	2.40[y]	484[y]
Spring (March)	2.64	2.53	2.38	2.53[x]	505[x]
Mean	2.53[a]	2.44[a]	2.35[b]		
Sale weight, lb	506[a]	491[a]	476[b]		

[a,b] Column effects, means in the same row with different superscripts differ, $P < 0.05$.
[x,y,z] Row effects, means in the same column with different superscripts differ, $P < 0.05$.

drinking water buckets for calves in hutches should not exceed 7 days. Extending the changing/rinsing interval to 14 days resulted in reduced performance, not only during the hutch phase but also through the next 100 to 110-day growing period. Overall daily gain and sale weight were reduced by 7.7 and 6.3%, respectively. Medical treatment rates were also increased by 40%.

Endnotes

[a] Poly-Tuff Standard Calf Hutch, Behlen Country, Columbus, NE 68602.
[b] Intermountain Farmers Association, 1147 West 2100 South, Salt Lake City, UT 84130.
[c] RE-SORB, Pfizer Animal Health, Exton, PA, Div. of Pfizer Inc, NY, NY 10017.
[d] Pen BP-48, Phoenix Scientific, Inc, Fort Dodge, IA 50501.
[e] LA 200, Pfizer Animal Health, Exton, PA, Div. of Pfizer Inc, NY, NY 10017.
[f] Vision 8 with SPUR, Intervet, Inc, Millsboro, DE 19966.
[g] Triangle 4 + PH-K, Fort Dodge Animal Health, Fort Dodge, IA 50501.

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