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Effect of weaning on performance and behaviour of calves and their dams in dairy cows – A review

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ABSTRACT

This article reviews the effects of 2 calf rearing systems (weaning vs suckling) on milk production, milk composition, udder health and reproduction of dairy cows and buffaloes; and effects on body weight gain, milk intake, milk intake time, immune status, health and behaviour of their calves. Restricted suckling increased milk yields to the level of 15 to 30% in purebred as well as in crossbred cows, lowered milk fat content and reduced the risk of mastitis. Suckling increased post-partum interval until first heat due to delayed post partum resumption of ovarian activity. The suckled calves had in general higher daily body weight gain, lower incidence of abnormal behaviours, better immune status and thus were more healthy as compared to weaned calves. The suckling system may, therefore, be more beneficial to the performance and welfare of calves and their mothers than artificial rearing system but may cause some economic losses due to reduced fat content in milk and delayed post partum estrus.

Key words: Behaviour, Dairy cows, Health, Performance, Suckling, Weaning

Under traditional management system of dairy animals in village conditions in India, the calves are allowed to suckle their dams for their milk feeding as well as for the let down of milk (Kamboj and Tomer 2002). However, at most of the organized dairy farms and at many of the commercial dairy farms in the country, where the main purpose is to produce milk for sale, the calves are weaned from their mothers at birth or a few days later and reared artificially, either alone or together with other calves. The most common arguments advance for weaning are the accurate recording of milk yield of cows/buffaloes, the economical and scientific feeding of the calves, facilitation of the mechanization and automation of farm operations such as machine milking, saving of labour cost and ensuring clean milk production etc. The weaned calves are often offered colostrum/milk in buckets, teat-bucket or bottles which does not always satisfy the calf's motivation to suckle (Smijisha and Kamboj 2012). At the same time the calves especially buffalo calves, may not consume the required amount of colostrum/milk by artificial feeding, which have several adverse consequences on their immune status, health, growth and behaviour (Smijisha and Kamboj 2010, Kamboj *et al*. 2006). Sucking behaviour is one of the most important behaviours in the reproductive process of mammals as it results in the transfer of milk from mother to the young during suckling. Suckling is the most potent stimulus for the proper let down of milk and for the establishment of normal milking temperament and the deprivation of suckling may have consequences on cows/buffaloes productive and reproductive performance and udder health. The provision of suckling may, on the other hand, delay the onset of normal estrus cycles and thus may prolong the calving to estrus duration and may reduce the fat content in milk. Keeping these aspects in view, an attempt has been made in this paper to review the recent literature on the influences of natural suckling vis-à-vis weaning on the performance, behavior and health of the cows and buffaloes and their calves.

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Influence of weaning on performance of cows

Milk yield: The results of several studies carried out on local cows and/or their crosses with European breeds in many countries (Table 1) indicated that the calf suckled cows yielded higher milk daily and total milk yield than that produced by non-suckled cows. The yields were on an average 15 to 30% higher as indicated by these studies and also reported by Little *et al*. (1991) and Walch (1974).

It emerged from these studies that the suckling system can stimulate the subsequent milk production. This higher milk production in restricted suckled cows was probably due to the effect of more frequent udder emptying because when

the calf is suckling the residual milk after milking, increased degree of udder emptying enhances production (Sandoval-Castro *et al*. 2000). More frequent udder emptying in the first part of lactation also improves development of milk secreting cells (Hale *et al*. 2003). In addition, enhanced teat stimulation provided by the suckling by calves can result in higher milk production (Bar-Peled *et al*. 1995). This may also be due to higher release of lactogenic hormones, i.e. prolactin and growth hormone both during and after the suckling period (Walch 1974). Another reason attributed to this was that when calves suckled their mothers, brain of the dam was stimulated and oxytocin continued to be secreted affecting milk ejection.

Milk composition: The results of studies on the effect of artificial rearing and calf suckling on milk composition (Table 2) indicated that fat content in milk of restricted suckled cows was lower than in case of cows with artificially reared calves. However, protein and solids-not-fat contents in milk did not vary between these 2 rearing systems. The lower fat content in milk of RS cows might be due to significantly higher fat content in residual milk as compared to that in whole milk (5.91 and 3.38% respectively) as reported by Boonbrahm *et al.* (2004) and 5.90 and 3.31% respectively as reported by Sanh *et al.* (1995). In one of the studies the residual milk has also been reported to contain 3 times more fat than normal milk (Chamberlain 1989). The higher amount of fat in residual milk has been explained to have resulted due to the fact that the fat globules are not evenly distributed in milk, and incomplete milking tends to leave high-fat milk behind, lowering the milk fat percentage of the milk taken at milking.

Udder health: The results of various studies regarding the effect of artificial rearing and calf suckling on udder health of crossbred cows are summarized in Table 3.

The status of udder health measured in terms of incidence of clinical and sub-clinical mastitis using California mastitis test (CMT) was better in restricted suckled Holstein×Zebu calves as compared to the weaned calves fed via a nipple bottles (Froberg *et al.* 2007, Mejia *et al*. 1998, Sedano *et al*. 2010) The protective effect of residual calf suckling on mastitis might be stimulated by (i) an increase in the complete emptying of the udder during suckling which may lead to a reduction in the substrate (milk) for bacterial growth, and/or (ii) the presence of antimicrobial lysozymes in calf saliva.

Reproductive performance of cows: The days from calving to ovulation were higher in cows subjected to restricted suckling than the cows which were not allowed calf suckling in purebred HF (Mendoza *et al.* 2010) as well as in *Bos taurus* × *Bos indicus* crossbred cows (Escobedo-Amezcua *et al*.

Table 1. Daily milk yield (kg) of cows and buffaloes under restricted suckling (RS) and artificial rearing (AR) of calves

Breed	Country	N	Mean (kg/day)		Workers
			RS	AR	
Murrah buffaloes	India	12	7.94	7.29	Kamboj *et al*. (2011)
Holstein multi-parous cows	Uruguay	32	25.7	16.2	Mendoza *et al.* (2010)
Brahman×Holstein crossbred cows	Tropical American	20	14.0	10.3	Tesorero *et al.* 2006
Holstein×Zebu, F1 crossbred cows	Mexico	24	7.44	6.50	Froberg *et al.* (2007)
Brahman×Holstein crossbred cows	Tropical American	24	9.7	7.7	Combellas *et al.* 2003)
Boran cows (Ethiopian zebu) :					
Total milk yield (kg) of low yielders	Ethiopia	39	793	369	Yilma *et al.* (2006)
Boran cows (Ethiopian zebu) :					
Total milk yield of high yielders	Ethiopia	39	1142	819	Yilma *et al.* (2006)
Purebred Mpwapwa cows	Tanzania	20	6.9±0.45	6.0±0.41	Mejia *et al.* (1998)
Crossbred Mpwapwa cows	Tanzania	16	8.6±0.54	6.4±0.59	Mejia *et al.* (1998)
Holstein×Local crossbred F1 cows	*Vietnam*	24	10.9	9.5	Sanh *et al.* (1997)
Creole × Friesian crossbred cows	Mauritius	32	8.55	6.37	Teeluck *et al.* (1981)

Table 2. Fat, protein and solids-not-fat (SNF) content in cow milk under restricted suckling (RS) and artificial rearing (AR) of calves

Breed	Country	N	Means (%)						Workers
			Fat%		Protein%		SNF%		
			RS	AR	RS	AR	RS	AR	
Holstein cows	Uruguay	32	3.21	4.11	-	-	-	-	Mendoza *et al.* (2010)
Crossbred cows (HF × Local)	Thailand	40	3.57	3.65	3.25 NS	3.22 NS	8.66 NS	8.61 NS	Boonbrahm *et al.* (2004)
Boran and HF, Ayrshire	Tanzania	24	3.31	3.49	3.14	3.33	-	-	Sanh *et al.* (1995)

NS, Nonsignificant.

Table 3. Incidence of mastitis (%) in cows allowed restricted suckling (RS) and artificial rearing (AR) of calves

Attribute	Mean incidence of mastitis (%)		Workers
	RS	AR	
Percent incidence of sub-clinical mastitis	37.87	59.53	Sedano *et al*. (2010)
Percent incidence of sub-clinical mastitis	5.55	33.33	Mejia *et al*. (1998)
Percent incidence of clinical mastitis	1.3	5.8	Sedano *et al*. (2010)
Udder quarters with CMT score 1	84%	68%,	Froberg *et al.* (2007)
Udder quarters with CMT score 5	7%	14%	Froberg *et al.* (2007)

Table 4. Mean daily body weight gain (g) of calves allowed restricted suckling (RS) of their dams and milk fed artificially (AR)

Breed	Country	N	Mean daily body weight gain (g)		Workers
			RS	AR	
Holstein multiparous	Uruguay	32	813	656	Mendoza *et al.* (2010)
HF × Zebu crosses	Germany	57	138.9 kg up to 6 months	117.0 kg up to 6 months	Roth *et al.* (2009)
Crossbred	Thailand	40	620	390	Boonbrahm *et al.* (2004)
Holstein	Mexico	27	480	470	Froberg *et al.* (2008)
Holstein× local	*Vietnam*	24	445	422	Sanh *et al.* (1997)
Shorthorn, Sahiwal and their crosses	Pakistan	20	552	370	Khan and Preston (1992)
European × Zebu	Mexico	539	446	277	Alvarez *et al.* (1980)

2010, Mejia *et al*. 1998, Msanga and Bryant 2003) and in *Bos indicus* purebred cows (Browning *et al*. 1994, Yilma *et al.* 2006). In both the systems the days open were the lowest (18.5 and 21 in RS and AR) in Holstein cows (Mendoza *et al.* 2010) and the highest (126 and 165) in crossbreds (Mejia *et al.* 1998) respectively. Boonbrahm *et al.* (2004) reported that the cows of the restricted suckling group (RS) showed their first oestrus postpartum on an average 18 days later than those not suckled. The days from calving to first ovulation were further related to the length of suckling, being higher when the suckling was restricted as compared to complete suckling (Escobedo-Amezcua *et al*. 2010, Browning *et al*. 1994, Sacoto *et al*. 2005). It has been hypothesized that suckling has a prolonged inhibitory effect on the secretions of luteinizing hormone (LH) and this negative effect requires an ovarian factor (Silveira *et al.* 1993). Also it is known that the effect of suckling is less potent as the postpartum interval progresses (Rund *et al.* 1989). The mechanism whereby ovarian activity postpartum is delayed can be attributed to the maternal-offspring bond. In effect, Williams *et al.* (1996) showed that suckling of cows by their own calves maintained the suppressed pattern of LH secretion, however, if an alien calf was suckling, the pulses of LH were approaching those of a forthcoming ovulation.

The postpartum ovarian activity is greatly influenced by suckling dairy as well as swamp buffaloes (Singh and Brar 2008). In dairy buffalo ovulation was induced early in weaned (40.0±6.0 days) than suckled buffaloes (56.0±9.0 days, Barkawi 1993). Suckled buffaloes took significantly ($P < 0.05$) longer period to exhibit their first postpartum estrus (71.7±11.1 days) and longer conception interval (98.0±17.5 vs. 70.3±9.6 days) as compared to their non-suckled counterparts (Arya and Madan 2001). The delayed onset of estrus in suckled buffaloes was also attributed to poor ovarian activity by Perera *et al.* (1992) who observed that ovarian activity was the major problem in areas with poor fertility and was influenced by suckling. Plasma LH levels in lactating Murrah buffaloes with calves weaned at birth were significantly lower during the second and third week postpartum for animals which eventually experienced anestrous beyond 90 days postpartum than in those cycling within 50 days postpartum (Batra and Pandey 1983). Usmani *et al.* (1990) also found that postpartum intervals to uterine involution, resumption of follicular development, first rise in milk progesterone, first palpable corpus luteum and first oestrus were longer for limited-suckled buffaloes than for non-suckled buffaloes. Qureshi and Ahmad (2008) reported that increasing suckling duration delayed postpartum ovulation (r=0.19) and postpartum estrus (r=0.23) and shortened duration of discharge of lochia (r=-0.26) but had no effect on placenta expulsion time (r=-0.19) or uterine involution (r=0.05). They also reported that non-suckled buffaloes had longer placenta expulsion time and shortest postpartum estrus intervals as compared to those suckled for one or more than one month. The length of suckling had no effect on uterine involution or conception rates.

Influence of weaning on the performance and behaviour of calves

Body weight gain of calves: The restricted suckled calves gained more weight as compared to artificially reared calves

in Holstein cows, in dual purpose cows and in crossbred cows (Table 4). The buffalo calves reared by restricted suckling of their dams yielded better growth rates than if the milk was provided in a feeder or pail (552 vs. 370 g/d) (Khan and Preston 1992). On the other hand Froberg *et al.* (2008) observed in Holstein cow's calves that, there was no apparent difference between RS (0.48±0.22 kg) and AR calves (0.47±0.09 kg) in the average daily weight gain (LWG) from birth to weaning, corresponding to a total weight gain for RS calves of 26.2±3.9 kg and AR calves 26.1±1.4 kg. However, the individual variation in LWG was significantly greater ($P < 0.01$) in the RS than in AR calves. In buffalo calves, the average daily gain was significantly ($P < 0.05$) higher in calves fed milk using a bottle with nipple (451±0.09 g); which simulated natural suckling than in buffalo calves fed milk using a bucket (348±0.11g). The nipple fed group of calves had lower rate of milk feeding which may have resulted in the more secretion of saliva, better mixing of the milk with digestive enzymes (Smijisha and Kamboj 2007).

The high weight gain in suckled calves is mainly ascribed to higher fat content in the residual milk, but it can also be related to differences in milk intake (Yilma *et al.* 2006, Sanh *et al*. 1997, Mejia *et al*. 1998). Froberg *et al.* (2008) also observed that the milk suckled by RS calves contained more fat and metabolisable energy (ME) per kg than the parlour milk fed to AR calves (6.1% vs 4.2% and 3.5 MJ/kg vs 2.9 MJ/kg). Further, calves allowed to suckle had a higher level of oxytocin compared to bucket-fed calves (Lupoli *et al*. 2001). Boonbrahm *et al.* (2004) found that the energy intake from milk and the total ration respectively in the bucket reared (BR) group was 50% and 38% lower in AR group of calves than in the restricted suckling (RS) group of calves. This was a result of the lower milk intake and the different fat composition of the consumed milk. During days 56 and 84 the average fat content in the residual milk consumed by the RS calves was 5.71% as compared to 3.19% in the milk fed to BR calves, which indicated a 78% higher fat content in the residual milk.

Milk intake time: The total duration of milk intake was twice as long for mother-fed calves (12.82±0.6 min) than for calves fed by the automatic milk feeder (5.17±1.0 min) as reported by Roth *et al.* (2009). This behavior remained constant with increasing age of calf and with increasing frequency of feeding in both systems of feeding. Prolonged milk intake reduced non-nutritive suckling or cross-sucking in several studies (Aurich and Weber 1994, Haley *et al.* 1998, Jung and Lidfors 2001). In an another study the average suckling time was 12 min for RS calves allowed thrice suckling daily and the average drinking time from a bucket with floating nipple was 1 min and 45 sec for AR calves in Holstein cows (Froberg *et al.* 2008). Boonbrahm *et al.* (2004) also reported that the bucket reared (BR) calves needed only 5–7 min to finish the milk offered per feeding, while restricted suckling (RS) calves took 10–15 min to suckle the residual milk from their dams. Smijisha and Kamboj (2007) reported that average milk feeding rate was significantly lower in bottle with nipple fed buffalo calves (222.56 g/min) as compared to bucket fed calves (426.10 g/min). This difference of milk ingestion duration could cause a difference in the digestion of some nutrients contained in milk due to the activation of salivary enzymes. Relatively slow rate of ingestion of milk be suckled calves causes greater secretion of saliva (Doyle 1991) and the greater contact of milk consumed by suckled calves with saliva results in greater secretion of pre-gastric esterase. The pre-gastric esterases are the principal enzymes of fat digestion in the abomasums and the increased secretion of these due to suckling could result in complete digestion in the abomasum.

Immune status of calves: Stott *et al.* (1979) observed that rates of early absorption and maximum absorption of colostral IgG were greater in serum of calves that suckled (22.11 mg/ml) than in calves fed colostrum by bottle (14.91 mg/ml). Selman *et al.* (1971) also reported that suckled colostrum from their dams usually attained much higher immune globulin concentrations in serum than did hand-fed calves. This was attributed to the fact that in most cases suckling occurs within the first 6 h postpartum, the amounts of colostrum consumed are usually large when compared to those traditionally offered by bucket and calves are somehow rendered far more efficient absorbers of immune lactoglobulins if left with their dams, possibly due to prolonged grooming they usually receive. Smijisha and Kamboj (2012) studied colostrum intake by buffalo calves by using a bottle with nipple and by a bucket, and concluded that the average intake of colostrum at very first feeding was significantly higher in calves offered colostrum in bottles with nipple (1.08 kg) as compared to the calves which ingested milk through a bucket (0.465 kg). The average total serum globulin concentration as well as average serum immunoglobulin G concentration were higher in nipple fed calves (46.46 mg/ml and 39.68 mg/ml respectively) as compared to bucket fed (38.46 mg/ml and 31.56 mg/ml respectively) at 48 h after birth. Stafford *et al.* (2005) also observed that as the nipple feeding resembles natural suckling, less time will be needed for the calf to get adapted to suckling and thus the calves will consume their required amount of colostrum in first 2 days. The natural suckling of colostrum, thus, could be the best practice followed by use of bottle with secrew-nipple and open bucket/pail feeding for improved immune status of calves.

Oral behaviour of calves: Under artificial system of feeding the milk is often offered to the calves in buckets, teat-buckets or automatic feeders, which does not always satisfy the calf's motivation to suckle (Broom 1981). An unfulfilled suckling need can lead to inter-sucking where calves suck the ears, tail, navel, prepuce and scrotum of other calves (Mees and Metz 1984) and the equipment in the pen

(de Wilt 1985). Roth *et al.* (2009) reported that calves fed milk from artificial feeder showed significantly more abnormal oral behaviours (cross-suckling) than calves that were allowed to perform natural sucking behaviour (4.74±1.8 vs 0.08±0.1 min/4 h). This supports the hypothesis that milk intake via an artificial teat does not fully satisfy the calves' motivation to perform sucking behaviour. However, other studies where the milk feeder was equipped with a dry teat also found a remarkable proportion of cross-sucking calves (Jensen 2004: 51%, Roth *et al.* 2007: 85.4%, Roth *et al.* 2008: 85.2%). Prolongation of duration of milk intake in mother-fed calves has been suggested to reduce non-nutritive sucking or cross sucking in several studies (Haley *et al.* 1998, Jung and Lidfors 2001). Froberg *et al.* (2008) reported that the artificial reared calves displayed significantly more cross-sucking, licking objects, calf sniffing other calves, calf licking other calves and calf rubbing other calves during milk feeding than the restricted suckling calves did during suckling (1.56±0.26 vs 0.05±0.04; 1.92±0.28 vs 0.51±0.17; 0.37±0.09 vs 3.33±0.36; 0.04±0.03 vs 1.35±0.31 and 0.05±0.03 vs 0.98±0.19).

Health performance: Health of the calves allowed natural suckling in general was better as compared to the health of artificially reared calves. Boonbrahm *et al.* (2004) studied the health performance of 40 calves and reported that the RS calves exhibited no losses and only 3 illnesses, whereas 3 bucket reared calves died and 9 developed illnesses. Mejia *et al.* (1998) also reported that there was very low calf mortality in RS calves as compared to artificial reared calves. Out of 18 artificially reared calves only 1 died, while there were no deaths in the restricted suckling group. Preston (1973) reported that the mortality of single-suckled calves was 5.2% whereas the mortality of those fed with milk from buckets was 12.3%. Ugarte and Preston (1973) analyzed the data on calf deaths occurring in 195, 000 births and found that the mortality was 9.9%, 6.5% and 7.2% in calves reared artificially, by restricted suckling and by natural rearing respectively.

Intestinal parasites were more common in the bucket-fed animals though not as common as in multiple-suckled calves (Ugarte and Preston 1972) although the temperature of bucket-fed milk, the rate of drinking and the quantity at each feed can also affect the health of bucket- fed calves. Smijisha and Kamboj (2010) reported that the incidence of feacal scour as well as total illnesses were higher in buffalo calves fed milk in buckets than those fed milk using nipple with bottle. These results suggested that the risk of infection is definitely increased by simply handling the milk. Possibly the milk antibodies and cells got attached to surface of bucket and thus less are available to coat the gut mucosa. Islam *et al.* (2005) studied the causes and consequences of calf mortality in a dairy farm of Bangladesh on crossbred cows and they found that on an average 1,012.39 kg of milk was lost for loss of each calf. Martin and Wiggins (1973) estimated that 20% calf mortality resulted in reduction of 38% profit of a livestock farm. Furthermore, 25% average early calf mortality hardly provides any chance for regular replacement of low producing animals. A minimum mortality rate of 5% is usually acceptable to dairy farm having standard management conditions.

It may be concluded that natural suckling of dams by calves increased the milk yield, lowered the milk fat content and reduced the risk of mastitis. Suckling can increase the postpartum interval until first heat due to delayed resumption of postpartum ovarian activity. The suckled calves gained higher daily body weight and had prolonged milk intake time satisfying their suckling instinct, which resulted in decreased abnormal behaviours like cross sucking, inter sucking, self licking, bar biting etc. in these calves. The suckled calves gained more colostral antibodies and thus had better immune status and in general were more healthy as compared to artificially reared calves. The suckling system may, therefore, be more beneficial to the performance and welfare of calves and their mothers than artificial rearing system. However, allowing natural suckling may cause some economic losses by way of reduced fat content in milk and prolonged post partum estrus.

Gaps and future areas of research

Buffaloes and the native Indian breeds of cows are known to have a greater maternal instinct than the purebred exotic breeds of cows and therefore the effects of weaning of calves or suckling on the mother and their calves are likely to be more pronounced in these species. Not many studies have been conducted on Indian dairy animals on these aspects under various production management systems prevalent in the country. Further the physiological bases to explain these likely effects need to be clearly understood so as to design better management practices. The improved performance and health of mothers and their calves under natural suckling need to be evaluated in terms of monetary gains (in view of some losses on account of reduced fat content in milk and delayed onset of postpartum estrus) for the adoption of suckling and or weaning for a given dairy animal. Further, in view of mechanizations of dairy farm operations taking place in the country in recent years more research is required to be undertaken to evaluate the integration of the practice of suckling or weaning with feeding practices under modern mechanized milking systems.

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