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Effect of Nightly Mixing versus Separation of Dams and Calves on Behavior, Production, and Calf Growth

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Effect of Nightly Mixing versus Separation of Dams and Calves on Behavior, Production, and Calf Growth

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Early separation of dairy calves and dams is viewed negatively by the public. The objective was to observe the effects of nightly mixing of dams and calves versus early separation on behavior, milk production, and average daily gain (**ADG**) over a 14-d period. Primiparous cows and their calves (N = 20) were separated within 6 h of birth. From d 0 to d 4, calves were housed in individual straw-bedded pens. Calves meeting enrollment criteria for successful passive transfer were assigned to Control (**C**): dams housed indoors 24h/d and calves individually housed from 6:00 to 20:00 and group housed on pasture from 20:00 to 6:00 or Mixed (**M**): dams housed indoors and calves individually housed from 6:00 to 20:00 and dams and calves commingled on pasture from 20:00 to 6:00 starting at d 5 postpartum. Calves were fed 4 L 26% crude protein and 20% fat milk replacer (Ag Central Co Op, Madisonville, TN) from d 0 to 4 and 6 L from d 5 to d 19. Calves were provided *ad libitum* starter grain (Calf Primer 1, AG Central Co Op, Madisonville, TN) and water. Within the freestalls, cows were housed within the same pen and milked twice daily at 7:30 and 19:30. Accelerometers were attached to dams and calves' rear legs before d 5 to collected behavioral data. Milk yield was collected on daily basis and sampled twice weekly for components. Calf weight was recorded twice weekly. The MIXED procedure (SAS 9.4, Cary, NC) was used to evaluate the effect of treatment and sex on milk production, milk components, and calf and dam behavior. T-tests were conducted to evaluate the effect of treatment ADG. M dams took more steps per d than C dams (1795.9 ± 86.1 vs 2114.5 ± 76.0, $P = 0.01$), but produced less milk (28.9 ± 1.9 vs 23.8 ±/ 1.7 kg, $P < 0.05$). Treatment did not influence calf or dam lying behavior, SCS, milk components, or ADG ($P \geq 0.13$). Nightly mixing of calves and dams did not affect behavior, milk quality, or calf growth. Differences in milk yield should be interpreted with caution, as cows were not balanced by projected milk yield. Partial exposure of cows and calves may be a viable opportunity to address public concerns.

Introduction

Early separation of calves from dams within hours of birth has become common farm practice. About 24% of dairy operations in the US separate the calf from the dam within 1 hour and 81.7% of operations remove the calf within 14.0 hrs (NAHMS, 2014). Ventura et al. (2013) reported that 48% of takers of an online survey, including both dairy affiliated and non-affiliated members of the public, viewed the separation of dams and calves immediately or within hours of birth negatively.

Housing dams with calves may provide potential benefits to the calf and dam. Weary and Chua (2000) found that calves separated from dams at day 4 required fewer days of treatment for scours than those separated at 6 hours or 1 day. Housing dams and calves together for 4 days to 2 weeks postpartum increased calf growth and body weight gain compared to calves housed without dam contact (Flower and Weary, 2001, Valníčková et al., 2015) Calves allowed to suckle gained 0.42 kg/d more than those separated and were more active than those fed with a bottle or via automatic feeder (Wagenaar and Langhout, 2007, Fröberg and Lidfors, 2009). Flower and Weary (2001) found that both dams and calves separated after 2 weeks of contact had more movements and spent more time standing during a period of isolation than those separated at birth. Dams' natural welfare may be better addressed by allowing licking, rubbing, and intimate continuous contact with calf (Wagenaar and Langhout, 2007).

Despite these advantages, across multiple studies milk production was significantly lower when dams were housed with their calves (Flower and Weary, 2001, Johnsen et al., 2016). Johnsen et al. (2015) reported that calves separated from their dams by a solid wall had numerically more high and medium pitch vocalizations than dams separated but maintaining visual contact. Calves who are switched from suckling to solid feed show greater signs of behavioral stress, and decreased intake following weaning (Fröberg and Lidfors, 2009). Additionally, contrary to Wagenaar and Langhout (2007), weight gain did not differ between calves separated from dams at 6 hours, 1 day postpartum, or 4 days postpartum (Weary and Chua, 2000).

Although calf behavior and weight gain among suckling versus separated calves are well documented, little research has explored the effects of housing on dams' behavior, health, and components. Providing producers with a feasible option that prevents excess dam milk loss and allows for natural welfare of dams and calves requires us to explore options for housing calves and dams together. The objective was to conduct a pilot study investigating the effects of early separation versus nightly commingling of dams and calves at day 5 on dam and calf behavior, milk production, milk components, uterine health, calf health, and weight gain. We hypothesized that there would be no differences in dam or calf behavior, milk components, health, or weight gain among dams housed with their calves and dams housed without their calves. We also hypothesized that dams housed with calves would produce less milk than dams housed without calves.

Materials and Methods

Experimental Overview

The experiment was conducted at East Tennessee Research and Education Center Little River Dairy Unit under University of Tennessee under IACUC protocol 2549-0917.Primiparous cows (N =20) calved between October 24 and November 07, 2017. Cows were housed on sand bedded freestalls from day 0 to 5, milked twice daily (7:30 and 20:00), and fed a total mixed ration (TMR) containing corn silage, alfalfa silage, cotton seed, and orange pulp three times daily (6, 10:30, and 16:00). Calves (N = 20) were removed from their dams within 6 hours of calving and housed in individual straw bedded pens until day 5.To ensure passive transfer was successful, blood serum sample was collected 24 to 72 hours postpartum and tested for serum total protein (STP). Calves with a STP ≥ 5.5g/dL were assigned to treatments based on sex and birth date. Previously collected colostrum (≥ 50mg/ml IgG) was administered for first four feedings postpartum in 2L increments. Starting on day 3, calves were fed 2L of 26% crude protein and 20% fat BOV SC ClariFly Medicated Dairy Herd & Beef Calf Milk Replacer (Ag Central Co Op, Madisonville, TN) twice daily (6 and 17). From d 0 postpartum, calves were provided with ad libitum access to Calf Primer 1 (AG Central Co Op, Madisonville, TN) and water.

Dam Treatments

On day 5, dams milk was visually examined for abnormalities before study enrollment. Based on calf-assignment, dams were assigned to control (C; n = 10) and mixed (M; n = 10) treatment. Control dams remained indoor 24 h/d. Mixed dams were housed indoors from 6:30 to 19:30 and housed on pasture with their calves from approximately 20:00-6:00. Dams were visually assessed for clinical mastitis at each milking. Cows with symptoms of clinical mastitis were separated into a sick pen and treated for 3 or 5 d depending on severity. IceTags (IceRobotics, Edinburgh, Scotland) were applied to all dams left leg between d2 and d5, postpartum to measure lying time, lying bouts, and standing time. On days 7 ± 3 and 19 ± 3, teat end swabs were collected from dams for microbial analysis, as described by Rendos et al. (1975). Twice weekly, dams were rectally palpated and scored for uterine discharge on a 0-4 scale to test, as described by Urton et al., 2005. Composite milk samples were collected from dams on d 7 ± 5, 14 ± 5, and 19 ± 5 and analyzed for fat %, protein %, and SCC (Tennessee Milk Quality Lab, Knoxville, TN). Milk weights were automatically recorded at every AM and PM milking from d 3 to d 19.

Calf treatments

Holstein calves were randomly assigned by calving date and sex to either a C or M group. Control calves (n = 10) were housed individually during the day (6:00 to 20:00) and group housed nightly (20:00 to 6:00).Mixed calves (n = 10) were individually housed daily and group housed with their respective dams nightly. Calves were fed 2L thrice daily (6, 13, and 19:30) of 26% crude protein and 20% fat BOV SC ClariFly Medicated Dairy Herd & Beef Calf Milk Replacer. Calves were treated with 10 mL Kaolin-Pectin (Durvet Inc., Blue Springs, MO) twice daily (6 and 19:30). Electrolytes (RE-SORB, Zoetis, Parsippany, NJ) were administered as needed.

HOBO data loggers (Onset, Bourne, MA) were secured with veterinary wrap to calves' rear legs from days 5 to 19 to record lying bouts, lying time, and standing time. HOBO data loggers were rotated weekly between rear legs. On d 0 + 1 and twice weekly from d 5 to 19, calf health was scored for the drooping, head tilt, coughing, nasal and ocular discharge, fecal form, and rectal temperature (University of Wisconsin Calf Health Scoring Criteria, Madison, WI). Calves diagnosed with a combined health score > 5 or a fever ≥ 39.4 º C were kept individually housed 24 h/d, until health score retuned to ≤ 5 and rectal temperature was< 39.4. On days 0 + 3, 7 ± 3, 14 ± 3, and 19 ± 3, calves were weighed (Paul Livestock Scale, Adrian J. Paul Company, Duncan, OK). Between d 10 and 14, calves were subjected to a human approach test and scored on a 0-10 point scale as described by MacKay et al. (2014). In short, calves were individually released from hutches into the paddock, and allowed to roam for 2 minutes. An unfamiliar human (not involved in handling, feeding, or data collection) approached the calf in 1m steps with 10 seconds between steps. Once calf was reached, the calf's head, back, and legs, with 10 seconds between each movement.

Visual Observation

Once weekly, between d 5 and d 19, cows and calves in each group were monitored by direct visual observation for a minimum of 2 h. Control calves were monitored for play behaviors, calf-calf interactions, and lying behaviors. Control dams were monitored for lying behavior and dam-dam interactions. Calves in the mixed group were monitored for play behaviors as described in figure 2, calf-calf interactions, calf-dam interactions, and lying behaviors. Dams in the mixed group were monitored for lying behavior, dam-dam interactions, and dam-calf interactions.

Statistical Analysis

The MIXED procedure of SAS (SAS 9.4, Cary NC) was used to evaluate the effect of calf sex and treatment on calf and dam lying time, standing time, and lying bouts, milk production, SCS, milk fat %, and milk protein %, using calf and dam as a repeated measure.

Lying time, standing time, and lying bouts of calves and dams were edited to remove the 1 and 99 percentile, based on biological significance. A multiple linear regression was used to evaluate the relationship between steps per day and milk yield, considering fixed effects of calf sex and treatment. Dam uterine involution score was assessed as a binomial distribution of healthy (score = 0 or 1) and sick (score ≥ 2). Quarter teat end swabs were evaluated in a binomial distribution of no growth and growth. Approach test was evaluated in a binomial distribution as easily approached (score ≥ 7) and not easily approached (score < 7). Average daily gain (ADG) was evaluated as total body weight gain over 19 d. T-tests (SAS 9.4) were conducted to evaluate the effect of treatment on calf health score, dam uterine involution score, quarter teat end swabs, approach test, and ADG.

Results

Six male calves and 4 female calves were assigned to each group (average BW at birth ± SEM: C = 82.9 ± 17.0, and M = 79.8 ± 12.2). Production and behavior results are summarized in Tables 1, 2, and 3. Control dams milk production was not significantly different from dams milk (25.4 ± 2.03 vs 23.4 ± 2.04, $P = 0.49$). Milk components did not differ between groups: mean fat % (4.40 ± 0.23 vs 4.10 ± 0.21, $P = 0.35$), mean protein % (2.93 ± 0.11 vs 2.99 ± 0.11, $P = 0.69$), and mean SCS (2.84 ± 0.53 vs 2.01 ± 0.47, $P = 0.25$), did not differ between dam treatment groups. Although uterine involution score tended to be numerically greater among control dams (0.33 ± 0.48 vs 0.15 ± 0.37, $P = 0.06$), biological significance was not established. Uterine involution was scored on a whole-number scale from 1 to 4, suggesting that average dam uterine involution score was normal, regardless of treatment. Although treatment did not impact dam lying time among C and M, respectively (8.73 ± 0.25 vs 8.45 ± 0.22, $P = 0.22$), total dam daily lying time varied by calf sex. Dams with female calves spent an average of 55.8 more minutes lying daily that dams with male calves (8.00 ± 0.22 vs 8.93 ± 0.25, *P* = 0.01). Number of lying bouts did not differ between M or C dams (10.7 ± 0.86 vs 9.07 ± 0.78, *P* = 0.18). Dams with female calves tended to have 2.3 more lying bouts than those with male calves (8.70 ± 0.76 vs 11.07 ± 0.88, *P* = 0.06). Mixed dams averaged 318.56 more steps/d than C dams (1795.94 ± 86.12 vs 2114.5 ± 75.97, *P* = 0.01). Dams with female calves tended to take more steps (1846.88 ± 76.39 vs 2063.55 ± 85.64, *P* = 0.08). Teat end samples were predominantly (7/46) contaminated, preventing further analysis, indicating neither treatment negatively impacted teat end health more. Treatment did not affect calf average daily gain (0.77 ± 0.37 vs 1.09 ± 0.75, *P* = 0.20). . Mean calf BW did not differ between M and C calves at any point during the study period (*P* = 0.64). Approachability, as determined by approach test, was equal between treatment groups (8.3 ± 1.06 vs 7.4 ± 2.63, *P* = 0.33), meaning that calves of both groups could be approached within 0m without issue. Calf lying time (16.9 ± 1.1 vs 18.6 ± 1.2, *P* = 0.33), lying bouts (30.94 ± 6.67 vs 30.56 ± 7.58, *P* = 0.26) and standing time (7.1 ± 1.1 vs 5.4 ± 1.2, *P* = 0.33) did not differ between treatment groups.

Discussion

Mixed dams produced similar quantity of milk to C dams, suggesting little to no suckling occurred. Among studies with cows and calves housed together, parlor milk yields are typically lower (Flower and Weary, 2001), for two reasons: 1) calves suckle dams and 2) exposure to machine milking provides less stimulation for oxytocin secretion De Passillé et al. (2008). Milk yield among dams decreased even if calves were limited to two suckling sessions per day (De Passille et al., 2008). Despite M dams taking 319 steps/d more than C dams, increased step count was not associated with decreased milk production. Washburn et al. (2002) found that cows on pasture throughout lactation produced 11% less milk than those in freestalls, due to increased energy expenditure associated with distance walked from parlor to pasture four times daily (White et al., 2002). Although M dams might have increased energy expenditure while traveling to and from the pasture, milk yield remained unaffected. Further, these results did not consider potential variation caused by genetic potential of primiparous cows.

Dams with female calves spent more time lying and had more lying bouts than dams with male calves. Male calves have been found to be associated with more calving difficulty than female calves because of effects not associated with birth weight or gestation length (Bellows et al., 1971). Though no heifers experienced dystocia during this study, increased difficulty of delivering a male calf may have contributed to pain or discomfort among dams, which could have been exacerbated by lying, the act of switching between standing and lying, or movement. This could explain the male calf dams' decrease in lying bouts, lying time, and step count compared to the female calf dams. Mixing dams with calves had no effect on dam daily lying time or lying bouts. This disagrees with other research, as Legrand et al. (2009) found that cows had lowest daily lying times on pasture, while cows confined indoors had the highest daily lying time. The reason for this disagreement may be because M cows were not confined to pasture 24 h/d, and spent hours 8:00 to 19:30 confined to a pen with the C cows. Number of lying bouts for both C and M cows were greater (30.94 ± 6.67 vs 30.56 ± 7.58, $P = 0.26$) than averages reported by Champion et al. (1997). This discrepancy could have been a result of all cows being kept in a pen for the hours of 8:00 to 19:30, whereas the cows used by Champion et al. (1997) were housed on pasture and were non lactating. Cows in this study were also fed three times daily, potentially causing lying bouts to increase as cows rose to eat and subsequently lied back down more often.

Though M cows tended to have lower uterine involution score than C cows, the low scores of both groups are normal and indicate good health, and are likely biologically insignificant. Suckling by calves is known to increase the rate of uterine involution (Földi et al., 2006), and the fact that calves were not observed suckling correlates with the lack of difference in uterine involution score between the two groups.

Calves from both groups on average allowed an unfamiliar human to approach within 0m of the animal and raise a hand to touch it before the calf's retreat. This disagrees with other studies on calf novelty responses. Krohn et al. (2003) found that calves removed from the dams immediately or within 4 days postpartum and handled by humans were more likely to initiate contact with a human than calves handled in the presence of dams. Other studies show that dam contact may positively influence novelty response. (Flower and Weary, 2001) found that calves housed with dams for 14 days interacted with an unfamiliar calf more than calves removed from dams at birth. Daros et al. (2014) found that calves had a more negative response bias to an ambiguous color stimulus after separation from their dams. Given what is known from these studies, the lack of difference in calf response between treatments was unexpected.

The average approach test scores for this study (8.3 ± 1.06 control vs 7.4 ± 2.63 treatment, $P = 0.33$) are greater than those found in other studies. For comparison, approach test scores obtained with adult cows reported by MacKay et al. (2014) averaged 2.8, indicating that the cows retreated when the experimenter was less than 2m but greater that 1m away from the animal. The high tolerance for approach found in this study, as well as the lack of variation between groups, may have been due to all calves being frequently fed by a variety of both familiar and novel humans. Calves are more willing to approach a human who they regularly see and have contact with while feeding (Krohn et al., 2003), which may explain the calves' response to the approach test.

Results of this approach test should be interpreted with caution. Small sample size may have contributed to the lack of difference between treatment groups. Additionally, since calves were not observed to have extended interactions with dams, the effects of dam-calf contact may not have been adequate to affect calves' psychology. Calves have been found to show no avoidance behavior toward humans when raised with human contact and no dam contact, but actively avoid humans when contacted by humans in the dam's presence (Krohn et al., 2003). Considering this negative effect of the dam's presence on willingness to approach a human, the results of this test may have differed if it were conducted in the presence of the dam. These results may also have been influenced by the test environment. The novelty testing was conducted in the treatment paddock after calf feeding and release from the hutches, and not in a familiar alleyway as described by MacKay et al. (2014) as the most repeatable method of approach testing.

Calf ADG did not differ between M and C treatments. Calves allowed to suckle their dams gain weight faster because of increased milk intake (Flower and Weary, 2001, De Passillé et al., 2008). Since calves were not observed suckling during the study, calves were not able to benefit from the increased milk intake associated with suckling, which corresponds with the lack of difference in ADG observed. Calf end weight for C and M calves, respectively, was 44.31 ± 5.12kg and 45.58 ± 4.58kg. Mean calf BW did not differ between M and C calves at any point over the study period, as figure 1 shows. This low difference in weight supports the postulation that calves did not suckle their dams, as M calves would be expected to have a greater rate of weight gain and a higher end body weight if suckling (Flower and Weary, 2001, De Passillé et al., 2008).

Weary and Chua (2000) suggest that calves that spend more time with their dams spend more time standing after separation from their dam than those separated immediately after birth. Calves housed in hutches were found to have more lying bouts per day than calves housed in a yard (Dellmeier et al., 1985). Since dams were not housed with calves 24 h/d, calf response to removal of the mother may not have had as strong of an effect on calf behavior because of the dam being removed from the calf daily. The calf may have been able to acclimatize to the dam being removed and returned hours later, and thus the response to separation in M calves may have been reduced. Differences in lying bouts may not have been found because all calves experienced the same housing treatments, being housed in hutches during the day and pasture at night. Calves of both treatments had more lying bouts than those reported by Dellmeier et al. (1985) for any housing treatment. Dellmeier et al. (1985) reported that calves in hutches changed position more frequently than those in stalls, pens, or a yard in order to seek or hide from sun depending on the weather. This effect combined with being moved to and from hutches twice daily may have contributed to a larger number of lying and standing bouts found in this study as compared to others.

This study was only representative of primiparous cows, therefore further studies should investigate more representative samples including multiparous cows. Further studies should also balance experimental groups on sex as well as for projected milk yield in order to reduce variation in results. Focus more on effects of dam as compared to that of calf. Approach score and teat swabs could be collected adhering closer to the protocols described in MacKay et al. (2014) and Rendos et al. (1975), respectively, in order to obtain more repeatable results.

Conclusion

This pilot study investigated a broad range of effects of nightly mixing of calves and dams. The results of this study may provide insight to the effect of dam-calf contact on dams in particular, which few studies have specifically investigated. Milk yield was found to be decreased in M cows, however biological significance of this was not established. No negative effects on milk components, standing and lying behavior, or uterine involution were associated with nightly mixing of calves and dams. No negative effects on calf ADG, standing and lying behavior, or approach score were associated with nightly mixing of calves and dams. Further studies should investigate these effects on multiparous dams alone and mixed multiparous and primiparous dams on behavior and production. Results obtained suggests that nightly commingling may be a viable method to address public concerns without sacrificing the welfare of dairy calves and dams.

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Table 1: Results of treatment group on dam milk production, milk components, uterine Involution, lying time, step count, and lying bouts.

Variable	**Control Dams ± SEM**	**Treatment Dams ± SEM**	***P* value**
Milk production (kg/d)	25.4 ± 2.03	23.4 ± 2.04	0.49
SCS	2.84 ± 0.53	2.01 ± 0.47	0.25
Fat %	4.40 ± 0.23	4.10 ± 0.21	0.35
Protein %	2.93 ± 0.11	2.99 ± 0.11	0.69
Uterine involution Score	0.33 ± 0.48	0.15 ± 0.37	0.06
Lying time/d dams (h/d)	8.73 ± 0.25	8.45 ± 0.22	0.13
Number of lying bouts (bouts/d)	10.7 ± 0.86	9.07 ± 0.78	0.18
Steps/d	1795.94 ± 86.12	2114.5 ± 75.97	0.01

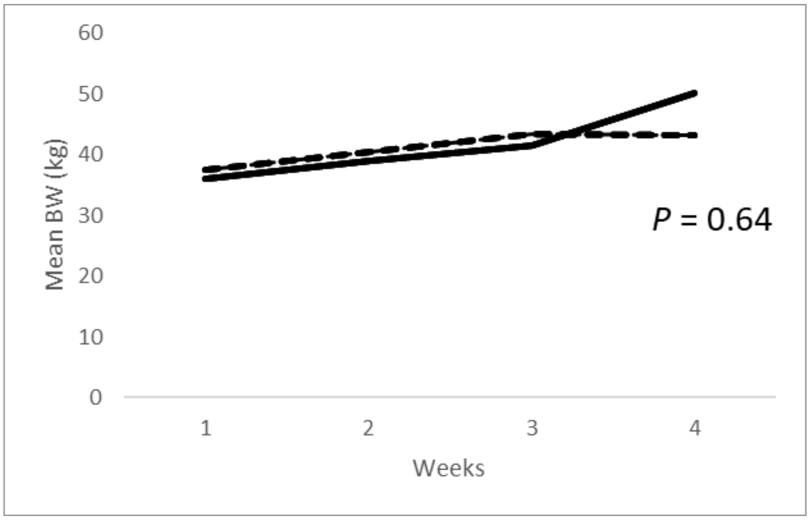
Table 2: Results of calf sex on dam lying time, lying bouts, and step count.

Variable	**Male Calves ± SEM**	**Female Calves ± SEM**	***P* value**
Lying time/d dams[1] (h/d)	8 ± 0.22	8.93 ± 0.25	0.01
Number of lying bouts[1] (bouts/d)	8.7 ± 0.76	11.07 ± 0.88	0.06
Steps/d [1]	1846.88 ± 76.39	2063.55 ± 85.64	0.08

Table 3: Results of treatment on calf ADG, approach test score, lying time, standing time, and lying bouts.

Variable	**Control Calves ± SEM**	**Treatment Calves ± SEM**	***P* value**
ADG (kg/d)	0.77 ± 0.37	1.09 ± 0.75	0.2
Approach Score	8.3 ± 1.06	7.4 ± 2.63	0.33
Lying time calves (h/d)	16.9 ± 1.1	18.6 ± 1.2	0.33
Standing time calves (h/d)	7.1 ± 1.1	5.4 ± 1.2	0.46
Lying bouts calves (bouts/d)	30.94 ± 6.67	30.56 ± 7.58	0.26

Figure 1: Mean weekly body weight of calves. C calves are represented by a dashed line and M calves are represented by a solid line. Weeks are defined as week 1: d 0 + 3, week 2: d 7 ± 3, week 3: d 14 ± 3, week 4: d 19 + 3.



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