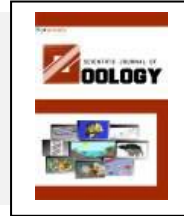


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Review article

Influence of suckling and/or milking method on yield and milk composition in dairy animals

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ABSTRACT

Achieving the maximum marketable milk yield with a high fat and protein content is desirable to producers to increase farm profitability. The present discussion points to the fact that rearing systems and milking method used affect either milk yield or milk composition during the entire lactation. Increased milk production elicited by suckling is probably due to the additional stimulus of the mammary gland, and is associated with improved mammary development through regulation of secretion of hormone during this period with markedly increase in milk. Dairy farmers can take advantage of suckling stimulus as a management tool combined with stipulated frequency of machine milking to increase milk production. Restricted suckling may increase total milk production without reducing milk available for human consumption or sale. The present discussion explores the consequences of different milking methods and/or suckling in dairy production enterprises for improving yield and milk composition in dairy animals.

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1. Introduction

Dual-purpose systems of milk production in which dams (cows, ewes, does) are milked but also suckle a young one are a relatively common feature of traditional agriculture in smallholder dairy farming in most developing countries. In these systems dairy production is dominated by dual-purpose breeds and restricted suckling systems in which milk and calf/kid/lamb production are combined (Preston and Vaccarro, 1989; Peris et al., 1997; Papachristoforou, 1990). Increasing the frequency of milk removal increases milk production in cattle as it does in many species (Pearson et al., 1979). There are two physiologic explanations for the impact of frequent milk removal on production. The first is the potential physical effect of increasing intramammary pressure to reduce the rate of milk synthesis within mammary epithelial cells. The intramammary pressure hypothesis suggests that physical forces of milk accumulating within the alveoli causes a compression of the secretory cell and this in turn reduces cellular metabolism and milk component synthesis. Oxytocin is responsible for milk ejection and suckling calves are thought to have more efficient milk ejection due to increased secretion of oxytocin elicited by the presence of the calf (Little et al., 1991). Lactation consists of two phases: milk secretion or synthesis, which is controlled in part by a hormonal complex originating in the anterior pituitary, and milk removal or ejection, which is controlled primarily by the release of the hormone oxytocin from the posterior pituitary (Gorewit et al., 1983). The growth of the mammary ducts is stimulated by oestrogen, and the lobule-alveolar development is stimulated by a combination of oestrogen and progesterone. These steroid hormones require prolactin and (or) growth hormone to stimulate mammary gland development and to initiate lactation (Tucker, 2000). The calf is often used as a facilitator of milk letdown during milkings (Bruckmaier and Wellnitz, 2008). It is reasonable to suggest that possible that oxytocin is involved in regulating the increase in milk production elicited by frequent milking or suckling, perhaps by allowing for more complete milk removal and a decrease in negative feedback on the gland. Gorewit and Sagi (1983) and Bruckmaier et al., (1994a,b) demonstrated that the increase of the oxytocin levels in blood could facilitate milk transfer from the alveoli to the cistern, and influenced positively the milk yield. Restricted suckling increases total milk production and does not usually reduce milk available for human consumption (Knowles and Edwards, 1983; Little et al., 1991; Tegegne et al., 1994).

2. Cattle

Dual-purpose systems of milk production in which cows are milked but also suckle a calf are a relatively common feature of traditional agriculture in developing countries (Margerison et al., 1994). Milk production is dominated by dual-purpose breeds and restricted suckling systems in which milk and calf production are combined (Preston and Vaccarro, 1989). Increasing the frequency of milk removal increases milk production in cattle as it does in many species (Pearson et al., 1979). Estimates of milk yields - based on the differences between the calves' weights before and after suckling - exceeded the yields of control cows milked by machine (Ryle and Orskov, 1990). The suckling systems are divided into three different categories depending on the purpose and duration of the suckling period. *Long-term suckling with or without additional milking* covering the period where the calf has a nutritional need for milk, and *short-term suckling*, where dams and young ones are kept together in the colostrum period only (Khrohn, 2001). It was suggested that longer lactation length might be due to the effect of continuous suckling by calf. In dairy cows, longer suckling period inhibits the growth of ovarian follicle and prolongs the period of anoestrus, thereby lengthening lactation length (Chandler and Robinson 1974). There is in fact much evidence from work carried out on large-scale dairy farms to show that suckling can increase milk production (Everitt et al 1968; Everitt and Phillips 1971; Walsh 1974; Chandler and Robinson 1974; Kaiser, 1975; Peel et al 1979; Thomas et al 1981; Copeman and Phillips 1983). In cattle increased frequency of udder emptying increased milk production, and suckling was superior to machine-milking. Comparing suckling and machine milking, milk production was highest for suckled cows and lowest for cows milked three times daily (Bar-Peled et al., 1995). Peel et al., (1979) predicted that for each additional week that heifers are sucked in early lactation (up to 4 weeks), the post-suckling milk yield will be increased by 4.3% compared with similar heifers machine milked from the commencement of lactation. Margerison et al., (2002) observed that there was no variation of suckling on machine milk yield, but there was an increase in total milk yield in comparison with cows whose calves were artificially reared, which agreed with previous research by Alvarez et al., (1980) and Tegegne et al., (1994). This increase in total yield is probably either due to a stimulation of milk yield as a result of more complete evacuation of the udder (Wilde and Peaker, 1990) or increased oxytocin production. The sucking of heifers before calving did not enhance post-partum

milk yields, however, the suckling of heifers for short periods after calving by calves that are being reared as dairy replacements offers a practical means of both increasing milk production, and possibly reducing the labour input of rearing the calves. The few available reports suggest that production may increase from 7 to almost 20% when cows are permitted to suckle calves (Fulkerson et al., 1978; Thomas et al., 1981). Increasing both mammary proliferation and differentiation of mammary cells of cows was observed by Wilde et al., (1987), suggesting that suckling plus frequent milking during early lactation enhance mammary development. Knight and Peaker (1984) indicated that the effect of the feedback inhibitor of lactation, which decreases milk secretion rate as milk accumulates in the udder. Secretions are stored within the internal space of the hollow alveoli and larger ducts between suckling episodes (Nickerson, 1992). The synthesis and release of milk constituents is continuous, until temporarily suspended by the distending pressure (Gruet et al., 2001). In fact, Walsh (1974) suggested that the increase in milk production elicited by suckling was probably due to the additional stimulus of the gland as well as the markedly improved mammary health of suckled animals. Moreover, since the well-fed cow can respond to the stimulus of suckling after milking by secreting more milk, late weaning may in fact promote increase the amount of milk available for sale. Longer lactations and a reduced risk of mastitis are additional benefits which may result from restricted suckling and the reproductive pattern of the cow is likely to be little affected, provided natural mating is used. It has been shown that cows suckled during 6 weeks after calving produce more milk (Bar-Peled et al., 1995). This is because differentiation of mammary epithelium continues into early lactation in cattle, factors regulating secretion of prolactin during this period may influence mammary development and consequently milk production (Akers & Lefcourt, 1984). Suckling of cows during early lactation has consistently been associated with a decrease in somatic cell count and a decrease in the incidence of clinical mastitis, in some cases by up to 50% or more (Little et al., 1991; Krohn, 2001). Restricted suckling plus machine milking have been shown to reduce milk somatic cell count when compared to machine milking alone in tropical dairy cows (Margerison, Preston & Phillips, 2002). Multiple suckling during early lactation has been reported to stimulate post-weaning milk production (Everitt & Phillips, 1971; Peel, Robinson & McGowan, 1979) and stimulate the butterfat production (Kaiser, 1975). Yilma et al., (2006) observed that suckling resulted in increased total milk yield as compared to non-suckling in both low yielders and high-yielders cows. However, suckling and high-yielding cows consumed more concentrate and total dry matter daily than non-suckling and low-yielding cows, respectively. Flavey and Chantalakahana (1999) indicated that a number of endogenous and exogenous factors have been reported to contribute to the delay or advancement of reproductive efficiency in cows. One of them is suckling regimes (frequency and duration), where weaning age of calves were for instance reported to influence the cycling of cows. Suckled cows had longer days to conception than milked cows and suckling had a positive (calf growth and milk production) as well as a negative (days to conception and calving interval) effect on the dairy performance of both local and crossbred cows. However, it is the only viable means of calf rearing under the smallholder dairy production system where indigenous cattle breeds are employed for milk production. In another study Tegegne (1989) through restricted suckling (twice a day) at Gobe ranch (central Ethiopia) in Arsi (Ethiopian zebu breed) cattle reduced post partum anoustrous interval and increased pregnancy rate. The significantly higher percent milk fat of non suckling cows might be due to the suckling effect whereby calves suckled their cows before and after hand milking. This is closer to observation by O'Connor (1994) who reported that the first milk drawn from the udder contains about 1.4 % fat while last milk or stripping contains about 8.7 % fat. Smith et al (1973), on the other hand, observed no increase in milk fat production (milk weight was not recorded) by cows grazing pasture during a period of drought, which suggests that a low plane of nutrition may limit the capacity to respond to suckling. However, due to incomplete milking if fat is left in the udder at the end of a milking; it is usually picked up during subsequent milkings. Much of the fat therefore might have been picked up by the calves in suckling group that suckled before and after milking as indicated earlier resulting in low fat content of the hand milked milk samples than that of the non suckling group. It has long been thought that the hormones released at milking may be involved in regulating the galactopoietic effects of frequent milking on milk production. Indeed, multiple hormones are released during milking including glucocorticoids and oxytocin. (Tucker et al., 1975; Carruthers & Hafs, 1980; Akers and Lefcourt, 1982). Oxytocin is required to obtain a proper milk ejection and disturbed milk ejection can cause decreased milk production (Bruckmaier & Blum, 1998). It has been observed that the release of oxytocin is greater in response to the suckling stimulus in cows compared to milking. In calves the feed intake related oxytocin levels are greater during suckling compared to when the calves are bucket fed (Lupoli et al., 2001). The longer lactation of cows suckling their own calf compared to those suckling other cows' calves has been reported previously (Knowles and Edwards 1983; Hippen and Escobar, 1984), which suggests that the lactation length may be influenced by the

strength of the bond between the cow and her calf. A more rapid evacuation of the udder of cows suckling their own calf, through increased oxytocin production, might reduce the involution of udder epithelial cells in late lactation (Gorman and Swanson, 1967). Another hormone which is secreted in greater amounts in response to suckling in cows is prolactin (Lupoli et al., 2001); this hormone is positively correlated with milk production (Koprowski & Tucker, 1973). Protein synthesis in the mammary gland depends on the uptake of amino acids from the circulatory system and it is controlled by lactogenic hormones (insulin, prolactin, and glucocorticoids) as well as by the blood concentrations of circulating amino acids (Weekes et al. 2006, Rhoads and Grudzien-Nogalska 2007).

3. Goat

The world's goat population increased around 55% between 1991 and 2011, while, the number of cattle grew by 9% and sheep numbers decreased by 7%. The production of goat milk increased by around between 1991 and 2011 (FAOSTAT, 2013), pointing to promising future for this sector, so any effort to encourage appropriate rearing systems in goat milk production will improve both quality and yields. In a study to ascertain the effect of two different kid rearing systems, natural or artificial, on milk composition and yield of Murciano-Granadina dairy goats, the results showed that the rearing systems used affected neither milk yield nor milk composition during the entire lactation. Moreover, the milk ejection mechanism in goats could be stimulated by milking as effectively as by suckling plus milking (Peris et al., 1997). In contrast, Masson and Decaen (1978) studying French goats observed that suckled mothers yielded 19% more milk than did those that were milked after giving birth, this was on the background that every goat in the study kept two kids instead of one. Akers (1985) and Bar-Peled et al., (1995) have suggested that suckling plus frequent milking during early lactation enhance mammary development. Increasing both mammary proliferation and differentiation of mammary cells of goats was observed by Wilde et al., (1987). Mammary proliferation continues for the first few weeks postpartum in goats (Knight and Peaker, 1984).

4. Sheep

In an effort to maximize commercial milk yield and lamb growth, a variety of mixed management systems that allow for both suckling and machine milking have been described (Papachristoforou, 1990). Mixed management systems, although not necessarily common in dairy cattle, are used extensively throughout the world for dairy ewes and goats. High-yielding dairy ewes produce relatively large amounts of milk compared with the requirement of the lamb (McKusick et al., 2001) and they release this milk in response to milking by machine rather than suckling by the lamb (Marnet and Negrao, 2000). High-yielding dairy ewes are capable of storing milk for up to 16 h between milking (Labussiere, 1988) and they persist in lactating for 6 mo or more (Barillet, 1997). Furthermore, high-yielding dairy ewes are capable of maintaining high yields and persistent lactations following an extended period of exclusive suckling before machine milking (Labussiere, 1988; Barillet, 1997; McKusick et al., 2001). A system of leaving lambs with the ewe for half the day and milking the ewe once per day during the first 30 d after parturition followed by twice-daily milking was the most profitable system because ewes raised their lambs and still produced 85% as much milk as did ewes milked twice per day from shortly after lambing (Thomas et al., 2001). Linzell and Peaker (1971) attributed no physiological relevance to the increased milk production from dams with twins but to the frequency of suckling. However, milk obtained from ewes nursing their lambs had a lower fat percentage than milk from ewes that had weaned their lambs and feeding supplemental fat increased milk fat percentage of ewes that had weaned their lambs but not of ewes that were still suckling their lambs. Approximately 25% of the total milk yield of a dairy ewe is produced during the first 30 d of lactation (Folman et al., 1966; Ricordeau and Denamur, 1962), a time when lambs are typically allowed to suckle their dams. The rates of milk production at weaning were not correlated to 120-d milk yield and were due to the rapid declines in milk production over the first week of machine milking, a finding that is consistent with the 30 to 50% decrease in milk production reported by others (Labussiere, 1988; McKusick et al., 2001). This may explain why the galactopoietic effects on milk production of ewes suckling single and twin lambs disappeared after 4 wk of machine milking. Milk production after

16 h of milk accumulation was correlated with milk yield after 4 wk of machine milking and we suggest that the rate of milk production measured at 16-h intervals reflects the ability of ewes to store milk between each milking. Dairy ewes are now capable of producing amounts of milk that exceed the requirements for normal lamb

growth (Bocquier et al., 1999). Therefore, for a dairy sheep enterprise, waiting until after 30 d to begin machine milking significantly reduces economic returns because less marketable milk is produced (Gargouri et al., 1993), yet this potentially benefits lamb growth (Peters and Heaney, 1974). Somatic cell count of exclusively suckled ewes is reportedly higher than that of ewes exclusively machine milked immediately postpartum (McKusick et al., 2000) quite possibly associated to udder trauma involved in aggressive suckling and the resulting recruitment of leukocytes (Bergonier et al., 1996).

5. Implication

In cattle, goats and sheep, smallholder dairy enterprises utilizing indigenous or crossbred's animal genetic resources need to consider the importance of suckling for increased productivity in terms of milk yield and the growth rate of young ones. However, it is crucial that suckling is accompanied by high plane of nutrition which may translate into improved milk yield and composition. The economic implication of suckling need to be studied further in different production systems in order to maximize production for both the dairy enterprise and improved growth rate of the young ones. Apart from milk yield and composition, these studies should take cognisance of the influence of suckling on reproduction traits, calf growth and survival which are critical for viability of the dairy enterprise.

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