



Behavioural priorities and feed intake in early post-partum dairy cows

Effects of calf presence

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Behavioural priorities and feed intake in early post-partum dairy cows – Effects of calf presence

Beteendeprioriteringar och foderintag för kor efter förlossning – Effekter av kalvens närvaro

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Abstract

The transition from the dry period to early lactation is the most metabolically challenging phase for dairy cows, during which sufficient feed intake is essential to support the following lactation and reduce the risk of metabolic disorders. Standard practice is to separate the calf from its mother after birth, but by keeping the calf after parturition, behavioural priorities of the cow may differ compared to cows without the calves, by increasing care taking behaviours. So far, no research has been done in this area, and the aim of this study was therefore to investigate if cow-calf contact (CCC) affected the cow's behavioural priorities related to feeding and resting, as well as dry matter intake (DMI), energy intake, and feed sorting in dairy cows in the first days postpartum. Data were collected from 19 Swedish Holstein (SH) and 22 Swedish Red Breed (SRB) dairy cows that were randomly allocated to either long contact (LC, $n=20$) or short contact (SC, calf separated approx. 12 h after birth, $n=21$). Behavioural data ($n=37$) was evaluated from video recordings using 5 minutes scan sampling for 3h followed by 1h pause for 48h after parturition for 2 discrete interval periods: interval A (0-7h postpartum) when all cows had contact with their calf and interval B (with 3 focus periods: B1=13-23h, B2=25-35h and B3=37-47h postpartum) when calves had been removed from SC cows. Feed data ($n=39$) included total feed intake and feed sorting over the first 2 days of lactation. There were no differences in cow or calf behaviour between the treatment groups during the first 7 h postpartum. However, significant effects of breed were shown in feeding time ($p<0.05$), with SH spending more time than SRB on feeding (9.4 and 7.6 % of the 7 hours, respectively). Also, a tendency for effect of breed was found for standing and lying ($p>0.05$) where SRB spent more time standing (60 %) and less time laying down (40 %), compared to SH (53 % standing, 47 % lying). During time interval B, a significant interaction was shown between treatment and interval ($p<0.05$). Post hoc analysis showed that LC cows increased their eating behaviour from interval B1 to interval B2, compared to SC cows which decreased their eating behaviour between these intervals ($p<0.05$). However, there was a strong tendency ($p=0.0516$) for SC to increase rumination time from interval B1 to B2, whereas rumination time did not change in LC cows between B1 and B2. Furthermore, in B2 there was a significant effect of breed ($p<0.05$) with SH spending more time on feeding (20 %) than to SRB (16 %). There was a significant effect of parity and day for both DMI ($p<0.0001$, and $p<0.05$) and energy intake ($p<0.0001$, and $p<0.05$ respectively), where multiparous cows and observation day 2 had higher DMI and energy intake than primiparous cows. Feed sorting was not affected by treatment. These results showed that primiparous cows spent more time standing (57 %) compared to multiparous cows (44 %), and that SH spent more time feeding (20 %) compared to SRB (16 %). Also, DMI and energy intake showed significant results for parity and day, while there was a tendency for more sorting in lower parity cows. In conclusion, CCC did not affect behavioural priorities or feed intake negatively.

Keywords: Cow-calf contact, dairy cows, post-partum, feed intake, behaviour, time budget

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Abbreviations

ADF	Acid Detergent Fibre
CCC	Cow Calf Contact
CP	Crude protein
DM	Dry Matter
DMI	Dry Matter Intake
EB	Energy Balance
LC	Long contact
ME	Metabolizable Energy
NDF	Neutral Detergent Fibre
NEB	Negative Energy Balance
NEFA	Non-Esterified Fatty Acids
PMR	Partial Mixed Ration
PSPS	Penn State Particle Separator
SARA	Subacute Ruminal Acidosis
SC	Short Contact
SH	Swedish Holstein
SRB	Swedish Red
TMR	Total Mixed Ration

1. Introduction

In modern dairy production, it is standard practice to separate the calf from its mother, where the cow is placed in a group of lactating cows, and the calf is placed in individual or group pens in a calf unit. The reasons for this practice include maximising milk yield for human consumption, biosecurity, and avoiding a stressful situation with cow and calf separation at a later point. Early separation of the cow and calf is primarily motivated by production efficiency and control of infectious diseases (Jensen 2011). The transition from the dry period to early lactation is one of the most physiologically demanding phases in the dairy cow's production cycle. As lactation begins, nutrient requirements increase rapidly to support milk synthesis, while feed intake is often reduced, placing cows at increased risk of negative energy balance and metabolic stress. Consequently, the transition period is associated with a high incidence of metabolic and infectious production diseases, making effective management essential for maintaining both animal welfare and productivity. Metabolic disorders such as hypocalcaemia (milk fever) and ketosis are particularly common during the first weeks after calving (Mulligan & Doherty 2008). Any extra demand during this period could therefore increase the risk of metabolic disorders. Consequently, farmers and researchers have expressed concerns that prolonged cow–calf contact may alter the cow's time budget by increasing the time devoted to nursing and maternal care, potentially affecting behavioural priorities such as feeding and resting (Jensen 2011; Johnsen et al. 2021; Whalin et al. 2025).

Behavioural aspects that contribute to the risk of production diseases in the early post-partum period are the decrease in feed and water intake before parturition and the high priority for the newborn during the first hours after parturition (Jensen, 2012). Negative energy balance (NEB) leads to immunosuppression, which increases the risk of developing secondary diseases. The reasons are often due to the diseases' relationships with each other and can therefore result in domino effects on the cow, which increases her risks of other diseases and reduced fertility and milk production (Mulligan & Doherty 2008). It is therefore important to ensure a sufficient feed intake after parturition, to minimize the cow's physiological changes and at the same time allow her to express natural behaviours. Cows in lactation have been shown to be able to regulate the consumption of feed by adjusting the total time, frequency and duration to a certain level if their environment requires it (Munksgaard et al. 2005). The question is how much the presence of the calf affects the feed intake in combinations with the changed priorities after parturition (Jensen 2011; 2012).

Public interest in cow-calf separation practices has increased, with concerns primarily related to animal welfare, including the emotional well-being and health of both the cow and the calf. Producers, on the other hand, often emphasize practical management aspects and potential challenges associated with prolonged cow-calf contact, such as increased stress during separation.

These differing perspectives highlight the complexity of balancing animal welfare considerations with farm management practices (Ventura et al. 2013). In response to the public worries about the early separation and animal welfare (Agenäs 2017), the possibility exists to use the system of cow-calf contact (CCC). The use of CCC can be in different types of systems where the duration of the connection and the weaning differ. The main focus of CCC systems is that the cow gets the opportunity to express nursing behaviours to bond with its offspring (Sirovnik et al. 2020). In systems where the cow and calves have contact with each other, the calves show better developed social abilities, better weight gain, and better function of their digestive system. Cows with CCC connect with their calves, show better udder health with no effect on the milk yield (Ventura et al. 2013), though it affects the amount of marketable milk, even if it is difficult to measure the exact milk loss (Churakov et al. 2023).

In today's available research about CCC, the main focus has been on different subjects related to milking, rearing, lower milk yield, or the society's view on early separation. So far, few articles have investigated how the calf presence affects the cow's feed intake and the potential risks. Due to the limited knowledge regarding the effects of calf presence on the cow's feed intake and behaviour the first days after calving, this study focuses on how the presence of the calf affects standing time, lying time, and feed intake in cows during the first days postpartum. This paper will therefore combine behavioural studies with measurements of feed intake, feed sorting. This thesis will investigate the differences between cows with the calf present >12 hours after parturition (long contact = LC), and cows who are separated from the calf 12 hours post-partum (short contact = SC). Therefore, the hypothesis for the study is:

“Cows that are allowed to keep their calf will spend more time on activities related to cow calf bonding and nursing the calf, and less time eating and resting. This without affecting the total feed intake or feed sorting during this period”.

2. Literature review

2.1 Behaviours

2.1.1 Cow-calf contact

Cows

Directly after parturition, cows' main focus is to nurse and lick their newborn (Jensen 2012). The motivation to lick the calf depends both on the hormonal state of the cow and on the amniotic fluid, which normally attracts cows. Cows' motivation to express the licking behaviour is at its highest the first hour after parturition and occupies their priorities up to 50 %, with lower occurrences by primiparous and multiparous cows possessing more than four parities. The decreased frequency of licking the calf can thus be compensated for in the second hour, but mostly by the primiparous cows (Edwards & Broom 1982). The intensity of the caregiving behaviours is at its highest the first hour after parturition (Jensen 2012), and decreases the following three days (Jensen 2011). Immediately after parturition, cows and their calves, housed in individual pens, are typically located within 1 metre of each other. However, this distance increases progressively over the following days (Lidfors 1996). A study by Jensen (2012) with 38 Danish Holstein Frisian cows showed that nursing-related maternal behaviours reduce the time cow's spent on feeding and resting during the first 6 hours after parturition. Because the transition period is associated with an increased risk of production diseases, the author suggests that providing ample opportunity for cows to rest and feed after calving may be beneficial for their welfare and recovery (Jensen 2012). Differences have been observed by Edwards & Broom (1982), with an increased time between parturition and eating hay for each parity, but where multiparous cows spend more time eating compared with primiparous cows. The reason for differences in feed intake can depend on multiparous cows are less excited about a new calf and keep a longer distance from its offspring (Edwards & Broom 1982). The decreased priority for drinking water is shorter, compared to the feed intake, and is maintained instead for two hours. Cows' duration of lying events changes after parturition, to an increased number of lying occasions and activity level, but with a decreased duration of lying. The opposite behavioural development, compared to before calving (Jensen 2012). After parturition and by the arrival of the placenta, a natural behaviour is to ingest it, to avoid predators and in combination with cows' attraction to birth fluids. The benefits of ingesting the placenta is its value of minerals, which can be lacking after parturition (Edwards & Broom 1982).

Behaviours by long-term contact (14 days) between the calf and its mother results in calves with better developed social skills together with later maternal behaviour, compared to calves with short term contact (24 hours). After intense care giving behaviours after parturition, the cow's duration of social contact with its offspring reduces, through behaviours such as licking and

sniffing. At the same time, the cow shows increased interest in social interaction with other cows. That type of behaviour can indicate the cows need of interaction with animals at her own stage and also reflect the natural time for introduction of the calf to the herd in their natural environment. In natural conditions, the cow introduces its calf to the herd usually after one to two weeks. This can be reflected to domestic cows, who increases the interests of other cows the following 3-11 days after parturition, but expressed in separate calving pens (Jensen 2011).

Differences in behaviour can likewise occur depending on parity and earlier experience, which affect the cow's behaviour; thus, they also affect the calf (Edwards & Broom 1982; Houwing et al. 1990; Jensen 2011). Dairy farms have a mean culling rate of 38%, which typically results in the same number of replacement animals. This contributes to a shorter productive lifespan and fewer older, multiparous cows (De Vries & Marcondes 2020). Earlier experiences of long-term contact with its mother leads to more nursing behaviours later in life, expressed by licking and feeding their own offspring (Jensen 2011). The duration of licking periods is shorter in primiparous cows, in combination with a more sensitive approach, where the amount of licking does not depend on external disturbances (Edwards & Broom 1982). Cows' parity does not only affect the time between parturition and suckling, but also affects the duration of suckling. The reason might depend on lower milk flow and less available milk for primiparous cows (Houwing et al. 1990). Behaviours such as aggression show in higher frequency in primiparous and can be related to the animal's birth experience, in combination with fear of its offspring and the new situation (Edwards & Broom 1982).

Calves

After parturition, the behaviour of the calf might depend on its sex and differ, which affects the calf's activities. Heifers are shown to have a shorter interval between birth and time for suckling, which might relay to their lighter birth weight, compared to bulls (Houwing et al. 1990). Calves normally show changes in their behaviour after the first days with contact to their mother, by increased play behaviour together with longer durations of social interactions with their mother (Jensen 2011). Social behaviour with the mother may depend on a lack of other conspecifics but also on strengthening the filial bond with its mother. The social behaviour can also be an indication of bonding to the mother, to later be introduced to the group (Jensen 2011).

2.1.2 Effects of the separation

The reasons for separation between the cow and its calf are several and depend, among other things, on control of diseases, milk production and economic losses due to production diseases (Mulligan & Doherty 2008; Jensen 2011). The behavioural responses to separation differ between the cow and its calf, and vary depending on when the separation occurs (Houwing et al. 1990; Weary & Chua 2000). The effect of separation between the cow and its calf differs between the two individuals and depends on the timing of the separation. Calves separated several days after birth show an increased standing time and more movements in the pen compared to calves

separated shortly after parturition (Weary & Chua 2000). In contrast, cows with a developed bond to their calf show a decreased intake of roughage and concentrate after separation from the calf. Roughage intake returns to normal level withing approximate 1 week and is not affected by breed or lactation number (Zyl et al. 2025). Different separation strategies include abrupt separation within hours or 1-4 days after parturition, as well as gradual weaning methods, such as nose-flap weaning and fence-line contact before complete separation (Weary & Chua 2000; Zyl et al. 2025)

From the calf perspective, separation several hours after its birth indicates to be favourable due to more time with its mother (Houwing et al. 1990). At separation direct after its birth, calves show a higher level of vocalisation, licking behaviours of themselves, and lower activity level. For calves with 96 hours of contact with its mother, the calves vocalise less, had a higher activity level, and higher oral behaviour such as licking compared to direct separation (Lidfors 1996). Contact with the mother allows the calf opportunities to ingest colostrum. It also allows the mother to perform essential caregiving behaviours, such as stimulating the calf's urination and defecation (Houwing et al. 1990). Likewise, with four days contact period between the cow and its calf, a decreased level of treatment for diarrhoea is shown. The reason can be due to higher intake of colostrum and high immunoglobulin concentration, but also by the physical contact with its mother that affects the calf weight gain positively (Weary & Chua 2000).

For the cow, the separation from its calf better to be made directly after birth, to minimize the bond that starts to build between the cow and calf (Houwing et al. 1990). The level of bond depends on the amount of licking expressed by the mother and increases with an extended period of licking the calf. Even with a short period of licking, a strong bond between the cow and its offspring becomes formed. Licking the calf is a behaviour expressed by the mother to reduce the calves heat loss, stimulate breathing, blood circulation, urination and defecation, but also to reduce the risk of infection and the presence of predators (Edwards & Broom 1982). The behavioural response of dairy cows differs between separation directly after parturition or after 96 hours. When separation is done immediately after parturition, the cow spent more time lying down and becomes less active compared to the cows with continued contact and after their separation 96 hours post parturition. Separations done after 96 hours affect the cow's behaviour by decreased time spent on rumination and lying down, due to a higher activity level. Later separation also shows a bigger difference in individual variation compared to direct separation (Lidfors 1996). The longer contact between the cow and its calf also affects the cow's behaviour by increased vocal behaviours (Lidfors 1996; Weary & Chua 2000). The peak of vocal expressions peaks at nine hours after separation with higher rates and frequencies (Weary & Chua 2000).

2.2 Feed

2.2.1 Effects of feed intake

The high energy requirements of dairy cows lead to an increased use of diets with higher concentrate levels. Smaller forage particle size can increase dry matter intake (DMI) by increasing the passage rate through the rumen, thereby reducing the time available for the microbes to digest the silage (Lammers et al. 1996). According to Kononoff et al. (2003), a total mixed ration (TMR) contains normally 40 to 60% concentrate, where the levels can be investigated by a pen state particle separator (PSPS) with at least an eight millimetres sieve. Feed with a smaller particle size leads to a decreased digestibility of the forage, but also to an increased microbial protein synthesis (Kononoff et al. 2003). To optimize the cow's digestion, the particle size of the feed mixtures should have an even variation to maintain a regular digestion with a sufficient passage rate of the feed. If the levels of fibre are insufficient or the silage is too chopped, the risk of metabolic disorders increases due to a decreased need for chewing, which declines ruminal pH since saliva buffers the rumen pH (Lammers et al. 1996). A longer time since the last delivery of feed increases the proportion of neutral detergent fibre (NDF), which may elevate the risk of dietary imbalance when combined with sorting of different particle sizes (DeVries et al. 2005; Greter et al. 2008).

The transition period is commonly defined as the period from three weeks before parturition to three weeks after calving and is considered a challenging phase for dairy cows due to the negative energy balance that occurs during early lactation. During the first five weeks postpartum, the digestibility of dry matter (DM), metabolizable energy (ME), and NDF is reduced. This lower digestibility occurs despite similar dry matter intake (DMI), suggesting impaired digestive efficiency. The cow's energy balance is positive until parturition, after which it becomes negative during early lactation. Despite an increase in gross energy intake during the first weeks postpartum, the energy balance (EB) remains negative for approximately eight weeks after calving. Consequently, energy is mobilized from body reserves to support milk production, resulting in increased circulating concentrations of non-esterified fatty acids (NEFA) due to enhanced mobilization of fatty acids from adipose tissue (Daniel et al. 2022). One common reason for a negative EB is decreased feed intake often observed 24 hours before calving (Schirrmann et al. 2013). The period of decreased feeding time, together with decreased feed intake, starts approximately 8 hours before parturition. Feed intake and time spent on feeding start to regain 6 hours after parturition but differs in recovery time. Feed intake is normally restored after 24 hours, whereas the feeding time is restored after 48 hours (Schirrmann et al. 2013). Cows 40-60 days into lactation, with constrained time for eating, resting, and social contact, show a higher priority to resting compared to eating and social contact. Thus, with behavioural priorities and reduced feed intake, an increased proportion of feed intake is shown and depend on the bite size or the intake ratio (Munksgaard et al. 2005). The period of digestion of the feed by rumination becomes affected by parturition and can also be affected by the

regrouping activities. Rumination is a behaviour which can be reflected as an expression in comfortable situations and a sign of animals in safe and controlled situations. At parturition, the ruminations decrease 4 hours before parturition and return to a normal level after 24-48 hours, but start the recovery 4 hours after parturition (Schirrmann et al. 2013).

2.2.2 Sorting of the feed

Cows normally consume feed particles of different sizes (Lammers et al. 1996). Due to cows' ability to nibble, they can more frequently sort their feed by select wanted particles with their tongue and push other particles away (Leonardi & Armentano 2003). When cows are sorting against long particles and for the fine particles in the feed mixture, it results in a lower ingestion of NDF (Leonardi & Armentano 2003; DeVries et al. 2011). This leads to a higher efficiency of their milk production but decreases the milk fat (DeVries et al. 2011). A reason for sorting against specific particles is the palatable components. The tasteful components usually consist of small or medium particles, whereas long particles often become sorted against (Greter et al. 2008). Sorting against long particles occurs regardless of the level of forage in the feed mix, but is less pronounced for mixtures with higher levels of forage (DeVries et al. 2007). Overfeeding of TMR can also increase the sorting behaviour expressed by the cow (Leonardi & Armentano 2007). However, overfeeding or *ad libitum* gives the animal the opportunity to express their natural behaviour of feed intake (Greter et al. 2008). Cows can change their sorting behaviour from sorting for small and medium particles to a decreased level for small particles during changes of rumen pH, especially for cows in early lactation. Due to changes in the mixture for dry cows with high levels of forage to a reduced level of forage, in combination with an increasing milk production and sorting against long and for short particles, the risk for subacute ruminal acidosis (SARA) increases. By sorting for short particles, the cow increases the VFA production and decreases the buffering capacity; thus, the risk for SARA increases. By increased ingestion of the easily digestible particles in the diet, the ruminal pH decreases due to a reduced level of rumination and the decreased buffering capacity in the rumen. By increased sorting of their mixture, against the small particles and for the medium and long particles, the cow tries to avoid SARA by increasing the sorting behaviour (DeVries et al. 2008).

To increase the intake of longer particles, adding dry alfalfa to the feed mix, the percentage of long particles in the mixture increases but in combination with an increased selection of small particles. The sorting behaviour increases therefore by the proportion of dry hay, but is not affected by its quality; thus every individual sorts in a different grade (Leonardi & Armentano 2003). When including straw to the TMR, feed sorting for medium and small particles increases but against the long particles, which lead to a decreased DM intake and an increased feeding time. Regardless of the amount of straw in the feed mixture, sorting against long particles and for small particles occurs; meanwhile, sorting of the medium particles differ depending on the level of straw. Due to the straw's higher DM and dryer characteristic, the likelihood to be sorted

against in combination with the other components with wetter characteristic in the mixture increases (Greter et al. 2008).

By increasing the number of times feed is delivered, from one to two times a day, the animals' feeding time is affected, but without affecting DMI. It can also be achieved by increasing the delivery of feed decrease the amount of forage in the ort (DeVries et al. 2005). Cows in early lactation, which is connected with the period of mobilizing most body reserves, show preferences for sweet diets and show a higher sorting behaviour for crude protein (CP) and against acid detergent fibre (ADF) (Nombekela et al. 1994; DeVries et al. 2011). Due to the low digestibility of ADF, the reason for feed sorting can therefore depend on the animal's effort to maximize the feed's digestibility (DeVries et al. 2011). Time spent on feed intake is affected by the level of forage in the available mixture, where longer time is spent at a higher amount of forage. However, the quantity of orts was not affected by the amount of forage. Lower level of forage, results in higher DM intake and higher intake rate but also a higher sorting activity, where the animals spend time on sorting for the small particles and against long and medium sized. (DeVries et al. 2007). The small particles, consisting of concentrate, do not affect feed sorting (DeVries et al. 2007; González et al. 2015). However, it can instead increase the feed intake of the mixture (González et al. 2015). TMR containing concentrates in form of meal instead of pellets, contains a higher proportion of short particles, meanwhile pellets can both results in a higher ingestion of the proportion medium and small particles (Greter et al. 2008; González et al. 2015).

Feed consumption can also be affected by the cow's parity, where multiparous cows consume more feed, but where the feed efficiency is the same between multiparous and primiparous cows. The efficiency of the animal's digestion between multiparous and primiparous cows, indicated by the level of NEFA and insulin, show similar levels between parity. The frequency of feed sorting is higher for primiparous cows, who sort their ration more compared to multiparous cows (DeVries et al. 2011).

3. Materials and methods

The study was conducted at the Swedish Livestock Centre (Uppsala, Sweden) during 4th of January to 4th of March 2026, as part of a larger ongoing research project on CCC in dairy cows.

3.1 Animals

The study plan included data collection from 20 SC cows and 20 LC cows. Predefined exclusion criteria were cows with established infection of *Staphylococcus aureus*, significant lameness, or aggressiveness towards the calf or the staff. Because one cow developed *S. aureus* and was excluded, an additional cow was included, resulting in data collected from 41 cows. Cows were allocated to one of two treatment groups using a semi-randomly procedure that balanced treatment allocation for calving date, breed, parity, calf gender, and calf breed. The treatment groups were: a) cows kept with their calf (LC, n=20) or b) cows that were separated from their calf after a minimum of 12 hours (SC, n=20). The 12-hour contact period in the SC group was chosen to align with a dairy company certification that the research farm takes part in. The cows in the study were both of the breeds Swedish Holstein (SH) and Swedish Red (SRB), inseminated with the same breed as the cow or inseminated with black Angus.

Sample size differed between analyses due to different exclusion criteria, where behavioural analyses included 37 cows, and feed intake analyses included 39 cows. One cow became diagnosed with *S. aureus* infection, and another cow became treated for ketosis were excluded from both data sets, whereas 2 cows giving birth to twins were excluded only from the behavioural dataset. The distribution of the animal treatment, parity and breed across the different subjects is shown in Table 1.

Table 1. Distribution of the animals in the study. Total amount is according to all animals with collected data. Treatments were divided into long contact (LC) where the calf was present the whole observation and short contact (SC) with 12 hours calf presence. Breeds refer to Swedish Red Breed (SRB) and Swedish Holstein (SH).

Category	Treatment		Parity		Breed	
	LC	SC	Primiparous	Multiparous	SRB	SH
Behaviour	18	19	15	22	19	18
Feed	19	20	15	24	21	18
Total	20	21	15	26	22	19

3.2 Housing

The study was conducted in two separate rooms inside the same building, at the dairy stable at the Swedish Livestock Centre (Uppsala, Sweden). The first room consisted of a free housing system area where the cows arrived 14 days before calving and an adjacent area with five calving pens, each measuring 11.9 m² (room 1). The second room did not have a loose housing area but included six adjacent calving pens, four pen at 12,1 m² and two pens at 8.9 m² (room 2). The bedding material for all pens consisted of sawdust. The wall of the pens was 1,42 meter high, made of plywood, which only made social contact with other calving pens possible over the walls or by the feeding table. All pens had their individual feeding and water station; the feed bunk had a barrier to prevent cows from mixing their feed with other animals (Figure 1).

Animals were randomly placed in the pens by the staff, depending on which pens were available, but by filling one room at a time. It was prioritised to start filling in room 1 (the one with an adjacent loose housing area), and once it was full, animals would then be placed into room 2.



Figure 1. Feed dividers to separate the feed between calving pens and to ensure that feed was separate from that offered to the dry cow group across the feed table.

3.3 Feeding

The animals were fed 2 times per day with a Partial Mixed Ration (PMR) in the morning and the afternoon, which were the same PMR the cows were given in the group of dry cows. Each morning the staff cleaned each animals feeding table, occurring between the morning milking and first feeding of PMR. PMR was given directly after removal of the orts, by a manually driven feeding wagon, which was equipped with a scale (Profilvågen, Sweden). Extra concentrate (Komplett Amin 220 from Lantmännen) was given when the cows were locked up in the feeding gate to be milked and the pen cleaned, which took approximately 30 minutes, which was sufficient for the cows to consume the concentrate. Each day, cows were given 175 grams of the mineral “Mixa optimal” from Lantmännen on top of the silage. The PMR and concentrate were weighed before feeding each individual, but the amount of silage represented the amount of *ad libitum*; meanwhile, levels of concentrate were adapted per individual with an increasing amount per day, in addition to the levels in the PMR.

The PMR consisted by a roughage mix of 77% of second-harvest silage, 20% corn silage, together with 3% straw and two different concentrates from Lantmännen. The proportion of the concentrate in the PMR consisted of 80% Komplett Amin 220 and 20% of Addera mega to the total level of 2 kilos per cow and day. The nutrient value from the PMR is shown in Table 2.

Table 2. Metabolizable energy (ME), dry matter (DM), crude protein (CP) and neutral detergent fibre (NDF) of the Partial Mixed Ration (PMR) for both long contact (LC) and short contact (SC) cows. Silage B replaced Silage A after the half period of data collection.

	ME*	DM %	CP %	NDF %
Corn silage¹	11.6	30	7.8	39.4
Silage A¹	10.8	37.4	12.8	43.3
Silage B¹	10.7	39.3	12.3	45.3
Straw²	6.6	85	6.9	74.8
Komplett amin 220³	13.3	88	22.0	20.0
Addera mega³	15.0	89	40.5	17.0

* = Metabolised Energy, MJ per kilo Dry Matter

Values from:

¹ = Eurofins (analysed in a conventional lab by methods of NIRS)

² = Feed table “Blå boken”

³ = Manufacturer’s information

3.4 Sampling

3.4.1 Video recording

Each pen was equipped with a separate camera (AXIS M1135-E/M1137-E, Axis Communications AB, Lund, Sweden) positioned above the feeding table to continuously record the area of the pens and their feeding tables. All cameras were placed in the same positions relative to the pen and used the same recording software. The observation period started immediately after parturition (when the calf is completely visible). If the parturition had occurred in the waiting area (loose house system), the observation period started when the cow and calf were placed inside the calving pen. Recording was stopped and started each day at 10:00 am during the period of data collection; thus, the observation continued until six milkings after parturition. The recordings were delivered as files in mp4 format and saved to a hard drive. No sound was included in the recordings.

The video analysis was performed using behaviour registration software (The Observer XT 14, Noldus Information Technology BV, Wageningen, The Netherlands). The observation source was offline observation from an external hard drive, with instantaneous sampling used as the observation method. Observation duration was an open-ended observation, with an interval length of 5 minutes due to the interval period to closely reflecting behaviours observed continuously (Mitlöhner et al. 2001).

3.4.2 Video analysis

The observed behaviours in the study are defined in an ethogram (Table 3) and were used to investigate the animals' time priorities during the observation period. The time budget for the recordings of the cows was scan samplings (with a 5 sec replay of the video to determine main behaviours) every 5th minute for 3 continuous hours, followed by a 1-hour break, followed by another 3-hour observation period and so on for 48h after parturition (Figure 2).

The video was analysed using Noldus Information Technology BV (Wageningen, Netherlands) during the recording periods. If animals became disturbed by the staff (e.g., milking cow, cleaning pen, treatment, etc.) or the animal was removed from the pen (e.g., calf weighing, tagging, etc) the 5-minute interval immediately before and two 5- minutes intervals immediately following the disturbance were removed. The number of observations was adjusted by continuing observations until 36 periods were scored for each 3-hour period.

To analyse the behaviour, the periods became divided into 2 different intervals, where interval A included period 1-2 and interval B included period 4-12. Period 3 became skipped due to the differences in time of the separation by the calf for SC cows and considers as a transition period. By dividing the periods into the different intervals, interval A show result with a present calf in both treatments and interval B with the calf only present for LC cows. Interval B can therefore

become divided into 3 smaller intervals where period 4-6 translates to B1, period 7-9 translates to B2, and period 10-12 translates to B3 (Figure 2).

Table 3. Definition of behaviours; ethogram used to record behaviours for the time budget. Modified from Jensen (2011; 2012); Ambriz-Vilchis et al. (2015) and Hill et al. (2017).

Behaviour	Definition
<i>Position</i>	
Lying	Lying on sternum or side. Head may be rested or raise
Standing	Body supported by 2, 3 or 4 legs, standing or walking
<i>Activities</i>	
Feeding	Head in feeding trough, or over feeding trough
Drinking	Muzzle in drinking bowl
Rumination	Cow chewing a regurgitated bolus, away from the feeding trough
Interacting with the cow/calf	Muzzle/tongue is pointing towards the cow's/calf's head or body in close proximity (within 1 calves head length)
Other	Other behaviours that were not included in the study
Out of frame	Animals head is out of frame and cannot tell the behaviour
<i>Calf</i>	
Suckling dam	Head is under the dam's belly in the udder area

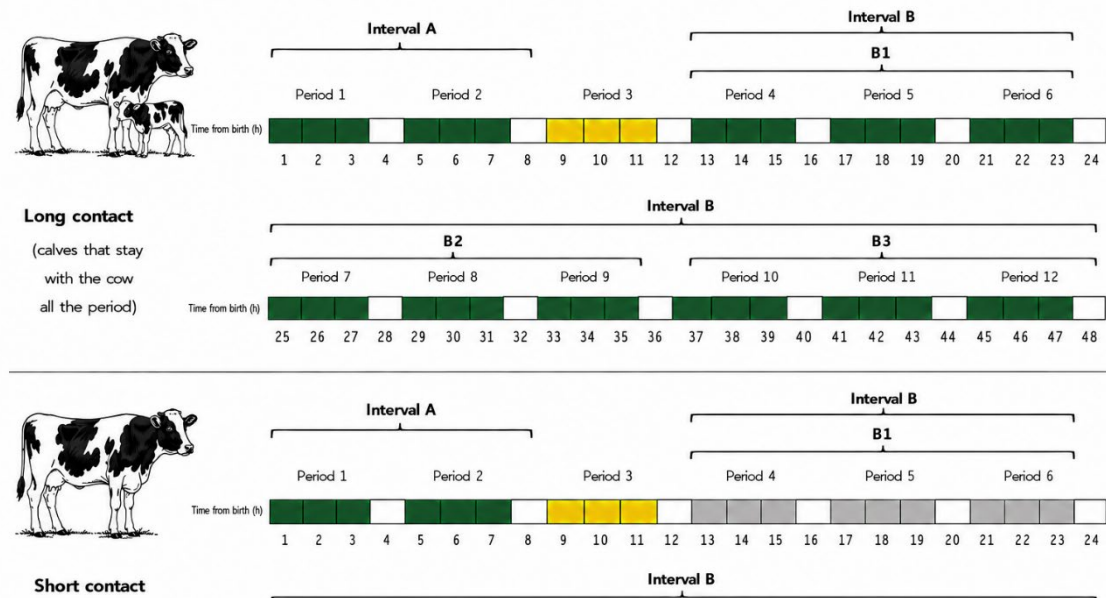


Figure 2. Observation schedule for behavioural observation, during the first 48-hour post parturition. Skipped observation occurred due to the differences in time of the separation by the calf for short contact (SC) cows and considered as a transition period. SC cows were separated from their calf 12 hours after parturition (Image created with ChatGPT).

3.4.3 Feed intake

Orts from each cow were weighed and sampled in the barn. The cleaning of the feeding table was performed once a day by the staff, in the morning, as the collection of Orts was made from the last 24 hours of feeding. Sampling of Orts, approximately 1 kilo per cow per day, was performed by mixing and then dividing the Orts into four quarters and removing two quarters at a time, sweep the smallest particles away, push the two remaining piles together, repeat the steps until the desired weight was left in two of the four piles (Figure 3). The Orts were then transported to the in vitro lab at Lövsta facility for separation, using the PSPS.



Figure 3. The steps of separation of Orts from each cow to get the amount needed for particle separation with the Penn State Particle Separation (PSPS) method. Step 2-4 was repeated until 1 kilo Orts remained.

Particle size separation was used to analyse the particle size of the Orts from the individual cows each day in the calving pen, together with the PMR before feeding. The separation was using PSPS with two different sieves at 19mm (long particles) and 8 mm (medium particles), plus the bottom pan (short/fine particles), which created three different fractions of the silage. A sample of 250g from each cow were separated on the PSPS on a flat surface, repeated series of five shakes horizontally, 17cm in length, before a turn of 90 degrees clockwise was made until the total amount of 40 shakes was reached (Kononoff et al. 2003). Thereafter, each fraction was weighted on an aluminium tray to be put in a dryer of 60 degrees Celsius for a minimum of 19-24 hours, to determine DM of each fraction. After turning off the oven, it was opened for a minimum of 1 hour before the final weighing of the dried Orts was performed.

Data collection of the feed consumption and sorting was recorded each day by the methods previously described. Due to the purpose of the research, the intake of feed and levels of nutrients were analysed on the 3 last day in the feeding pen, due to the purpose of the thesis and since SC cows were separated from their calf after a minimum of 12 hours.

3.5 Calculations & statistics

Calculations on the DMI, ME and sorting was based on fresh matter percent and were performed in Microsoft Excel, which was also used for the graphical illustrations. The DMI was calculated by adding the consumed silage, together with the concentrate in the PMR and the separate fed concentrate. The ME intake was calculated by adding the results of multiplied the consumed silage, concentrate in PMR, and separate fed concentrate with each individual ME.

The grade of sorting was calculated by dividing the actual intake of each fraction with the expected intake. If no sorting was performed, the value became 1; values over 1 indicate a higher consumption than expected of a certain fraction, and values under 1 indicate a lower consumption. To calculate the expected intake, the given silage was subtracted with theorts, to then be multiplied by the feed wagon percentage of each particle size. A sorting index was then calculated by use the sorting grade minus 1 and elevated to 2for each particle size fraction and summing them together. By calculating the index, the more sorting was revealed as a higher value.

Statistical analyses were performed using JMP 19 student edition (North Carolina, USA) for both feed data and behavioural data.

The statistical model for behavioural data was a generalised linear model for interval A with logit link and overdispersion adjustments that included fixed factors of breed (SH/SRB), parity (Primiparous/Multiparous), and treatment (LC/SC). The fixed factor for calves' breed included 3 levels (SH/SRB/Beef). Non-significant interactions were removed from the final model. For interval B, a generalised linear mixed model was used where 3 different sub-groups were included as fixed factors (B1/B2/B3) and interactions between treatment and sub-groups, as well as the random effects of Cow ID repeated over the sub-groups.

The statistical model for feed data was a mixed model that included fixed factors of breed (SRB/SH), parity (Primiparous/Multiparous), treatment (LC/SC) and treatment day (1/2) and their first order interactions. Non-significant interactions were removed by a stepwise procedure from the final model. The random effects of Cow ID were included in the statistical model. The residuals were checked for normality. If residuals were not normally distributed, the variables were log transformed and the results were back transformed before presentation. Post hoc comparisons were done using Tukey HSD tests.

4. Results

4.1 Behaviours

Due to practical reasons, some calves were removed from the SC cows before the third observation period had ended. Three calves were separated during the second observation period, which led to the exclusion of 3 additional cows, but only in interval A. Consequently, the total number of analysed cows in interval A was reduced to 34, while the number of cows in interval B remained at 37. For the same reason, the calves belonging to the excluded cows were also removed from the observations, resulting in 34 analysed calves in interval A. All calf results in group B were obtained from calves in the LC treatment group.

4.1.1 Standing

Cows in interval A showed no significant effects on treatment (Figure 5) or parity. However, a tendency of effect on breed was shown ($p = 0.0815$) where SRB was standing more (60 %) compared to SH (53 %). For cows in interval B, significant effects were shown of parity ($p < 0.001$) where primiparous cows standing more (57 %) compared to multiparous cows (44 %). Across the observation period, LC cows spent 52 ± 8.3 % (mean $\pm$ SD) of the observation time standing, compared with 51 ± 10.1 % for SC cows.

The behaviour of calves in interval A showed no significant effects of treatment, parity or breed. In period B, the percentage of standing is shown in Figure 4 together with interval A. LC calves spent 16 ± 2.7 % (mean $\pm$ SD) of their time standing.

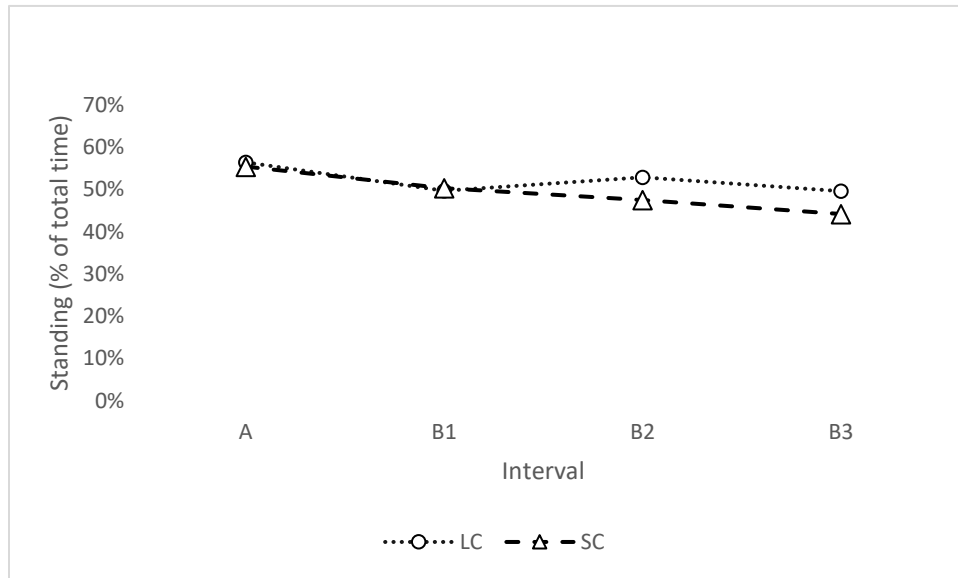


Figure 5. Time spent standing for cows in the long contact (LC) and short contact (SC) treatments (LC: Calf present during the entire period, SC: Calf separated after interval A). Interval A represent hour 0-7 after parturition, B1 represent hour 13-23, B2 represent hour 25-35 and B3 represent hour 37-47.

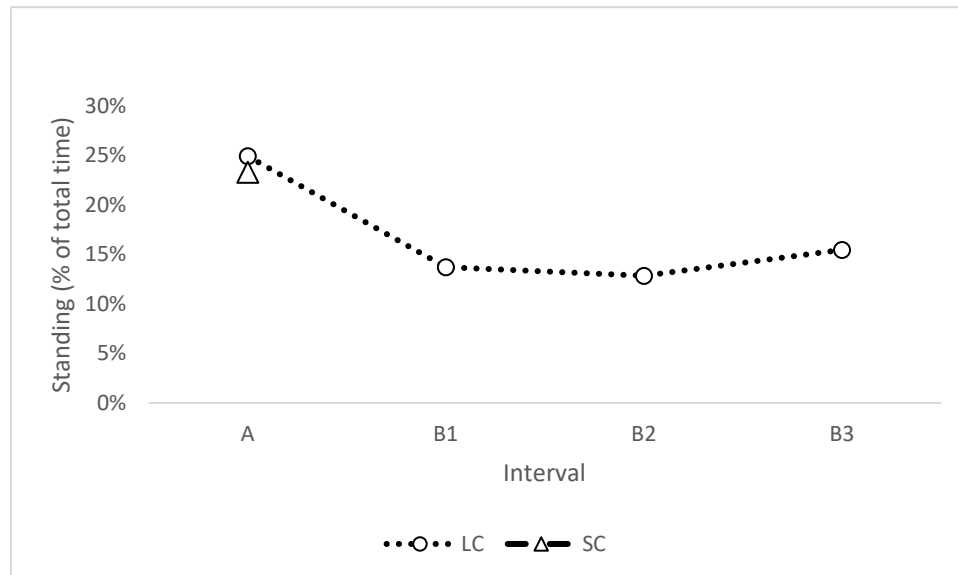


Figure 4. Time spent standing for calves in the long contact (LC) and short contact (SC) treatments (LC: Calf present during the entire period, SC: Calf separated after interval A). Interval A represent hour 0-7 after parturition, B1 represent hour 13-23, B2 represent hour 25-35 and B3 represent hour 37-47. Only interval A included both treatments.

4.1.2 Lying

There were no significant effects on treatment, parity or breed on time spent lying for the cows in interval A. However, a tendency of effect on breed was shown ($p = 0.0815$) where SH were lying more (48 %) compared to SRB (40 %). For cows in interval B, significant effects showed of parity ($p < 0.001$) but no other traits or interactions showed any significant or tendencies. Multiparous cows were lying more (56 %) compared to primiparous cows (43 %). Differences between treatments is shown in Figure 6. LC cows spent 48 ± 8.3 % (mean $\pm$ SD) of the observation time lying, compared with 50 ± 10.1 % for SC cows.

Calves in interval A showed no significant effects on lying of either treatment, parity or breed. In period B, the percentage of lying is shown in Figure 7 together with interval A. LC calves spent 81 ± 2.6 % (mean $\pm$ SD) of the observation time lying.

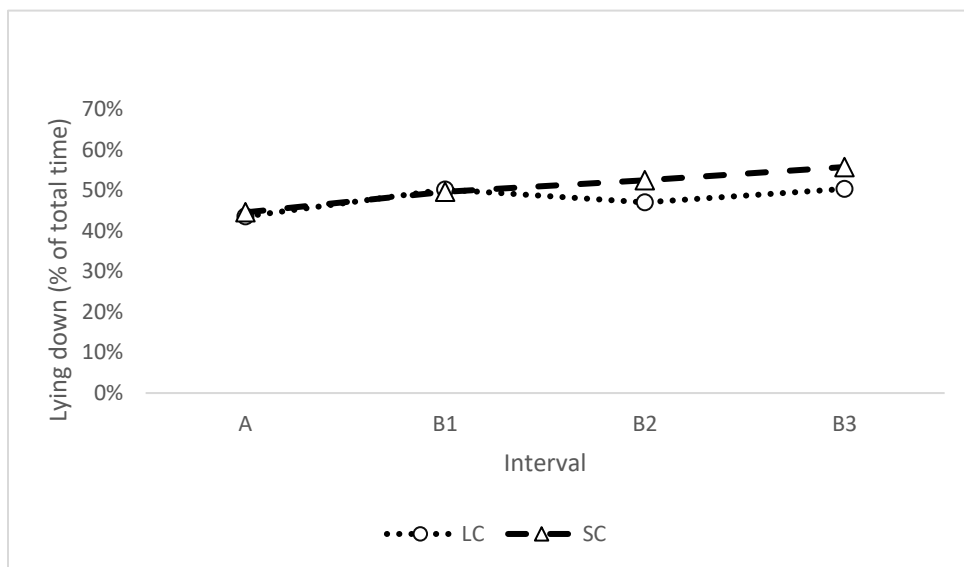


Figure 6. Time spent lying for cows in the long contact (LC) and short contact (SC) treatments (LC: Calf present during the entire period, SC: Calf separated after interval A). Interval A represent hour 0-7 after parturition, B1 represent hour 13-23, B2 represent hour 25-35 and B3 represent hour 37-47

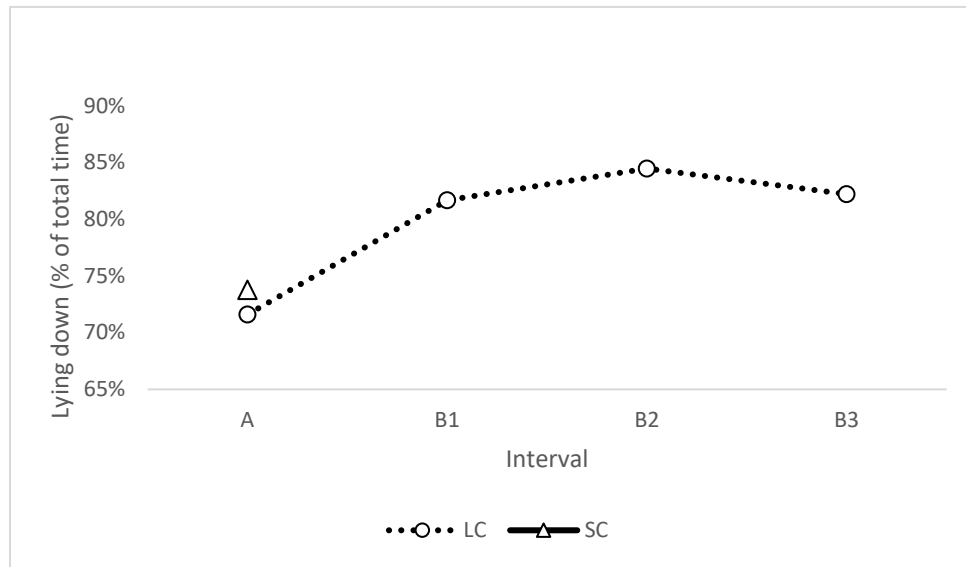


Figure 7. Time spent lying for calves in the long contact (LC) and short contact (SC) treatments (LC: Calf present during the entire period, SC: Calf separated after interval A). Interval A represent hour 0-7 after parturition, B1 represent hour 13-23, B2 represent hour 25-35 and B3 represent hour 37-47. Only interval A included both treatments.

4.1.3 Feeding

In interval A, only breed affected time spent on feeding for the cows ($p < 0.05$) while treatment or parity had no significant effects. The differences between the breeds showed that SH spend more time on feeding (9.4 %) compared to SRB (7.6 %). For cows in interval B, there was a significant interaction between treatment and interval ($p < 0.05$, Figure 8). Post hoc analysis showed that LC cows increased their eating behaviour from interval B1 to interval B2, compared to SC cows that remained the same in both periods ($p < 0.05$). There was a significant effect of breed ($p < 0.05$) with SH spent more time on feeding (20 %) compared to SRB (16 %). LC cows spent 16 ± 5.0 % (mean $\pm$ SD) of the observation time feeding, compared with 16 ± 4.2 % for SC cows.

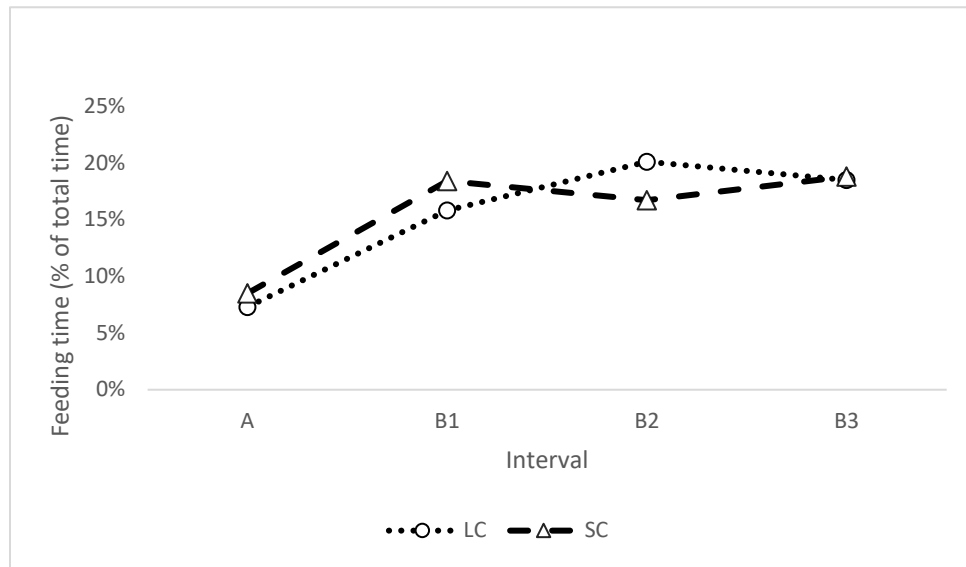


Figure 8. Time spent feeding in the long contact (LC) and short contact (SC) treatment (LC: Calf present during the entire period, SC: Calf separated after interval A). Interval A represent hour 0-7 after parturition, B1 represent hour 13-23, B2 represent hour 25-35 and B3 represent hour 37-47.

4.1.4 Drinking

There were no significant effects of treatment, parity or breed on drinking behaviour in any of the observed intervals. LC cows spent $1.4 \pm 1.01\%$ (mean $\pm$ SD) of the observation time drinking, compared with $1.3 \pm 0.6\%$ for SC cows.

4.1.5 Rumination

In interval A, there were no significant effects on time spent ruminating for the cows of treatment, parity or breed. Cows in interval B showed a strong tendency ($p = 0.0516$) for the interactions between treatment and time interval, where SC animals increased rumination from interval B1 to B2 but LC cows remained the same during these intervals (Figure 10). There were no significant effects of parity or breed in interval B. LC cows spent $31 \pm 6.6\%$ (mean $\pm$ SD) of the observation time ruminating, compared with $31 \pm 5.8\%$ for SC cows.

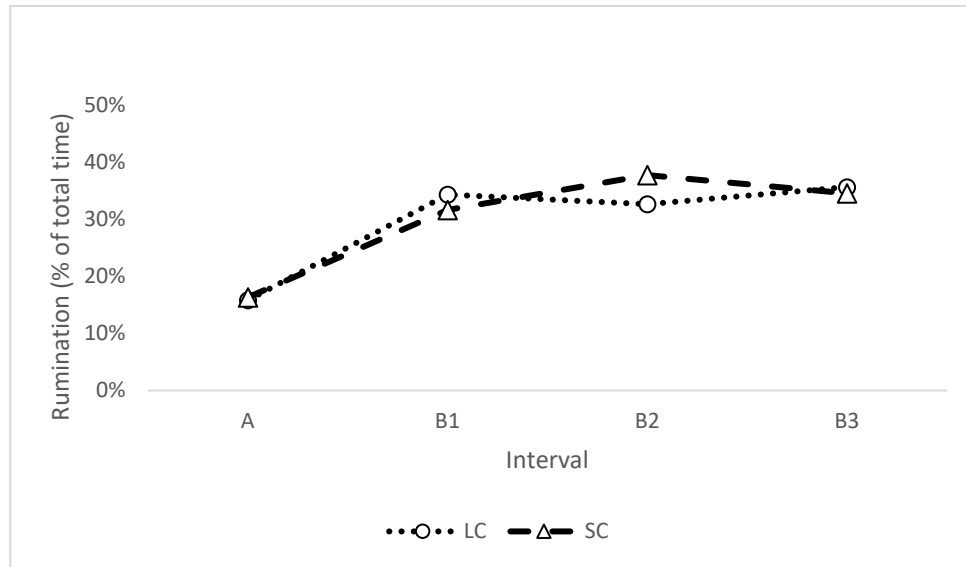


Figure 9. Rumination time for cows in the long contact (LC) and short contact (SC) treatments (LC: Calf present during the entire period, SC: Calf separated after interval A). Interval A represent hour 0-7 after parturition, B1 represent hour 13-23, B2 represent hour 25-35 and B3 represent hour 37-47.

4.1.6 Interactions between cow and calf

Cows had no significant effects of treatment, parity or breed on interactions in any of the observed intervals. Both treatments interacted with their offspring the same level (24 %) in interval A, where in interval B, LC cows interacted at the same level (6.6 %) the whole period. LC cows spent 9.9 ± 2.58 % (mean $\pm$ SD) of the observation time interacting with their calves.

Calf in interval A showed no significant effects on treatment, parity or breed. Both treatments interacted with their mother the same level (6.2 %) in interval A, where in interval B, LC calves interacted with their mothers at the same level (2.2 %). LC calves spent 3.9 ± 1.02 % (mean $\pm$ SD) of the observation time interacting with their mothers.

4.1.7 Calf suckling the dam

Calf suckling behaviour in interval A showed no significant result of treatment, parity or breed. However, a tendency was shown of parity ($p = 0.0799$) where calves to multiparous cows spent less time on suckling (3.3 %) compared to primiparous calves (4.8 %). Differences between treatments is shown in Figure 13. LC calves spent 3.4 ± 1.44 % (mean $\pm$ SD) of the observation time at suckling.

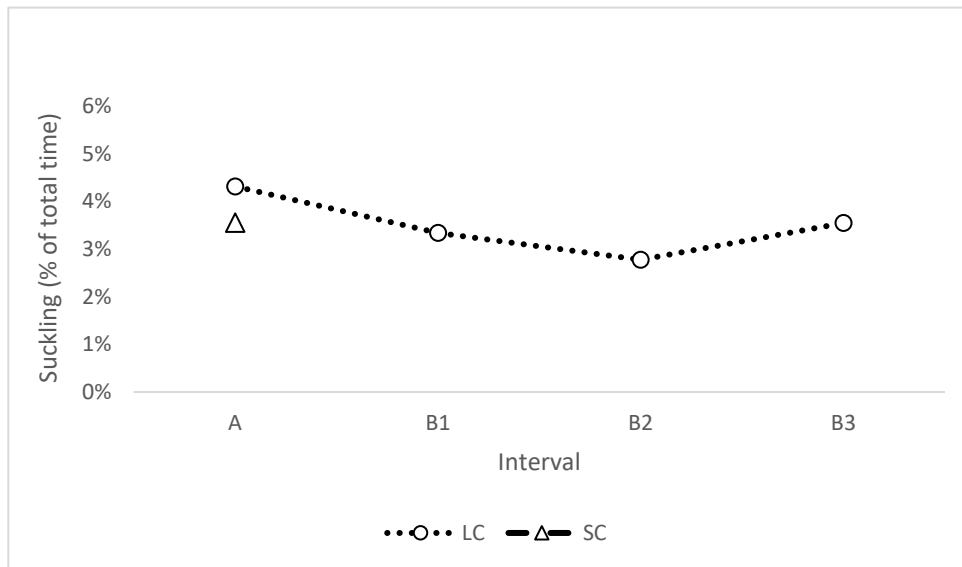


Figure 10. Time spent suckling (% of total time) for calves in the short contact (SC) or long contact (LC) group. Interval A represent hour 0-7 after parturition, B1 represent hour 13-23, B2 represent hour 25-35 and B3 represent hour 37-47. SC calves were separated from their dams at 12 hours and were therefore only included in Interval A.

4.2 Feed

Two of the cows did not consume all the extra concentrate given at milkings, but their data was analysed in the same way as the other animals. The average time spent in the calving pen on day 3, measured from midnight, was 11 hours for the SC cows and 6.8 hours for the LC cows. Since the morning feeding was performed at 8 am, the last day of observation had to be removed because this gave a biased effect on feeding speed and feed intake affected the result.

4.2.1 DMI

Significant effects were shown of parity ($p < 0.001$) and day ($p < 0.05$) as multiparous cows consumed higher level of DMI ($18 \text{ kg DM} \pm 0.5$) compared to primiparous cows ($14 \text{ kg} \pm 0.7$). Cows consumed higher level of DMI on day 2 ($17 \text{ kg DM} \pm 0.6$) compared to day 1 ($15 \text{ kg DMI} \pm 0.6$). No significant effects of treatment (Figure 14), breed, or other tested interactions were observed.

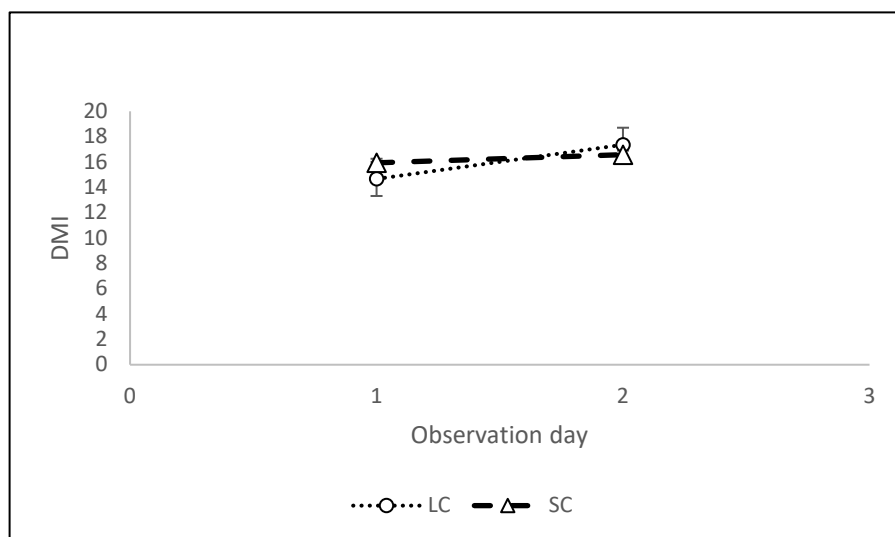


Figure 11. Intake of kilo dry matter per observation day for the different treatments. Short contact (SC) cows are separated from their calf 12 hours after parturition, meanwhile long contact (LC) had their calf present throughout the observation period.

4.2.2 Energy intake

Significant effects were found of parity ($p < 0.001$) and day ($p < 0.05$) as multiparous cows consumed higher level of ME ($206 \text{ MJ ME} \pm 5.7$) compared to primiparous cows ($162 \text{ MJ ME} \pm 7.2$). Cows consumed higher level of ME on day 2 ($193 \text{ MJ ME} \pm 6.1$) compared to day 1 ($175 \text{ MJ ME} \pm 6.1$). No significant effects were observed on treatment (Figure 15), breed, or other tested interactions.

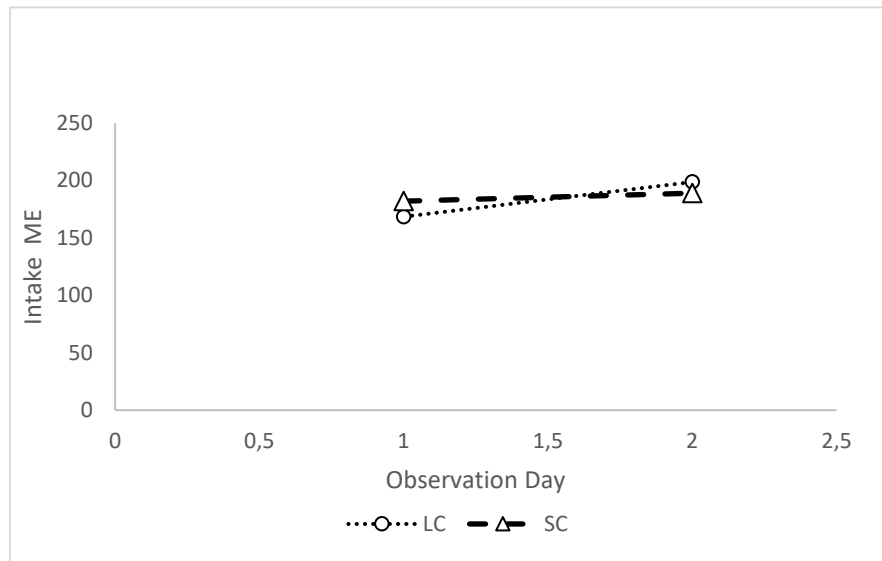


Figure 12. Intake of ME (MJ) per observation day for the long contact (LC) and short contact (SC) treatment groups. SC cows were separated from their calf 12 hours after parturition, while LC had their calf present throughout the observation period.

4.2.3 Sorting

No significant effects were shown for sorting. However, there was a tendency for an effect of parity ($p = 0.07$), where multiparous cows had a lower sorting index (0.007, dimensionless) compared with primiparous cows (0.017, dimensionless). Results for feed sorting according to treatment are presented in Table 7.

Table 4. Least square means (LSMeans) with standard errors (SE) for feed sorting based on log-transformed data. Before log transformation, a ratio of 1 indicates no sorting, values >1 indicate selection for the fraction, and values <1 indicate selection against the fraction. On the log-transformed scale presented in the table, 0 indicates no sorting, positive values indicate selection for the fraction, and negative values indicate selection against the fraction.

	19 mm		8mm		Bottom pan		Total	
	LSMean	SE	LSMean	SE	LSMean	SE	LSMean	SE
Treatment								
LC	0.07	0.27	-0.17	0.07	-0.16	0.05	-4.41	0.48
SC	0.05	0.03	-0.05	0.07	-0.08	0.05	-4.56	0.47

5. Discussion

5.1 Behaviour

The present study investigated whether cow-calf contact (CCC) during the first 48 h postpartum affected behavioural priorities in dairy cows. This was with particular attention to behaviours related to feeding, resting, and maternal interactions. Opposite to the original hypothesis, the results showed no negative effects of calf presence on the behavioural time budget of the cows. No significant effects for treatment were observed for standing, lying, drinking, rumination, interactions, or suckling behaviour during the observations. Several behavioural differences were associated with parity and breed, suggesting that central animal related factors also had an influence on behavioural expression. The lack of major treatment effects may indicate that cows were able to maintain essential maintenance behaviours despite the presence of the calf. Earlier studies have reported that maternal behaviours immediately after parturition may temporarily reduce time allocated to feeding and resting due to the high motivation to take care of and lick the calf (Jensen 2012). However, these behavioural priorities are generally most pronounced during the first hours post-partum and gradually decrease over time (Jensen 2011). Since the present study analysed behavioural patterns over a 48-hour period, it is possible that the strongest maternal behavioural occurred during the earliest stages after calving and was therefore diluted when observations were summarised across a longer time or by disturbances by staff.

The results suggest further that dairy cows may possess a degree of behavioural flexibility during the transition period. Munksgaard et al. (2005) showed that dairy cows can adapt feeding behaviour and time allocation when exposed to environmental or management limitations. In this study, LC cows did not reduce feeding activities compared to SC cows despite the additional opportunity for maternal interaction. This may indicate that cows compensated behaviourally by adjusting the timing or intensity of feeding behaviour rather than reducing total feeding activity. A significant interaction between treatment and observation interval was observed during interval B for feeding and rumination. Cows in treatment LC increased feeding behaviour between periods B1 and B2, whereas feeding behaviour decreased in interval B2 in SC cows. One possible explanation is that LC cows slowly reallocated time from maternal activities toward feeding behaviour as the postpartum period progressed and the maternal bond stabilised. Earlier research has shown that behaviours of maternal care are most intense immediately after calving and decline during the following days (Jensen 2011; 2012). The increase in feeding behaviour among LC cows during later intervals might therefore reflect a behavioural transition from intense interactions to the calf, towards restoration of normal maintenance behaviours. Meanwhile, the reduced feeding behaviour observed in SC cows during interval B1 may indicate a behavioural response to the separation from the calf, which occurred shortly before this observation interval. Previous research has shown that cows separated from their calves immediately after birth spend

more time lying and are less active than cows remaining in contact with their calves (Lidfors 1996). Since a cow-calf bond can be established after only a short period of interaction (Edwards & Broom 1982), the separation performed after approximately 12 h in the present study may have occurred after an attachment had already begun to develop. Consequently, the behavioural changes observed among SC cows could reflect a response to the disruption of this emerging bond. Houwing et al. (1990) suggested that immediate separation may reduce the formation of a strong cow-calf attachment, potentially limiting behavioural responses associated with later separation.

The results of this study showed no treatment effects for rumination, although a tendency for an interaction between treatment and interval was identified. SC cows showed an increase in rumination from interval B1 to B2, whereas LC cows maintained a more stable level through the intervals. The stable rumination pattern observed in LC cows could therefore suggest that prolonged calf contact did not compromise behavioural recovery after calving. One possible explanation to the result is that separated cows had fewer opportunities to engage in maternal behaviours and therefore allocated more time to maintenance behaviours, but also due to their situation in an empty calving pen without other stimuli. Increased rumination may thus reflect reduced behavioural activity following separation rather than an indication of improved welfare or lower stress. Similar reductions in activity following separation have previously been reported by Lidfors (1996). For standing and lying behaviour, parity had a significant influence in interval B where primiparous cows spent more time standing and less time lying compared to multiparous cows. Similar parity-related differences have been reported and can reflect behavioural inexperience, social stress, or increased sensitivity among primiparous cows during the transition period (Edwards & Broom 1982; Jensen 2011). Primiparous cows might therefore require longer time for adaptation to both the calving environment and maternal role, which results in higher activity level and reduced resting behaviours. Since lying behaviour is closely associated with recovery and welfare, lower lying time observed among primiparous cows could indicate greater physiological or behavioural challenges during the first days of lactation. With today's dairy production with a culling rate around 38 % is this important knowledge to adjust for due to the similar recruitment rate to maintain the number of cows (De Vries & Marcondes 2020). Breed effect was observed for both standing and feeding behaviour, where SH spent more time on feeding and lying, whereas SRB spent more time on standing. These differences may be associated with breed-specific variation in metabolic demands, feeding motivation, or behavioural temperament. However, because breed was not a focus of the study will these interpretations remain speculative.

Neither maternal interaction nor calf suckling behaviour differed significantly between treatments in interval A, which indicates cow and calves established maternal interactions. This aligns with earlier research that demonstrates strong maternal behaviours can develop rapidly after birth, even with relatively short periods of contact (Edwards & Broom 1982). The lack of differences in

interaction behaviour during period A occurred probably because of the similarities between treatments. However, interactions in interval B show reduced expression of the behaviour and its importance in the first hours postpartum. Overall, the behavioural findings indicate that continued presence of the calf during the first 48 hours after parturition did not significantly disrupt behavioural priorities related to feeding, resting, or rumination. Instead, parity and breed appeared to contribute more strongly to behavioural variation than the treatment.

5.2 Feed

The transition period is one of the most metabolically demanding phases in dairy production, where sufficient feed intake is essential to reduce the risk of negative energy balance and associated metabolic disorders (Mulligan & Doherty 2008). This study aimed therefore to investigate whether calf contact affected DMI, energy intake, or feed sorting behaviour during the postpartum period. In this study, parity and observation day showed clear effects on both DMI and energy intake. It indicated that multiparous cows consumed more feed and energy than primiparous cows, and was higher on day 2. These results are consistent with previous research showing greater dry matter intake among multiparous cows, likely associated with their greater milk production demands (DeVries et al. 2011). A possible explanation is that younger cows compensate for lower intake capacity by selectively consuming more nutrient-dense feed particles, due to the tendency for parity to feed selection in this study. However, no significant treatment effects were shown for sorting behaviour, which indicates that either parity or the calf presence did not alter the cows' selection for certain feed particles. Earlier studies have shown that primiparous cows show more selective feeding behaviour and higher sorting activity compared with multiparous cows (DeVries et al. 2011). A possible explanation is that younger cows compensate for lower total intake capacity by selectively consuming more nutrient-dense feed particles or by spending more time at the feeding table; thus, no such effects were shown in this study. The absence of significant treatment effect on sorting behaviour may also reflect the good feeding management used in the study.

The feed in this study was fed *ad libitum*, using a PMR with consistent composition throughout the experiment. By feeding *ad libitum*, cows allow a greater opportunity to express natural selection behaviour without strong competition for feed resources (Greter et al. 2008). Furthermore, feed delivery routines were standardised across treatments, reducing the likelihood that management factors contributed to treatment differences. The PMR included a small amount of straw, which has previously been associated with increased sorting against longer particles due to its dry characteristics and lower tastiness (Greter et al. 2008). Despite this, no substantial sorting differences were shown. This suggests therefore that the presence of the calf did not alter the cows' motivation to selectively consume specific fractions of feed. Taken together, the feed-related findings indicate that calf contact during the first days after parturition did not negatively

affect feed intake or sorting behaviour. Instead, the results showed effects of parity and day which may indicate a risk of NEB in primiparous cows.

5.3 Integrated discussion

The primary objective of this study was to investigate whether the presence of the calf influenced behavioural priorities and feed intake in dairy cows during the immediate postpartum period. The overall findings indicate that calf contact for more than 12 hours had no negative effects either on behavioural time budgets or feed intake. The original hypothesis proposed that LC cows would allocate more time toward bonding behaviours and less time toward feeding and resting behaviours, without affecting the total feed intake or sorting behaviour. The results of this study only partially support the hypothesis, as LC cows spent more time on feeding compared to SC cows after separation, even if the feed intake did not show any treatment effects. The absence of significant treatment effects should, however, be interpreted with some caution, as the behavioural analyses included only 37 cows after exclusions, which may have limited the ability to detect small treatment differences. Although LC cows had the opportunity to maintain maternal interactions with their calves, no significant reduction in lying and rumination behaviour was observed compared to SC cows. This may suggest that LC cows are capable of balancing maternal motivation with essential maintenance behaviours after parturition.

Maternal care immediately after calving is considered highly prioritised (Jensen 2012) and can be confirmed by the result of lower DMI and energy intake on day 1. The lower feed intake on day 1 can also depend on the different calving time during the observation day and the previous knowledge about cows' decreased feed intake on the last day before calving (Schirrmann et al. 2013). However, the present study shows that calf contact did not compromise feed intake or resting behaviour to a measurable level during the first 48 hours after parturition. A possible explanation is the undefined behaviour in the study, where SC cows had 47% undefined behaviour, whereas LC cows had 43% undefined behaviour. This gives the cow an opportunity to adjust other behaviours, such as licking itself or interacting with others, and show similar levels of observed behaviours. From a welfare perspective, this is an important observation, as it suggests that extended calf contact may allow expression of maternal behaviours without causing disruptions in behaviours associated with metabolic recovery. These findings may support not only improved animal welfare, but also the cow's ability to express more natural behaviour (Jensen 2011; 2012; Ventura et al. 2013). However, the potential negative effects on marketable milk yield and the increased stress associated with later separation (Lidfors 1996; Weary & Chua 2000; Churakov et al. 2023) raise important ethical questions regarding the balance between animal welfare, societal expectations, production efficiency, and animal health. Parity consistently affected both behavioural and nutritional variables, with primiparous cows showing higher time spent on standing and suckling, lower feed/energy intake, and a tendency towards

increased feed sorting. Therefore, these findings suggest that younger cows may experience greater behavioural and metabolic challenges after parturition, compared to multiparous cows.

When interpreting the results, several methodological limitations should be considered. Although SC cows were intended to be separated approximately 12 hours after calving, practical management at the commercial research facility resulted in some variation in the actual separation time. Consequently, three cows had to be excluded from the behavioural analysis because the separation occurred too far from the intended time point, reducing the sample size. Furthermore, the study evaluated only the first 48 hours postpartum. While this period captures the immediate behavioural response to calf presence and separation, it may be too short to detect longer-term adaptations in behaviour, feed intake, and metabolic recovery. Finally, the relatively limited sample size may have reduced the statistical power to detect smaller treatment effects. As this study formed part of a larger ongoing research project conducted, some methodological compromises were necessary. Another limitation concerns the absence of physiological indicators of stress or metabolic status. Measurements such as cortisol, NEFA, ketone bodies, or milk production parameters could provide a more comprehensive understanding of how the calf presence influences the physiological adaptation of dairy cows during the first days of lactation. Future studies should therefore combine behavioural observation with metabolic and endocrinological studies to better evaluate the biological consequences of CCC. Despite this restriction, this study contributes valuable information to an area with limited existing research and can be used for future research designs. Previous studies on CCC have been focused on calf welfare, milk yield, or public perception of early separation, whereas relatively few studies have investigated the relationship between maternal behaviour and feed intake during the transition period. The present finding is therefore important to a better understanding of how postpartum cows adapt behaviourally and nutritionally when calves remain present.

6. Conclusion

The results indicate that contact with the calf during the first 48 h after calving did not reduce feed intake or resting behaviour compared with separation after approximately 12 h. Although LC cows had the opportunity to perform maternal behaviours, they maintained behavioural priorities associated with recovery after calving. Furthermore, LC cows increased the time spent feeding after calving, whereas SC cows reduced their feeding time following separation, despite no overall treatment effect on feed intake. These findings suggest that CCC may be compatible with maintaining behavioural and nutritional stability during the first days of lactation. However, parity appeared to have a greater influence on feed intake and energy intake than calf contact, and further studies with adjusted sample size and longer observation periods are needed to evaluate long-term effects on animal welfare, production, and metabolic health.

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Popular science summary

This study investigated whether keeping calves with their mother the first three days after birth affected the cow's feed intake or behaviour. The subject is important because the period directly after calving is one of the most demanding phases in a dairy cow's life. During this time, cows require a large amount of energy to support milk production, while also recovering from calving. The study was conducted at the Swedish Livestock Centre (Uppsala, Sweden) between January and March 2026. A total of 41 cows was included in the study, but some of them were excluded for specific reasons before the data collection was completed. Half of the cows were kept with their calf after birth, while others were separated from their calf 12 hours after calving. Cow behaviour was recorded using video cameras placed above each calving pen. Feed intake was measured by weighing the offered feed and the leftovers each day. The study investigated behaviours such as standing, lying, feeding, rumination, and interactions between the cow and calf. The results showed that keeping the calf with the cow did not affect the cow's feed intake or behavioural priorities negatively during the first days after calving. Most behavioural differences were instead related to factors such as parity or breed.

The findings are important because public concern about early separation between cow and calf has increased. Many consumers associate extended cow-calf contact with improved welfare, while producers are often concerned that prolonged contact may negatively affect production, management, or the cow's recovery after calving. Overall, these findings suggest that short-term contact with the calf may allow cows to express maternal behaviours without negatively affecting feed intake during the first days of lactation. These findings also showed that separation at 12 hours after calving leads to changes in cow behaviours. The study contributes to increased knowledge about how cow-calf contact may influence the welfare of dairy cows during the first days after giving birth.

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