Effect of weaning calves from mother at different ages on their growth and milk yield of mothers

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ABSTRACT: The aim of this study was to determine the impact of the length of calf sucking milk from its own mother on calf growth at the age of 3 months and milk yield of mothers. We tested a hypothesis that the nursing of calves by their own mothers increases the body weight of calves and decreases the milk production. 50 Holstein primiparous cows and their calves were divided into three groups according to the sucking length of calves: 7 days (A), 14 days (B) and 21 days (C). All calves suckled mother's colostrum and milk while mothers were milked twice per day. After weaning from mother calves were kept in individual hutches until 56 days of life, and then in group housing pens. In the period from birth to weaning the calves of group A reached the lowest and the calves of group C the highest daily gains (0.35 kg, 0.46 kg, 0.54 kg; $P < 0.01$). The lowest gain was recorded in animals of group A (0.55 kg) and the highest gain was reached by calves of group C (0.74 kg) for the period from birth to three months of age. For the first 305 days of lactation cows of group A produced insignificantly more milk than group C (7356.5 kg, 6779.2 kg, 6663.9 kg). A significant difference in milk production was recorded only during the first seven months of lactation (5494.5 kg, 5041.9 kg, and 4872.3 kg; $P < 0.05$). The long stay of calves with their mothers influences the growth of calves positively, but the milk production of mothers may decrease. Therefore, the stay of calves with the dam within 21 days after birth is not recommended for high-yielding dairy cows.

Keywords: calf; cow; restricted suckling; weaning; growth; milk production

Rearing after birth may have a significant impact on subsequent performance and behaviour of animals. Proper rearing conditions of a healthy and viable calf in this period are another prerequisite for making the best use of its genetic potential for dairy cows (Arave et al., 1985; Frelich et al., 2008; Řehák et al., 2009). Weaning is an important intervention in the life of calf. A situation at the time of weaning is similar in all countries with advanced agriculture. Calves are removed from mother immediately after birth and fed a milk replacer. Only about 10% of calves, particularly from small herds, are fed native milk until weaning (Krohn et al., 1999). Apart from immediate welfare problems, the early separation of dam and calf has negative implications for the health of cow, calf diseases, high susceptibility to stress, and instability of the former social behaviour (Brouček et al., 2008).

Allowing a longer period of maternal suckling probably improves the welfare of calves both during the suckling period and later in life, but the magnitude of the positive effect has not been quantified yet. On the other hand, the separation of the calf from its mother later after birth might be a higher stress for both the dam and the calf. Milk production would be reduced after separation when the cow and calf were together for 10 days (Metz and Metz, 1985), also the amount of produced milk would be lower.

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Cattle have a long suckling period, lasting until 6 to 9 months of age in natural situations (Pilarczyk and Wojcik, 2007), during which the cow provides the calf with natural suckling, maternal support and a complex array of stimulations. The dam herself is strongly affected by the calf suckling and the mutual bond. Nursed calves gain significantly more weight during the period they were nursed (Flower and Weary, 2001), no doubt because of the higher milk intake (De Passille and Rushen, 2006). With the same level of starter concentrate allowance, calves reared under restricted suckling management had increased growth and body weight at weaning than those artificially reared. Unweaned calves can drink more milk or milk replacer than is traditionally provided to them without any negative effects on their health (Borderas et al., 2009). According to Margerison et al. (1997) and Mendoza et al. (2010) restricted suckling, when the cow is milked, may be a simple and viable alternative for dairy farmers interested in obtaining heavier male or female calves at weaning without substantially affecting the management of the herd.

When keeping a calf with its mother, the mother provides care and necessary impetus to bilateral contacts, which strongly activate the calf in the first hours and days of life. In addition, the calf can drink colostrum as often as required, by the required quantity of colostrum with optimum temperature (Brouček et al., 1995). The most physiological manner of calf feeding is sucking the cow; the interval between individual drinking periods depends on the time necessary for the digestion of milk. Calves that are suckled drink more milk than calves fed by open bucket (Hammell et al., 1988), and consequently have a higher growth rate (Metz, 1987; Margerison and Phillips, 2000; Flower and Weary, 2001). Suckled calves are also able to maintain the higher growth rate for several months after the suckling period (Metz and Metz, 1985) and lower mortality rates than artificially reared calves (Margerison et al., 1997). Brouček et al. (2004) evaluated milk production in dairy cattle reared in different systems. In the 305-day lactation the highest milk production was reached by primiparous dairy cows that were fed by the nursing cow.

The aim of this study was to determine the impact of the length of calf sucking milk from its own mother on calf growth and milk yield of mothers. We tested a hypothesis that the nursing of calves by their own mother increases the body weight of calves and decreases the milk production.

MATERIAL AND METHODS

Fifty Holstein primiparous cows and 50 their calves (A = 16, 8 males and 8 females; B = 18, 8 males and 10 females; C = 7 males and 9 females) were kept in individual pens of the maternity barn. The heifers were kept in group pens with loose housing and straw bedding for the last two months before calving and moved to individual maternity pens three days before parturition. Cows originated from three sires. They were randomly divided by their live weight on the second day after parturition and by sire lineage into three groups according to the length of calf sucking: 7 days (A), 14 days (B), and 21 days (C). After weaning from mothers (early – 7^{th} day of life, later – 14^{th} day and late – 21^{st} day) calves were relocated into individual hutches until 56 days of life, and then the animals were kept in group housing pens in the calf barn.

All calves suckled mother's colostrum and milk, while mothers were milked twice per day (restricted suckling management). After the calves were moved to individual hutches, they received a milk replacer from a bucket with nipples. Until the 27^{th} day of life the calves received 6 l of milk replacer, from 28^{th} to 56^{th} 8 l of milk replacer. From the 7^{th} day to weaning the calves were offered a concentrate mixture and lucerne hay *ad libitum*. They received 1.5 kg of concentrate mixture per day and lucerne hay in free choice from weaning to three months of age.

The primiparous cows were fed a mixed ration consisting of maize silage, lucerne haylage, lucerne hay, barley straw, brewer's grain, sugar-beet pulp, and concentrate mixture for high-yielding cows.

The total mixed diet was administered to troughs in the production barn by a feeding wagon once a day during milking. Feeding was allowed throughout the 24-h period, except during milking. The total mixed ration was balanced according to Slovakian nutrient requirements of dairy cattle (Petrikovic and Sommer, 2002). The feed ration included the factors and equations adopted for maintenance, growth, reproduction and lactation. Dairy cows were fed according to the stages of lactation.

Early lactation (the first four months): feed ration contained 19.2 kg of dry matter (DM), 131 MJ NEL, 1.84 kg PDI, 2.89 kg of crude protein and 3.41 kg of crude fibre. Calculated milk efficiency of this total mixed diet was 32 kg milk.

Mid-lactation (5^{th}–7^{th} month): feed ration contained 18.34 kg DM, 120.3 MJ NEL, 1.61 kg PDI, 2.64 kg of crude protein and 3.48 kg of crude fibre.

Calculated milk efficiency of this total mixed diet was 27 kg milk.

Late lactation: feed ration contained 16.3 kg DM, 104.9 MJ NEL, 1.53 kg PDI, 2.29 kg crude protein. Calculated milk efficiency of this total mixed diet was 20 kg milk.

The weight of calves was recorded at birth, at the age of 7, 14, and 21 days, when they were moved from individual hutches at the age of 56 days and 3 months of life.

The mothers were moved to a production free-stall barn after the weaning of calves. All heifer-cows were milked in the milking parlour (Boumatic 2 × 5) from the second day of lactation. The amount of milk was monitored daily by the computer. The milk composition was determined twice a month. The content of fat, protein, lactose, total solids, and the somatic cells counts were measured using an infrared analysis (Milkoscan 133, Foss Electric, Hillerød, Denmark). Standardized 305-day lactation was evaluated. The health condition of mothers was recorded continuously. Fluidity, colour, consistency of calf faeces and health condition were evaluated twice daily according to Larson et al. (1977).

The data were analysed using a General Linear Model ANOVA by the statistical package STATISTIX, Version 9.0 (Anonymous, 2008). The normality of data distribution was evaluated by the Wilk-Shapiro/Rankin Plot procedure. All data conformed to a normal distribution. Significant differences among means were tested by Bonferroni's method. Values are expressed as means ± standard deviation of the mean.

RESULTS AND DISCUSSION

Growth of calves

Calves of group A reached the lowest average daily gain while group C had the highest average daily gain (0.33 ± 0.29 kg, 0.70 ± 0.34 kg, 0.76 ± 0.37 kg, $P < 0.01$) within two weeks of age. A similar state was recorded at the age of 21 days (0.32 ± 0.26 kg; 0.58 ± 0.26 kg; 0.79 ± 0.31 kg; $P < 0.001$) (Table 1). In the period from birth to weaning at the age 56 days the calves of group A reached the average daily gain of 0.35 ± 0.16 kg, calves in group B had 0.46 ± 0.13 kg and the animals of group C attained 0.54 ± 0.14 kg ($P < 0.01$). The difference between groups A and C was highly significant (Table 1). The average daily gains for the period from birth to three months of age were statistically different among groups ($P < 0.001$). The lowest gain was recorded in animals of group A (0.55 ± 0.11 kg) and the highest gain in calves of group C (0.74 ± 0.12 kg).

At the age of 56 days, when weaning from milk nutrition was realized, we found a highly significant difference ($P < 0.05$) in the live weight between animals of group A (63.4 ± 8.9 kg) and group C (71.4 ± 6.6 kg) (Table 2). Similarly, differences in live

Table 1. Average daily gains of calves (kg)

Period	Group	*n*	Mean	SD	Significance
Birth to 14 days	A	16	0.33	0.29	** A:B,C**
	B	18	0.70	0.34	
	C	16	0.76	0.37	
Birth to 21 days	A	16	0.32	0.26	*** A:C*** A:B*
	B	18	0.58	0.26	
	C	16	0.79	0.31	
Birth to 56 days	A	15	0.35	0.16	** A:C**
	B	17	0.46	0.13	
	C	16	0.54	0.14	
Birth to 90 days	A	16	0.55	0.11	*** A:C*** A:B*
	B	17	0.66	0.14	
	C	15	0.74	0.12	

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$; SD = standard deviation of mean

Table 2. Live body weight of calves (kg)

Age (day)	Group	*n*	Mean	SD	Significance
Birth	A	16	43.56	3.42	NS
	B	18	41.00	4.38	
	C	16	41.44	4.29	
7	A	16	46.28	4.79	NS
	B	18	46.94	5.04	
	C	16	45.81	5.39	
14	A	16	48.22	4.99	NS
	B	18	50.86	6.06	
	C	16	52.03	6.11	
21	A	16	50.38	5.66	** A:C**
	B	18	53.14	6.72	
	C	16	57.97	5.96	
56	A	15	63.44	8.90	* A:C*
	B	17	66.53	7.54	
	C	16	71.42	6.63	
90	A	15	93.68	9.31	** A:C**
	B	17	100.53	13.20	
	C	15	108.23	10.51	

*$P < 0.05$; **$P < 0.01$; SD = standard deviation of mean; NS = non significant

weights were also recorded at the age of three months (93.7 ± 9.3 kg, 100.5 ± 13.2 kg, 108.2 ± 10.5 kg, $P < 0.01$). No significant differences were found out in the health condition and faeces of calves. One calf with neonatal diarrhoea with antibiotic treatment was recorded in the first week in group A. One case of omphalophlebitis was diagnosed in each group. Two calves (groups A and B) died between 31 and 50 days of age, one calf from C group on the 64th day, all from a clinical respiratory-tract disease. There was no difference among groups in appearance scores from the second week to 90 days.

The calves fed by their own mothers and removed from mother on the 56th day grew faster than the conventionally fed calves, probably as a result of the better quality and higher intake of milk drink. The animals of group C received more valuable liquid nutrition from udders and probably in greater amounts than the animals from groups A and B. Bar-Peled et al. (1997) studied the calves that were fed a milk replacer in buckets or were allowed to suckle the dam three times daily. Results indicated that the calves that suckled milk during the first 42 days of age had higher average daily gains, earlier age at calving and a tendency of higher milk production than did the calves fed a milk replacer. Similarly Khalili et al. (1992) found out that a high amount of milk or milk replacer in early life resulted in higher live weight than in calves fed a lower amount of milk. Daily gains of calves during the sucking period are dependent on the quantity of milk available to the calf (Krohn, 2001). Calves fed more milk remained healthy and gained weight much more rapidly before weaning (De Passille, 2001).

In the present study, the live weight was subsequently maintained. Highly significant ($P < 0.01$) differences were recorded between the group A and C at the age of three months. Up to the age of 90 days the animals separated from mother on the seventh day had the lowest daily gains and calves separated from the mother on the 21st day reached the highest daily gains. Obviously, the weight advantage of the *ad libitum*-fed calves persisted for several weeks after weaning at least similarly like it was reported by Jasper and Weary (2002). Similar results of live weight in calves nursed by mothers were found out by Metz (1987). However, large volumes of milk reduce the concentrate consumption, feeding mo-

tivation, and growth advantages after weaning (De Passille, 2001; Borderas et. al., 2007).

Milk production

In the present study the impact of the length of calf's stay with mother on the milk yield of mother was investigated. We found a significant difference in the second month of lactation only ($P < 0.05$) (Figure 1). The production of group A was the highest while group C had the lowest production (879.0 ± 123.1 kg, 806.6 ± 95.7 kg, and 755.9 ± 93.2 kg, $P < 0.05$). The cause of the lowest production in group C was drinking the milk of calves and retaining the milk of dairy cows to ensure calf nutrition. Tančin and Bruckmaier (2001) reported that after 3-6 week housing of calves with their own mothers the milk production of cows decreased as a result of insufficient ejection or retention of milk for the calf.

For the entire (305 days) first lactation the cows of group A that were suckled for 7 days produced 7356.5 ± 891.7 kg milk, dairy cows suckled by calves for 14 days (group B) produced 6779.2 ± 738.1 kg milk and dairy cows that were housed with a calf for 21 days (group C) produced 6663.9 ± 922.2 kg milk. The differences were not statistically significant (Table 3). A similar trend was also recorded in the other milk composition parameters. Only the amount of lactose differed significantly ($P < 0.05$) (368.6 ± 67.9 kg, 325.9 ± 37.2 kg, and 320.4 ± 54.1 kg).

The first-calf heifers of group A displayed the trend of the highest milk production during the first four months of lactation (3163.1 ± 460.4 kg, 2979.1 ± 314.9 kg, and 2853.5 ± 331.5 kg) (Table 3). A similar trend was also recorded in the period from the fifth to the seventh month of lactation (2261.7 ± 326.3 kg, 2062.8 ± 233.5 kg, and 2018.8 ± 375.5 kg) (Table 4).

In the evaluation of the first seven months of lactation a significant difference was recorded in milk production only (5494.5 ± 714.8 kg, 5041.9 ± 482.0 kg, and 4872.3 ± 669.7 kg; $P < 0.05$). The ani-

Table 3. Milk performance of mothers per 305-day lactation and for the first four months of lactation

Item (kg)	Group	*n*	305-day lactation			First four months of lactation		
			mean	SD	significance	mean	SD	significance
Milk	A	14	7356.5	891.7	NS	3183.1	460.4	NS
	B	16	6779.2	738.1		2979.1	314.9	
	C	12	6663.9	922.2		2853.5	331.5	
FCM	A	14	6379.9	701.3	NS	2725.3	341.6	NS
	B	16	6158.3	575.8		2634.5	208.2	
	C	12	5964.5	776.8		2512.5	237.9	
Fat	A	14	229.2	27.1	NS	96.8	11.6	NS
	B	16	229.8	24.4		96.2	7.7	
	C	12	219.9	30.7		91.4	8.5	
Protein	A	14	219.5	26.8	NS	89.0	13.0	NS
	B	16	207.9	25.7		83.9	10.5	
	C	12	205.9	28.7		82.6	10.1	
Lactose	A	14	368.6	67.9	*	169.8	24.8	NS
	B	16	325.9	37.2		159.3	18.1	
	C	12	320.4	54.1		151.9	21.0	
Total solids	A	14	847.63	97.6	NS	357.6	48.6	NS
	B	16	806.2	81.7		341.6	32.5	
	C	12	788.8	112.6		328.5	36.8	

*$P < 0.05$; SD = standard deviation of mean; NS = non significant

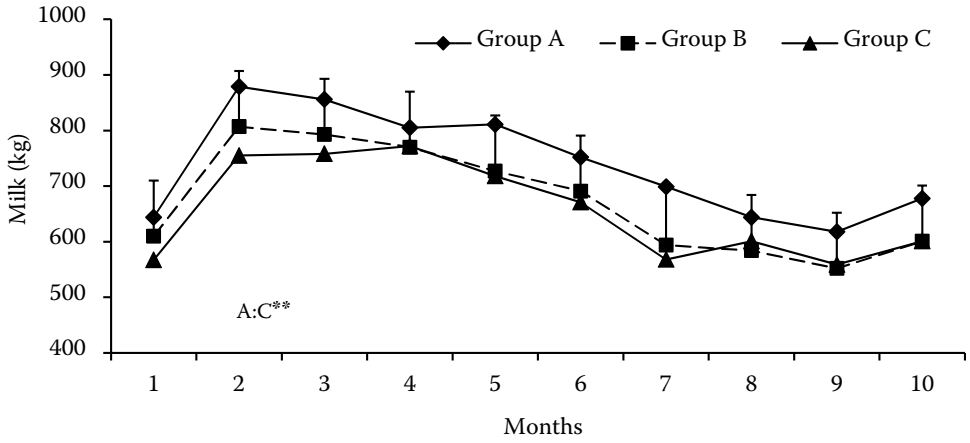

Figure 1. Milk production in individual months of the first 305 days lactation (kg)

A = sucking length by the calf to the 7th day; B = sucking length by the calf to the 14th day; C = sucking length by the calf to the 21st day

mals of group A produced significantly more milk than the first-calf heifers from group C (Table 4).

We did not obtain any sufficient evidence of effects exerted by the sire lineage. Five fresh cows were culled in the period from birth to the weaning of calves (poor body condition, respiratory diseases). Three cows were culled during lactation. The main causes were digestive problems and laminitis.

Table 4. Milk performance of mothers from the fifth to the seventh month of lactation and per first seven months of lactation

Item (kg)	Group	*n*	5^{th}–7^{th} month of lactation			First seven months of lactation		
			mean	SD	significance	mean	SD	significance
Milk	A	15	2261.7	326.3	NS	5494.5	714.8	* A:C*
	B	16	2062.8	233.5		5041.9	482.0	
	C	13	2018.8	375.5		4872.3	669.7	
FCM	A	15	1916.8	245.6	NS	4676.0	530.5	NS
	B	16	1855.7	209.1		4490.2	351.3	
	C	13	1757.2	294.5		4269.8	499.7	
Fat	A	15	67.5	9.2	NS	165.2	18.5	NS
	B	16	68.7	11.3		164.9	16.5	
	C	13	63.3	11.3		154.7	18.1	
Protein	A	15	68.2	10.5	NS	158.8	20.7	NS
	B	16	64.7	8.6		148.5	16.4	
	C	13	63.3	11.4		145.9	20.3	
Lactose	A	15	110.5	16.9	NS	280.3	19.2	NS
	B	16	100.5	12.1		259.7	15.4	
	C	13	99.2	20.9		251.0	21.4	
Total solids	A	15	260.1	36.3	NS	623.3	75.5	NS
	B	16	246.1	26.2		587.7	50.4	
	C	13	237.5	43.3		566.1	73.9	

SD = standard deviation of mean; NS = non significant

Uncontrolled access of the calf to the mother can reduce milk yield (Rushen and Passille, 1998). The intensity of sucking has a quite strong influence on the amount of milk released in the process of milking when milking is combined with suckling (Tančin and Bruckmaier, 2001). The cause of possible lower production of dairy cows during restricted suckling and after weaning of the calf may be retaining milk by dairy cow to ensure calf nutrition. According to Shamay et al. (2005), nursing by *ad libitum* milk, as compared with milk replacer, affected live weight but not the size of the adult animal, and increased FCM yield at the first lactation. Different growth intensities of heifers before breeding, even under the same housing system and nutritional conditions, seem to influence their milk production during the first lactation (Bouška et al., 2007; Uhrinčať et al., 2007; Jílek et al., 2008; Frelich et al., 2009).

We did not find any significant differences in somatic cell counts in milk. However, the dairy cows that were suckled by calves for the longest time had the highest somatic cell count in each month of lactation. It may also relate to the fact that the teat canal is frequently strained by calf suckling and remains opened longer, which results in the penetration of microorganisms into the mammary gland. A reduction in milk production can be associated with the higher count of somatic cells, which was confirmed in cows with the suckling period of 21 days (group C).

The positive effects of keeping dairy cows and calves together were mainly shown for calves that reached higher weight gains. However, the positive effects for the dairy cow were less obvious, but they have not probably been studied enough.

CONCLUSIONS

We concluded that the calves reared with their mothers for a longer time reached higher live weight at weaning and at the age of 90 days. It is so because native milk suits the animals and calves receive it according to their needs. The highest milk production was reached by dairy cows that were suckled by the calf for the shortest time. Prolonged nursing reduces the milk production of mothers. Therefore the farmer has to decide either on the higher production of mothers or on higher increases in body weight in calves with the lower consumption of milk replacer, and probably with higher production of milk in adulthood.

Consequently, allowing the calf to suckle the mother for a longer time may be a better alternative from the aspect of calf welfare and performance.

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