Effects of Age of Dairy Calves First Offered Free Drinking Water on Feed Intake, Growth, and Health

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Summary and Implications

Offering adequate amount of clean drinking water to dairy calves has become recently a significant concern in the dairy industry. This also brought attention to the fact that many dairy farmers wait for a couple of weeks to offer drinking water to newly borne calves even though offering water from birth is the recommendation. Neonate calves could consume considerable amount of water via whole milk or milk replacer but it's not clear that amount alone would fulfill the water requirements to support growth and development. The present study was conducted to examine the effects of receiving drinking water from birth or about two weeks (**wk**) later on water and grain intake, and growth and health performances of Holstein heifer calves receiving a large amount (6 to 9 kg/d) of whole milk. The results revealed that, when offered from birth, calves drank significant amount (0.70 kg) of water in addition to a large amount of water they received via whole milk (about 5.0 kg/d) during the first two weeks of their life. Calves not receiving drinking water from birth consumed more grain and drank more water, once offered. Nonetheless, both groups achieved similar drinking water and grain intakes by the time they were 5 wk old. Regardless of the water and grain intake differences during neonate life, calves receiving or not receiving drinking water from birth had similar growth rates and body weight from birth to 10 wk of age. Nonetheless, calves receiving water from birth tended to have lower scours scores, and greater body lengths and hip heights after weaning compared to the calves receiving drinking water later. Overall, offering drinking water to calves from birth itself appeared to offer positive benefits even in systems promoting a large amount of liquid feed (whole milk or milk replacer) intake.

Introduction

The recent National Dairy Health Monitoring System survey of USDA has indicated that dairy calves in the majority of dairy farms do not receive water from the first day of their life even though it is the recommendation in Animal Care Reference Manual of National Dairy Farm Program. According to the survey, age of dairy calves when first offered drinking water range from 8 to 20 d with a mean age of 17 d. Large herds tend to offer water earlier than small herds. Offering drinking water from first day of life may appear unnecessary as pre-weaned calves are on a liquid diet. However, unlike milk or milk replacer bypassing the rumen, the water enters the rumen and thus provides a media to ruminal microbes to live in. Moreover, water in liquid diets may not be adequate to replenish body water losses under summer temperatures. A paper published in the Journal of Dairy Science in 1984 showed that offering drinking water to calves increased grain intake and weight gains by increasing starter grain intake. Calves in this paper received 1.9 to 3.8 kg of milk replacer providing calves with approximately 1.6 to 3.2 kg of water. A couple of decades later, a number of independent studies pointed out a significant positive relationship between nutrient intake during pre-weaning period and milk yields in first lactation. This has led to recommendations for feeding increased volume of milk replacer or whole milk to dairy calves. The impact of drinking water in modern-day calves receiving large amount of water via milk replacer or whole milk is yet to be explored systematically. The objective of the present study was to examine the effects of offering drinking water from birth or a couple of weeks later on water and grain intake, and growth and health performance in Holstein heifer calves receiving ad libitum amounts of whole milk during pre-weaning period.

Materials and Methods

All animal procedures in this study were conducted under approval of the Animal Care and Use Committee at Iowa State University. We used 30 Holstein heifer calves born in Dairy Research and Teaching Farm at Iowa State University (ISU-Dairy) from August 22 to October 8 in 2017. Immediately after feeding colostrum, calves were blocked by parity of the dam, calving difficulty, birth weight, and fortnight of the month they were born, and then randomly allotted to two treatments (15 calves per treatment); 1) provision of drinking water from birth (**W0**), and 2) provision of drinking water 17 d after birth (**W17**)

All the calves were housed in individual pens in the indoor calf facility of ISU-Dairy. Colostrum feeding and vaccination of all the calves were carried out as per the guidelines in ISU-Dairy. Calves were bottled-fed with 2 kg of pasteurized whole milk three times per day until they were 14 d old. From d 14 to d 42, the milk volume was increased to 3 kg. Calves were weaned partially on d 42 and fed 3 kg of milk only one time per day until they were completely weaned on d 49. Calves had free access to a grain-based starter diet and clean water to drink in two separate plastic buckets throughout the experimental period covering the first 10 wk of the life of each calf. Drinking water intake (kg/d) of individual calves was measured taking the difference between the offered and left-over

amounts. A separate set of water buckets with similar water volumes were used to measure evaporative water losses for which the drinking water intake measurements were eventually corrected. We did not observe a tendency for playing with water buckets and spilling water in any of the calves. The grain intake of calves measured daily by taking the difference between the offered and refused amounts.

Body weight (**BW**), hip height (**HH**), body length (**BL**), heart girth (**HG**) and hip width (**HW**) were measured at the end of each week. Only at the end of the second week, when the majority of calves had scours, blood was collected from jugular vein into 5 mL vacutainer tubes with heparin for the analysis of blood hematocrit, sodium, potassium, glucose and pH. Consistency of feces from individual calves was scored daily before morning feeding throughout the experiment. A 4-point scale was used for fecal scoring. Calves with fecal scores ≥2 were considered to have scours and offered a solution of electrolytes until the condition became normal. The present experiment covered the period from August 22 to December 17 in 2017. Statistical significance of the treatments (W0 vs. W17) on water and grain intake, number of days with scours and severity of scours, and growth performance were analyzed using SAS 9.4 (SAS Inst. Inc., Cary, NC). The MIXED and GLM procedures were applied respectively, when repeated or single observations were used pertaining to each calf.

Results and Discussion

Calves receiving water from birth (W0) drank on average 0.703 kg/d of free water besides the water (about 5.0 kg/d) consumed via whole milk during first 17 d after birth (Figure 1). On the other hand, calves not receiving water (W17) drank about 0.550 kg/d more water ($P < 0.009$) than W0 calves once offered after d 17 (Table 1). Drinking water intake of both groups was similar at 1.85 kg/d ($P = 0.639$) during the week they were partially weaned (d 43 to 49, Table 1). Once completely weaned, water intake increased in both groups by more than two folds to about 5.0 kg/d. The W17 calves ate more grain ($P<0.003$) than W0 calves during the first 17 d during when they did not receive water to drink (Table 1). However, grain intake of W0 and W17 became similar after d 17 ($P = 0.389$). Drinking water intake and grain intake had a strong positive correlation (r = 0.90, data not shown) throughout the study agreeing the common understanding that DMI predominantly drive drinking water intake. Drinking water intake had a strong positive relationship with age (r = 0.79 and Figure 1), the majority of which was confounded in the positive relation between grain intake and age (r = 0.80 and Figure 2). Both grain and water intake increased at much slower rates (0.013 and 0.177 kg/week, respectively) before weaning than after weaning (0.760 and 1.430 kg/week) indicating the significance of whole milk in fulfilling nutrient and water requirements of pre-weaned calves. Furthermore, regardless of the treatment, calves drank more water per kg of grain during partial-weaning period (6.0 to 7.5 kg/kg) than during post-weaning period (2.6 to 2.8 kg/kg) indicating the importance of providing adequate drinking water, specifically when calves are being weaned gradually.

As expected, BW, HH, HW, HG, and BL increased with age ($P < 0.001$). Offering water at birth or not did not have an impact on any of these measurements during pre-weaning period (Table 2 and Figure 3). Moreover, calves in W0 and W17 groups had similar BW, HH, HW, and HG at weaning and similar average daily gains (ADG) over the first 10 wk of their life. Nonetheless, calves receiving drinking water from birth had greater BL than W17 calves at weaning ($P = 0.038$). Moreover, W0 calves tended to have greater HH ($P = 0.068$) and BL ($P = 0.087$) than W17 calves during the post weaning period (Table 1 and Figure 3). A research group at Pennsylvania State University recently showed a positive association between hip height of heifer calves and their first lactation milk yield, independent of the relationship with body weight. Therefore, the improved HH of W0 calves suggests long-term benefits of offering water to calves from birth in terms of future milk production potential. Calves receiving free water tended ($P = 0.074$) to develop scours about 2 d earlier (d 9 vs. d 11) than the calves receiving free water later (Table 3). However, both groups had scours continuously for 7 d, even though the severity was numerically greater ($P = 0.199$) in W17 calves than W0 calves. Blood hematocrit, concentrations of glucose and potassium, and pH on d 14 were similar between W0 and W17 calves (Table 3). Blood sodium concentrations tended ($P = 0.058$) to be greater in W17 and W0. This could be due to a greater intake of electrolyte solution given the greater severity of scours among W17 calves. In summary, neonate calves drank 0.70 kg/d of free water in addition to a large amount of water (about 5 kg) they received via whole milk. Those calves ate less grain as neonates, had numerically lower scours scores and similar BW and ADG, and were related to greater body length and hip height after weaning compared to calves receiving drinking water about two weeks later. More prominent benefits of offering clean drinking water to new-born calves could be seen with protocols promoting lower liquid feed intake, and perhaps under summer temperatures.

Acknowledgements

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Table 1. Mean water and grain intake of Holstein heifer calves receiving drinking water from birth (W0) or after 17 d of age (W17)

	W0	W17	*P*-value
Water Intake, kg/d			
0 to 17 d	0.703	0.000	<0.001
18 to 42 d	0.890	1.436	<0.009
43 to 49 d	1.790	1.930	0.639
50 to 70 d	4.820	5.150	0.369
Grain Intake, kg/d			
0 to 17 d	0.004	0.016	0.015
18 to 42 d	0.077	0.084	0.389
43 to 49 d	0.550	0.600	0.560
50 to 70 d	2.140	2.210	0.712
Water Intake, kg/kg of Grain			
43 to 49 d	7.530	5.990	0.538
50 to 70 d	2.790	2.600	0.698

Table 2. Mean body weight and body volume measurements of Holstein heifer calves receiving drinking water from birth (W0) or after 17 d of age (W17)

	W0	W17	*P*-value
Birth Weight (kg)	37.50	37.90	0.370
At Weaning (49 d)			
Body Weight (kg)	67.50	66.80	0.890
Hip Height (cm)	90.60	90.00	0.359
Hip Width (cm)	22.80	22.80	0.857
Body Length (cm)	82.10	79.70	0.038
Heart Girth (cm)	95.10	94.50	0.607
Post-weaning (50 to 70 d)			
Body Weight (kg)	81.83	80.81	0.651
Hip Height (cm)	93.25	92.25	0.068
Hip Width (cm)	9.59	9.50	0.496
Body Length (cm)	86.78	85.33	0.087
Heart Girth (cm)	100.3	99.59	0.532
Average daily gain (kg/d)			
0 to 20 d	1.45	1.40	0.689
21 to 42 d	1.50	1.37	0.391
43 to 49 d	0.58	0.83	0.414
50 to 70 d	2.32	2.24	0.670

Table 3. Mean scours indices and some blood parameters of Holstein heifer calves receiving drinking water from birth (W0) or after 17 d of age (W17)

Variable	W0	W17	*P*-value
Scours (during first 4 weeks)			
Age scours started, d	8.9	11.4	0.074
Days with scours	6.5	7.13	0.859
Scours score	2	2.05	0.199
Blood parameters (14 d of age)			
Hematocrit, % PCU	23.2	23.4	0.923
Glucose (mg/dL)	133	123	0.622
Na (mmol/L)	134.4	136.1	0.058
K (mmol/L)	4.29	4.27	0.852
pH	7.42	7.41	0.335

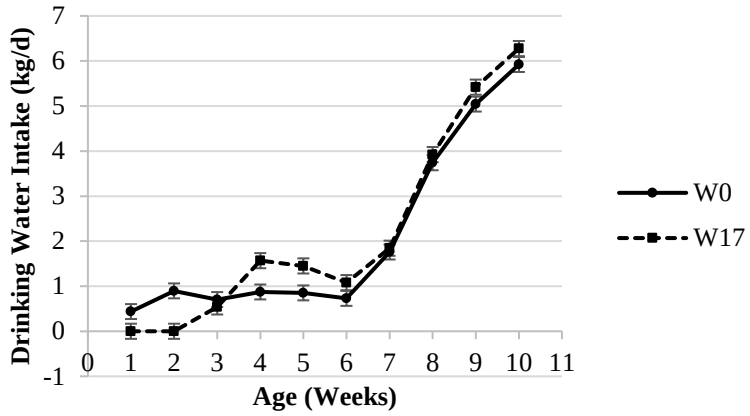

Figure 1. Weekly drinking water intake (Least square mean ± SE) of Holstein heifer calves receiving drinking water from birth (**W0**) or after 17 d of age (**W17**)

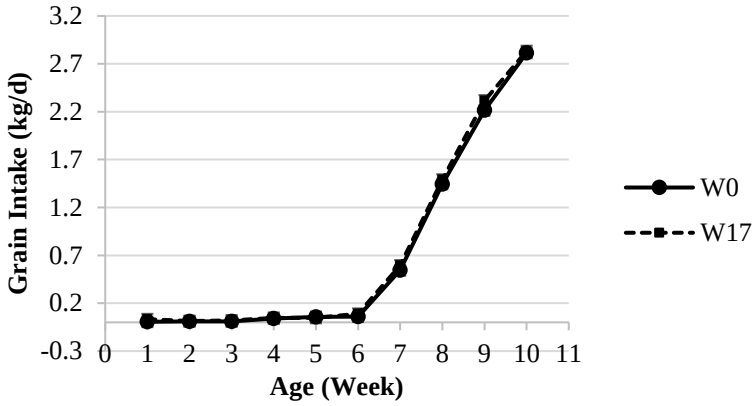

Figure 2. Weekly grain intake (Least square mean ± SE) of Holstein heifer calves receiving drinking water from birth (**W0**) or after 17 d of age (**W17**)

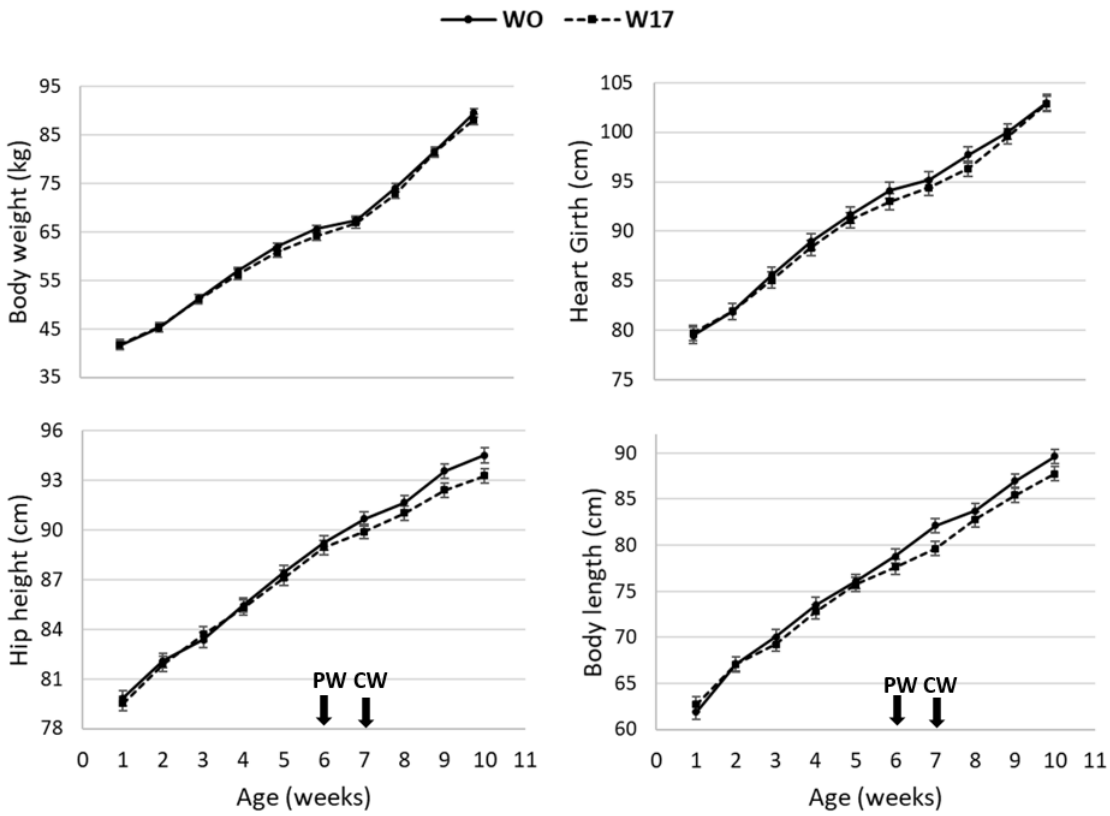

Figure 3. Weekly body measurements (Least square mean ± SE) of Holstein heifer calves receiving drinking water from birth (**W0**) or after 17 d of age (**W17**), and weaned partially (**PW**) and completely (**CW**) on 42, and 49 d of age, respectively