

Vocalization and behavior of Holstein cows and calves after partial and complete separation[□]

Vocalización y comportamiento de vacas y terneros Holstein luego de separación parcial y total

Vocalização e comportamento de bezerras e vacas Holandesas após separação parcial e completa

Shin-Jae Rhim^{1*}, PhD.

¹*School of Bioresource and Bioscience, Chung-Ang University, Ansong 456-756, Korea.*

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Summary

Background: a potential negative impact on the welfare and growth of the calf occurs when it is separated from its mother. **Objective:** this study was conducted in order to understand how the vocal and behavioral characteristics of cows and calves differ between partial and complete separations. **Methods:** 30 cows and their calves (60 study participants in total) housed in different barns were observed for 10 consecutive hours using video technology on days 1, 6, and 11 after partial and complete separations. **Results:** vocalization frequency was higher ($p < 0.05$) following partial separation for both cows and calves. After complete separation, cows exhibited significantly more ($p < 0.05$) lying behavior as well as fewer ($p < 0.05$) standing and sniffing behaviors. **Conclusions:** the study revealed higher intensity and occurrence of vocalization levels and behavioral changes in cows and calves following partial separation. It is concluded that partial separation could imply higher interaction between cows and calves and also greater animal welfare challenges in comparison with complete separation.

Key words: *animal welfare, behavior, cattle, video technology, vocal characteristics.*

Resumen

Antecedentes: un posible impacto negativo sobre el bienestar y el crecimiento del ternero se produce cuando este se separa de su madre. **Objetivo:** este estudio tuvo como objetivo comprender como las características vocales y de comportamiento de vacas y terneros difieren luego de la separación parcial o completa entre ambos. **Métodos:** 30 vacas y sus terneros (60 animales en total) alojados en establos separados fueron observados durante 10 horas consecutivas utilizando tecnología de video durante los días 1, 6, y 11 después de separación parcial o completa. **Resultados:** la frecuencia de vocalización fue mayor ($p < 0,05$) tras la separación parcial de vacas y ternero. Después de la separación completa, las vacas yacían más en el piso ($p < 0,05$), permanecían menos tiempo de pie y tenían menos comportamiento de olfateo

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* Corresponding author: Shin-Jae Rhim, School of Bioresource and Bioscience, Chung-Ang University, Ansong 456-756, Korea. Tel: 82-31-670-4842, Fax: 82-31-676-4842. E-mail: sjrhim@cau.ac.kr

($p < 0,05$). **Conclusiones:** el estudio reveló una mayor intensidad y frecuencia de vocalizaciones y cambios de comportamiento en las vacas y los terneros tras la separación parcial. Se concluye que la separación parcial podría implicar una mayor interacción entre las vacas y los terneros y también mayores desafíos de bienestar animal en comparación con la separación completa.

Palabras clave: *bienestar animal, características vocales, comportamiento, ganado, tecnología de video.*

Resumo

Antecedentes: um possível impacto negativo no bem-estar e crescimento ocorre quando o bezerro é separado de sua mãe. **Objetivo:** descrever as características comportamentais e emissões vocais de bezerros e vacas Holandesas após separação parcial e completa. **Métodos:** 30 vacas e seus bezerros (para um total de 60 amostras no estudo) localizados em diferentes lugares foram observados consecutivamente usando a tecnologia do vídeo por 10 h nos dias 1, 6 e 11 em separações completas e parciais. **Resultados:** a frequência de emissões vocais foi maior tanto nas vacas quanto nos bezerros ($p < 0,05$) após uma separação parcial. Após uma separação completa, as vacas exibiram com uma frequência significativamente maior o comportamento de estar deitadas ($p < 0,05$), tanto quanto significativamente menor ($p < 0,05$) o comportamento de estar paradas e de cheirar. **Conclusões:** a pesquisa revelou maiores níveis de vocalização e comportamento nas vacas e bezerros após a separação parcial. Conclui-se com estes resultados que a separação parcial permite uma maior interação entre a vaca e o ternero, fato que implica um maior desafio em relação ao bem-estar animal comparado com a separação completa.

Palavras chave: *bem-estar animal, comportamento, gado de leite, tecnologia de vídeo, vocalização.*

Introduction

In intensive dairy farming, it is common to remove the calf from the cow immediately or shortly after parturition and to rear the calf on whole milk or a milk substitute using buckets or nipples (Khan *et al.*, 2007; Budzynska and Weary, 2008; Fröberg *et al.*, 2008). The milk-feeding period is very critical (Svensson *et al.*, 2003), as calves at this age are at greatest risk for diarrhea and respiratory diseases (Lundborg *et al.*, 2005). Handling the calf immediately following birth is necessary for routine management procedures (Turner and Lawrence, 2007; Fröberg and Lidfors, 2009). Housing the calves in individual booths is thought to help control disease, abnormal sucking behavior, and feed intake (Nielsen, 2009; Duve and Jensen, 2011).

There are indications that early interactions between cow and calf resulting from the calf's colostrum intake extend beyond the immune system benefits (Krohn *et al.*, 1999). Cow and calf separation can cause stress, particularly if the separation occurs after a substantial period of time together. Following initial separation, the cow makes attempts to reunite with the calf through increased locomotion and vocalization and can even

resort to breaking separation fences (Phillips, 2002). Social isolation is stressful for calves (Raussi *et al.*, 2003) and may inhibit the acquisition of essential social skills needed to cope in a group environment, which all dairy cattle are subjected to later in life (Veissier *et al.*, 1994). Growing up without contact with the mother has severe consequences for young animals (Roth *et al.*, 2009).

A potentially negative impact on calf welfare occurs when it is separated from its mother. Early separation can result in adverse effects such as the thwarting of maternal behavior, which can eventually lead to isolation of the neonate (Flower and Weary, 2003). Responses to separation within the first 10 minutes, including increased heart rate and vocalization, are quite mild (Hopster *et al.*, 1995). When cows and their calves are separated, they spend a long time pacing the field boundaries in an attempt to reunite as well as standing and watching each other (Price *et al.*, 2001). Moreover, the management system can influence cow and calf behavior. Calves raised in isolation can excessively lick themselves as well as foreign objects. (Stephens, 1982; Wood-Gush *et al.*, 1984).

No study in South Korea has been conducted on the behavioral research of Holstein cows and

calves after separations. This study focused on investigating differences in the vocal and behavioral stress of Holstein cows and calves as a result of different separation methods.

Methods

This study was carried out at the experimental research station of Chung-Ang University, located in Ansong, Gyeonggi Province, Korea. A total of 30 cows and 30 calves were observed. All of the cows gave birth to their calves in separate calving pens (3.0 x 3.0 m). Calves were separated from their mothers on the day of birth using either partial or complete separation methods. For partial separation, the calf was housed in a barn (3.0 x 3.0 m) adjacent to the cow barn (6.0 x 6.0 m), with no visible contact with the mother. The barns were separated by a solid wood wall, which visually isolated the cow and calf. However, they could recognize each other via auditory and olfactory senses through the barrier. During complete separation the calf was isolated in a separate barn (3.0 x 3.0 m) located a far distance from the other.

Calves were bottle fed whole milk while cows were fed a total mixed ration (TMR) twice a day along with full access to water. Cows were machine milked by the staff twice daily at 06:00 and 16:00. All cows and calves were kept in an enclosed barn on deep litter without access to a barnyard or pasture and their health was monitored throughout the study, at least two times weekly.

Fifteen replicates of each treatment were evaluated during 2007 and 2008. Two wide-angle video cameras were installed at the corner of the ceiling. Cow and calf behavior was video-recorded continuously for 10 h per day over 3 non-consecutive days. Behaviors were analyzed based on images and vocalizations digitally recorded from 08:00 to 18:00 h on days 1, 6, and 11 (day 0 = day of birth). Video was analyzed using a jog-shuttle function. Instantaneous scan sampling was carried out at 2 min intervals. In order to eliminate subjective bias and potential discrepancies among individuals, all video recordings were

viewed by a trained observer with no knowledge of the treatment (Li and Wang, 2011).

Vocalizations were determined based on direct video observation. The following behaviors were recorded: standing, lying, eating, ruminating, licking, sniffing, among others (Table 1). The frequency and duration (in minutes) of these behaviors was recorded from video recordings of days 1, 6, and 11 following separation.

Table 1. Observed behaviors and their respective definitions (adapted from Loberg *et al.*, 2008; Fröberg and Lidfors, 2009). All behaviors were recorded in the scan sampling.

Behavior	Description
Vocalizing	Making an audible sound through the mouth
Standing	Standing at certain position without movement
Lying	Lying down in any resting position
Eating	Taking TMR in to the mouth followed by chewing and swallowing
Ruminating	Chewing after regurgitating
Licking	Licking objects or themselves
Sniffing	Appearing to inhale air through the nose
Other	All other behaviors not listed above

All data were analyzed using the Glimmix procedure of the SAS software (SAS Inst. Cary, NY, USA) with the pen serving as the experimental unit. The residual data sets were tested for normal distribution using the Univariate procedure of SAS. The data were log-transformed to follow normal distribution (Zar, 1999) and analyzed by ANOVA. Tukey's post hoc tests were used to determine pair-wise differences between treatments; significance was declared at $p < 0.05$.

Results

Separation exhibited a significant impact on the frequency of vocalizations for calves under partial (ANOVA, $F_{2,28} = 8.59$, $p < 0.05$) and complete ($F_{2,28} = 17.26$, $p < 0.001$) separation periods. During partial separation, calf vocalization frequency was greater on days 1 and 6 (Tukey's test, $p < 0.05$). Also, the calf vocalization frequency was higher on day 1 and lower on day 11 ($p < 0.01$). There were no differences in cow vocalization frequency undergoing partial separation ($F_{2,28} = -2.14$, $p = 0.27$). However, cow vocalization frequency differed significantly

on days 1, 6, and 11 during complete separation ($F_{2,28} = 19.35, p < 0.001$). Vocalization frequency was higher on day 1 than days 6 and 11 ($p < 0.01$). There were no differences in vocalization frequency for cows and calves on day 1 under both partial and complete separations. However, vocalization frequency was significantly different under partial and complete separation conditions for cows and calves (Figure 1).

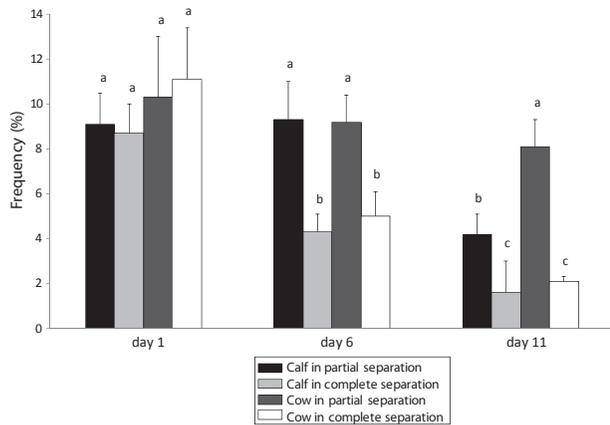


Figure 1. Square root transformed least square means (\pm SE) for the proportion of time spent vocalizing at day 1, day 6, and day 11 following partial and complete separations. Different letters indicate significant differences between the mean values on a given day ($p < 0.05$).

Total duration of standing for cows was significantly different in partial ($F_{2,28} = 6.91,$

$p < 0.05$) versus complete ($F_{2,28} = 9.47, p < 0.05$) separations at days 1, 6, and 11 following separation. The duration of standing time was long at day 1 and short at day 11 in both cases ($p < 0.05$). Time spent lying was significantly different among days 1, 6, and 11 in partial ($F_{2,28} = 8.16, p < 0.05$) and complete ($F_{2,28} = 12.38, p < 0.05$) separations. The duration of lying was higher in day 11 and lower in day 1 for both separations ($p < 0.05$). The frequency of sniffing was not significantly different for partial ($F_{2,28} = -10.23, p = 0.58$) and complete ($F_{2,28} = -15.39, p = 0.76$) separations on days 1, 6, and 11 (Table 2).

For calves, the total duration of standing was different for partial ($F_{2,28} = 5.23, p < 0.05$) and complete ($F_{2,28} = 6.42, p < 0.05$) separation between days 1, 6, and day 11 following separation. The duration of standing was higher on day 1 and lower on day 11 for both partial ($p < 0.05$) and complete ($p < 0.05$) separations. However, the duration of lying increased as time passed. During partial separation, the frequency of licking ($F_{2,28} = -4.15, p = 0.45$) and sniffing ($F_{2,28} = -7.52, p = 0.67$) was not significantly different according to the day. However, licking and sniffing frequency was higher on day 1 ($p < 0.05$) and lower on day 11 ($p < 0.05$) (Table 3).

Table 2. Mean (\pm S.E.) behavior of cows on days 1, 6, and 11 following partial and complete separation.

Behaviors	Day 1		Day 6		Day 11	
	Partial	Complete	Partial	Complete	Partial	Complete
Total duration of standing (min/h)	24.3 \pm 3.6	22.7 \pm 2.9	25.6 \pm 5.7	17.2 \pm 3.4	21.2 \pm 2.1	13.1 \pm 2.4
Transformed data	1.8 ^b	1.8 ^b	1.8 ^b	1.5 ^c	1.7 ^b	1.4 ^c
Total duration of lying (min/h)	5.6 \pm 1.4	15.2 \pm 2.9	10.5 \pm 2.3	18.2 \pm 4.3	11.3 \pm 1.9	19.3 \pm 3.1
Transformed data	1.1 ^d	1.5 ^c	1.4 ^c	1.6 ^b	1.4 ^c	1.7 ^b
Frequency of sniffing (No./h)	45.3 \pm 6.8	21.7 \pm 3.5	47.2 \pm 4.5	19.3 \pm 2.4	42.6 \pm 5.3	20.1 \pm 3.1
Transformed data	2.1 ^a	1.7 ^b	2.1 ^a	1.7 ^b	2.0 ^a	1.7 ^b

Different letters indicate significant differences between mean values on a given day ($p < 0.05$).

Table 3. Mean (\pm S.E.) behavior of calves at day 1, 6, and 11 following partial and complete separations.

Behaviors	Day 1		Day 6		Day 11	
	Partial	Complete	Partial	Complete	Partial	Complete
Total duration of standing (min/h)	32.1 \pm 6.3	30.7 \pm 4.2	30.8 \pm 3.4	21.3 \pm 2.9	25.2 \pm 3.5	15.4 \pm 1.7
Transformed data	2.0 ^a	2.0 ^a	2.0 ^a	1.8 ^b	1.8 ^b	1.6 ^b
Total duration of lying (min/h)	3.4 \pm 1.1	5.7 \pm 1.4	6.2 \pm 2.7	8.5 \pm 2.1	6.0 \pm 1.3	15.2 \pm 2.6
Transformed data	0.9 ^d	1.3 ^c	1.3 ^c	1.4 ^c	1.3 ^c	1.6 ^b
Frequency of licking (No./h)	47.2 \pm 5.9	49.3 \pm 3.6	39.3 \pm 3.9	26.9 \pm 5.1	30.2 \pm 6.1	15.1 \pm 3.3
Transformed data	2.2 ^a	2.2 ^a	2.1 ^a	1.8 ^b	2.2 ^a	1.6 ^b
Frequency of sniffing (No./h)	31.2 \pm 2.6	34.6 \pm 2.9	29.8 \pm 3.1	20.3 \pm 2.1	34.2 \pm 3.9	18.3 \pm 2.7
Transformed data	2.2 ^a	2.2 ^a	2.2 ^a	1.8 ^b	2.2 ^a	1.7 ^b

Different letters indicate significant differences between mean values on a given day ($p < 0.05$).

Discussion

Cows and calves in this study demonstrated a strong vocal response following separation, with many demonstrating peak response on the first day following separation in both partial and complete separations. During complete separation, vocalization decreased as time passed, as compared with partial separation. Future studies on this topic should continue to monitor vocal responses until a clear trend towards baseline levels is shown. Following separation, all cows demonstrated vocalizations, indicating that cows respond maternally in looking for their calves (Hopster *et al.*, 1995; Loberg *et al.*, 2008).

Cattle are known to respond vocally, physically, and psychologically to stressful situations (Watts and Stookey, 2000). Previous studies suggest that calves are often highly vocal following separation after weaning (Thomas *et al.*, 2001; Jasper *et al.*, 2008). Separation can be highly stressful for the calves. Watts (2001) observed pairs naturally separated under extensive pasture conditions, reporting that both cows and calves demonstrated an increase in their rate of vocalization and spent more time walking, which culminated in reunion and nursing.

Domesticated animals in intensive husbandry settings often demonstrate behaviors that occur outside of their normal functional context. For example, calves reared separately from their mothers and hand-fed milk will occasionally suck on objects in the pen or at other calves (Mason and Rushen, 2006; Rushen *et al.*, 2008).

During this study, the total duration of standing during partial separation was greater for the cows in days 6 and 11 than in complete separation. Most of this behavior involved standing with the head toward the wooden wall. This behavior suggests the cow's willingness to reunite with the calf. Calves tended to stand with their head toward the wooden wall during partial separation.

Partial separation may facilitate the attachment between dam and calf. Vocal and olfactory senses may have interfered with attachment. Time lying down increased for cows and calves in the days following both types of separation, suggesting

a gradual adaptation to their new environments. During complete separation, the vocalization frequencies of cows and calves significantly declined at days 6 and 11, suggesting adaptation following separation between dams and their calves. According to the results observed in this study, partial separation is good for calf welfare.

Vocalization and behaviors such as lying, standing, and sniffing may be alternative responses to separation. There is evidence of consistent yet unique differences among calf response to diverse challenges (van Reenen *et al.*, 2004). No physiological measures were taken in this study, but other physiological research has supported the hypothesis that separation is a stressful experience for both mother and young. Lefcourt and Elsasser (1995) reported increases in peripheral catecholamine concentrations in beef calves as well as increases in epinephrine concentrations in dams in response to separation.

Under commercial conditions, the dairy cow and calf should be separated in order for the cow to be milked. One current argument against early cow-calf contact is that the immediate distress of separation remains high (Flower and Weary, 2001). Because separation is linked to distress, it has been suggested that the cow and calf should have the opportunity to stay together for some time. The question of how to balance the positive effects of early cow-calf contact against the negative effects of distress following separation remains to be answered. Further research is needed to determine the underlying biological characteristics of the cows and calves that are behaviorally observed during long term studies following separation.

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