Group Housing and Feeding Systems for Calves - Opportunities and Challenges

Bob James, Kayla Machado
Dept. of Dairy Science
Virginia Polytechnic Institute and State University
3310 Litton Reaves
Blacksburg, VA 24061
540-231-4770 Phone; 540-231-5014 Fax
jamesre@vt.edu

Introduction

Group housing of preweaned calves is gaining in popularity in the U.S. This practice has been adopted for several reasons. Research at the University of British Columbia and in Europe has documented potential benefits to animal welfare. Dairies view the practice as a means to improve labor efficiency in feeding the pre-weaned calf. Upon initial consideration, the practice of group feeding calves seems to contradict many of the commonly accepted tenets for feeding and management of young calves which includes:

- Isolation to minimize calf to calf contact and disease transmission
- Feeding limited amounts of milk to encourage starter intake and early weaning
- Feeding twice daily

However, research has demonstrated that there are many desirable features of the group feeding systems which merit careful consideration by dairies. It is important to realize that consideration of management of group feeding systems is multi-faceted. Successful adoption of this concept requires knowledge of:

- Dairy calf nutrient requirements to support gains of 1.5 to 2.0 lb. per day
- Feeding system operation and management
- Differences in dairy calf behavior of group fed calves
- Human behavior to adapt to a different approach to calf management

Each component is necessary to assure that the benefits of the system are achieved.

A short review of recent changes in calf feeding helps to establish the potential advantages and limitations of group housing systems. It has become more popular to feed calves increased levels of liquid diets. When the basic principles of ration balancing are applied to dairy calf nutrition, it is evident that feeding calves limited amounts of milk solids (~1 lb.) is barely sufficient to meet maintenance requirements with little remaining to support calf growth. At 32^{o}F, a 100 lb. calf must consume 1.2 gallons of whole milk to solely to maintain body weight. Low intake of milk or milk replacer solids is especially a problem for calves during the first 3 weeks of life when starter intake is limited. Higher feeding rates of milk or milk replacer solids results in higher daily feed costs but improved feed efficiency of body weight gain and lower cost per unit of weight gain. Additionally, higher intake of solids in the liquid diet by dairy calves is associated with significant reductions in morbidity and mortality (Godden et al, 2005). However, increased feeding rates (up to 2.5 lb. of milk solids/day) have been resisted by some dairy producers and practitioners and have been associated with a perception of increased diarrhea and possibly abomasal bloat. Evidence is circumstantial and bloat is more commonly observed under conditions of poor sanitation, irregular mixing of milk replacer powder, low or irregular liquid diet temperatures and irregular feeding schedules.

An additional potential benefit of group fed calves is the implementation of more frequent feeding. Several studies (Sockett et al., 2011; Kmicikewycz et al, 2011) indicate that increasing feeding frequency from twice daily to three or four times daily results in improved body weight gain, starter intake, feed efficiency and an increase in survival of calves through their first lactation. These responses seem logical given that, given the opportunity, calves will nurse more frequently than twice daily. This likely results in more consistent nutrient flow and improved efficiency of utilization of protein and energy by the calf (van den Borne et al., 2006). More frequent feeding may be critically important in situations when milk solids are fed at rates less than 1.5 lb. / day. Under these conditions of limited intake and with long intervals between the evening and morning feeding, calves may be mobilizing body fat stores to maintain body temperature. If body fat is limited as occurs in limit-fed calves, it's not uncommon to for body fat to drop to 2% of body composition in calves less than 2 weeks of age. Unfortunately, most individual housing calf management systems are not well suited to more frequent feeding of calves. Surveys of dairy farms and calf growers reveal that only 8 – 14% of farms fed calves three times daily.

Group housing of calves has not been widely adopted on U.S. dairies. There are several ways to deliver the liquid diet to group housed calves.

- Mob feeding
- Free choice acidified milk or milk replacer
- Computer controlled automatic feeders.

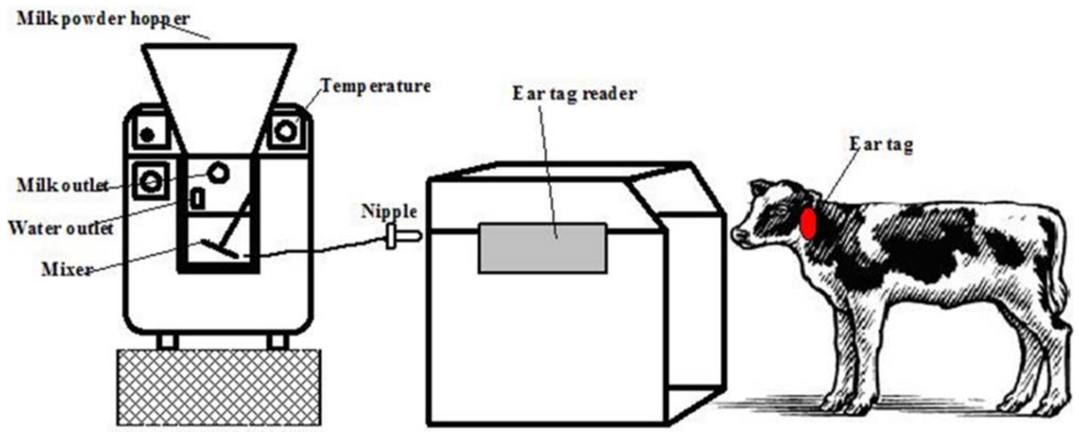
<u>Mob feeding</u> of calves is a common practice in grazing dairies practicing seasonal calving. This practice involves placing larger containers with multiple nipples in the calf pen until all the liquid is consumed, which is generally less than 30 minutes. Sufficient liquid is added to provide the average calf with the desired amount of liquid. Although it encourages labor efficiency, there are some challenges with this system. The most common problem is cross sucking which is a greater problem if the feeder is removed from the pen shortly after calves have finished eating.

More elaborate systems using <u>acidified milk or milk replacer</u> to preserve and limit liquid intake are gaining popularity on some dairies in more northern climates. These systems are very labor efficient but there is a lack of control of intake by individual calves, and minimal sanitation of nipples and feeding equipment. Systems developed in Canada utilize formic acid which is illegal in the U.S. The reader is encouraged to read the publication by Anderson (2008) for further information on free access acidified liquid feeding systems.

Computer controlled automatic calf feeding systems are gaining rapidly in popularity as a means of accurately delivering the liquid diet while controlling meal size and frequency. More sophisticated systems provide valuable management information to enable the calf manager to monitor diet consumption by individual calves and make timely intervention for calves becoming ill. This paper will focus most on the research and practical implications involved with automated calf feeding systems.

Basic components of calf autofeeders

Calf autofeeders involve the basic components shown in the illustration below (Biotic Industries, Bell Buckle, TN).



These systems vary widely in sophistication and price ranging from systems which record minimal data and have simple feeding programs to more involved systems with extensive capabilities to program different feeding plans for individual calves in a group and monitor calf performance. The essential features of autofeeders include a feeding stall and feed box which contain a device enabling electronic identification of calves. Most new systems utilize the RFID ear tags. The nipple is connected via a flexible tube to a mixing bowl where defined amounts of powder and water are mixed as prescribed by the system. Calves are limited by meal size, number of meals per day and time intervals between meals. Additional features of systems will be described later in this manuscript.

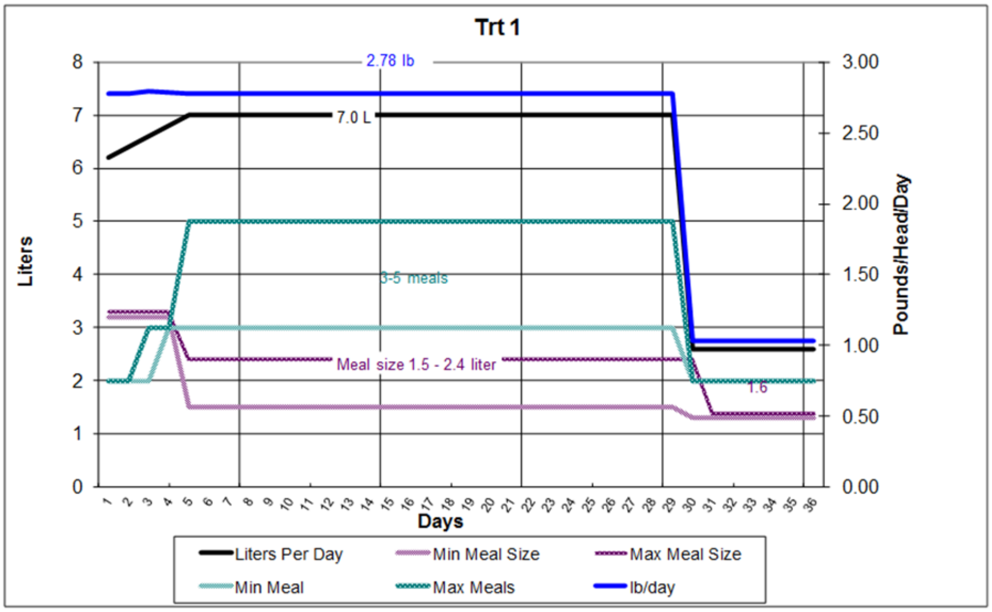
Behavior of group-housed calves with autofeeder systems

Workers in Denmark and Canada have conducted numerous behavioral studies which have enabled the development of recommendations for management of autofeeder systems. A common problem observed in calves housed individually is the "post weaning" slump which is apparently related to the adjustment of calves to group housing and the competition for feed. Studies by Chua et al (2001) found that calves raised in pairs continued to gain weight normally during the week of weaning while those housed individually experienced the "growth check" commonly observed in traditional calf rearing systems. This suggests that group housing calves prior to weaning promotes development of social skills and reduces fear of interaction with other calves. Another significant concern of group-housed and fed calves is the occurrence of cross sucking. Jensen (2003) found that feeding calves via nipple buckets as opposed to open buckets resulted in a significant reduction of cross sucking. Cross sucking tends not to be a problem in calf autofeeder systems as compared to mob feeders. However, the author has noted increased cross sucking in some operations with very high daily allocations (over 3 lb. of milk solids/daily) or large meal sizes (>3 liters/feeding) Reductions in flow rate of milk to prolong milk feeding also seem to satisfy the calves urge to suck after completing the liquid feeding meal. The work conducted by Jensen (2004, 2005) and von Keyserlingk et al (2004) has resulted in the recommendations for stocking rates given by major manufacturers of calf autofeeder systems. General relationships are what would be expected in group housing situations. More calves per feeder results in greater competition for the nipple and an increased rate of intake. A second important factor governing autofeeder management recommendations is the milk allowance per day and per feeding. When calves are limit-fed milk (less than 1.5 lb. per day) calves spent more time in the feeder without being rewarded with additional milk. Similarly when milk allowances per feeding session are small (one pint or less) calves remain in the stall longer without being rewarded.

General recommendations and features of calf autofeeder systems

- Age when calves are introduced to the autofeeder system is strongly dependent upon fresh cow and newborn calf management. Aggressive colostrum management programs are essential to successful adaptation to the autofeeder. Consider routine monitoring of serum proteins during the first week to assess success of the colostrum program. Most farms house calves in individual housing systems for at least the first 5 days to ensure that the calf is eating well.
- Calves are trained to feeders by leading them to the nipple when they are moved into the group housing. Eliminating the morning feeding the day that calves are moved into the autofeeder group encourages adaptation to the system. Research by Svennson and Liberg (2006) and Jensen ((2008) shows that moving calves onto the feeder at less than 6 days requires more effort to train calves to the feeder. Research by Jensen (2006) has shown that calves introduced to feeders at day 14 required less training time. Calves introduced to the feeder at day 6 spent less time in the feeder after ingesting milk and ingested less milk. They were less successful in competing for milk feeder access, particularly when there is a wider range in age of calves in the pen and with higher stocking rates per feeding station (>25). There also appears to be less risk of respiratory disease when entrance into the feeder is delayed until 10 – 14 days of age.
- Stocking rates of no more than 25 calves per nipple are advised.
- Milk allowances range from 1.5 to as much as 2.7 lb. (680 – 1225g) of milk solids per calf per day. On a volume basis this amounts to 1.4 to 2.3 gallons (5.3 – 8.7 L) of liquid per day.
- Meal sizes vary from 1 pint to 2.6 quarts (.5 to 2.5 L) each. In many systems, calves must earn enough credits to be able to receive milk or milk replacer from the feeder. As an example, if a calf is allocated 9 liters of "milk" per day, they will earn about .4 liter allocation for each hour of the day. They must accrue enough credits to achieve their minimum meal size specified by the system which might be 1.5 liters. This would mean that there must be a minimum of about 3 hours and 45 minutes between feedings.
- When milk replacer is used, powder is diluted with water to approximately 13 – 15% solids. Caution is advised when specifying dilution as most autofeeding systems express the grams of milk replacer to add to each liter of water. Therefore 150g added to a liter of water is not 15% solid but 13% (1,000 ml of water + 150 g of powder = 1150 final weight. Therefore 150g of powder/1150g of total weight = 13% solids) .
- Number of meals per day varies by the system. Some basic calf autofeeders have a small mixing bowl and provide meals of 1 pint per visit. In these systems milk allowances exceeding 1 to 1.5 gallons daily require numerous daily visits to obtain the daily allowance (>12) In other systems calves are limited to a maximum amount per visit and the feeder will mix multiple batches of liquid up to the maximum. Typically calves nursing from more sophisticated systems consume ~4 – 5 meals per day.
- Feeding programs vary considerably depending upon the system. The basic systems are frequently programmed to provide all calves with similar meal sizes and daily allowances,

regardless of their age. However, the more sophisticated systems enable feeding a defined feeding program in which milk allowance is gradually increased over several days and then decreases to accomplish a "soft" weaning which is felt to reduce the stress of weaning. An example of such a feeding program is shown below. (Courtesy: T.J. Earleywine, Land O Lakes Animal Milk, Shoreview, MN). In more sophisticated systems multiple feeding programs can be in effect within one pen so that smaller calves or those of a different breed may be accommodated.



More sophisticated systems also enable use of pasteurized waste milk in addition to milk replacer.

- More sophisticated systems enable medicating calves with either dry or liquid medication. This enables the manager to administer additional electrolytes, antibiotics or other therapies on an individual basis.
- More advanced computer controlled stations will also delivery calf starter grain. These systems will trigger "soft" weaning from liquids when calf starter grain intake reaches levels indicated by the computer. However, research has shown that these systems don't encourage intake and many users don't use this feature and provide small open feed bunks with free choice calf starter.
- Sanitation is automatic in some systems and manual in others.

Virginia Tech Calf Autofeeder Survey

During the summer of 2011, eleven dairies in Virginia and North Carolina were visited and administered a survey to determine calf feeding and management practices prior to and after implementing the autofeeders and the cost of systems implemented. During the initial and later visits, duplicate samples of the liquid diet were obtained aseptically by disconnecting the line to the nipple and retrieving the sample when half of the liquid in each mixing bowl had left the feeder. Temperature of the liquid was determined immediately by an electronic thermometer. Solids levels were estimated by use of a brix refractometer (Moore et al., 2009). (The Brix or digital refractometer will show changes in solids levels that are valid within a given milk replacer or whole milk. However, they do not provide valid estimates of total solids between different milk replacers or when compared to whole milk.) Samples were immediately cooled, transported to the laboratory and frozen until later analysis for standard plate counts using the 3M petri film system (3M, St. Paul, MN). Calf autofeeders were classified as basic or sophisticated. Basic systems delivered preset amounts of milk replacer and had minimal retention of calf feeding data from day to day. Sophisticated systems employed more detailed feeding programs as described above and retained intake data as long as desired with management information geared towards more intensive evaluation of calf liquid intake. These systems also incorporated many of the features described previously. Three dairies using each system were selected for repeat visits for three consecutive months.

The objective of this field study was to determine how dairies implemented these systems and to evaluate performance of these systems under field conditions.

What We Learned

General information. Herds ranged in size from 125 to 3,100. In the largest herd, autofeeders were used to feed calves in excess of the calf hutches already present on the dairy. One 1,300 cow dairy constructed two new facilities containing 8 basic calf autofeeders. Calves per feeder ranged from 11 – 35. All farms used only milk replacer which varied from 20:20 to 28:20 (protein: fat). Farms indicated that physical characteristics of the powder were important to assure that the powder flowed freely from the storage bin to the mixing bowl and that it mixed quickly.

Cost. Due to limited numbers of herds, it was difficult to estimate total costs of establishing the calf autofeeder system. Basic calf autofeeder systems cost approximately $1,600 - $2,400 per unit with each unit capable of feeding up to 25 calves. More sophisticated systems cost ~$15,000 – 18,000 for a unit that includes two feeding stations, software and is capable of feeding two more stations with slightly more cost. Such units could feed up to 60 calves with 2 feeding stations on one central unite. Additional costs include construction of group housing or adaptation of existing structures to accommodate the feeders. Autofeeders must be protected from weather and freezing. There was a wide range in these costs.

Standard plate count. A goal for SPC for pasteurized waste milk systems is <20,000 cfu/ml. Previous work by our group and others has found this to be an achievable goal. The SPC of liquid samples in this study ranged from $<10^5$ to $> 10^{7\ cfu}$/ml. There was considerable overlap between systems, but mean counts were higher in the basic systems which were manually cleaned. Nearly all farms cleaned the mixing bowl daily, but cleaned the lines or nipples less frequently. Newer sophisticated systems enable all liquid delivery lines and mixing bowls to be automatically cleaned daily or as often as desired.

Brix refractometer. Brix readings varied from 7 to 18. Average and range of readings were similar for both systems. This indicated the need to adequately calibrate the delivery of milk replacer solids and water on a frequent basis. Owing to the newness of these systems in Virginia and North Carolina, technical support varied considerably in installation and maintenance of the equipment. Our work would indicate that routine monitoring of total solids is advised on at least a weekly basis. Once again, more sophisticated autofeeders weigh powder and water during mixing and delivery and feature auto calibrating on a daily basis.

Temperature. Liquid temperature varied from 81 to 118^{o}F (27 – 48^{o}C). Recommended delivery temperature would be 100 – 105^{o}F (38 – 40^{o}C). Colder temperatures impede adequate mixing of the powder and water which can lead to clogging of lines and possibly enhance bacterial growth. Cold temperatures also "cold stress" calves. Higher temperatures impede consumption of the liquid and definitely don't encourage calves to adapt to the system.

Calf management

1. Age when calves transitioned from individual housing to the autofeeder ranged from 3 to 14 days of age. Three days is probably too early given that the drive to consume liquids is still fragile.
2. Calves were not hand fed their AM liquid diet allowance the morning before putting them on the feeder. Farms recommended that calves must be good, vigorous eaters prior to putting them on the feeder. Minimum meal size was set at 1.2 L for the first few days and set for 3 meals per day initially. These levels are probably lower than desired.
3. Range in age of calves within a pen should be minimized. This presents a problem for smaller farms with few calves. Each farm in our study had at least two pens of calves regardless of herd size. Pens were depopulated and cleaned and feeders were extensively cleaned prior to adding new calves. Ranges in age exceeding three weeks would be discouraged as younger animals would not compete well at the feeder.
4. Weaning was achieved with an abrupt drop in liquid diet and continued at this low level for 7 days. This appeared to strongly encourage starter intake.

Facility management. In many cases older facilities were adapted to group calf housing with varying degrees of success. In other cases three-sided or green house buildings were utilized.

- Ventilation to minimize accumulation of moisture is essential.
- More liberal space allocation /calf contributes to drier bedding. Farms in this study provided 30 to 50 sq. ft/calf.
- Feeding stalls should be located within 3 ft of the autofeeder to facilitate more effective cleaning of milk lines between the feeder and nipple.
- Feeding stalls should be solid sided and of minimal width to discourage multiple calves from trying into access the feeder.
- Do not restrict the area leading up to the feeding stall.
- Provide plenty of fresh clean water. Clean waterers daily and locate the waterers several feet away from starter bunk.

Miscellaneous. This section includes advice based upon our observations of the study farms and previously published information.

- Equipment varies in how they determine when a calf is eligible to receive their next meal. In some of the lower priced machines the times are the same for all calves. This results in a rush to the machine when calves realize that they are eligible for another meal. This is particularly a problem when meal sizes are small. More sophisticated machines determine meal availability for each calf with the result that stall use is more uniform.

- Agitation of milk replacer and warm water is less aggressive in some machines resulting in clumps of powder moving down the line from the mixing bowl to the nipple. These feeders tended to have more residual milk remaining in the lines.
- More sophisticated machines handle waste milk in addition to milk replacer. This creates a new set of management challenges as waste milk should be pasteurized prior to storing, cooled and then warmed again prior to feeding. Some systems given the known solids content will automatically add milk replacer powder and water to achieve the desired final solids level in the diet. Given the variable supply of waste milk and the variable solids content of waste milk it is challenging to maintain consistency in the feeding program and to adequately sanitize the equipment.
- Dairy producers interested in adopting this technology should have the proper management mindset. These individuals should have the following skills and management behaviors:
    - They are data oriented and should evaluate the intake and other management information provided each morning and periodically throughout the day.
    - Calf managers should "walk" the pens periodically to evaluate calf behavior and detect illnesses that are not indicated in computer reports.
    - There is an opportunity for improved labor efficiency. However, many producers in this survey noted that time formerly spent feeding was spent reviewing reports, walking pens and cleaning the feeder.
- Calf behavior will be dramatically different. When calves are fed twice daily in individual pens, they respond to people entering the barn through increased activity and vocalization. Calves fed via an autofeeder system will not respond to people entering the pen. If a calf does so, it usually means that they have not been trained to the feeder or there is an equipment malfunction.

Conclusion

Calf autofeeders are a proven technology that offers some attributes which are very positive for calf nutrition and management. More frequent feeding is probably less stressful for the calf and appears to promote more efficient feed utilization. It's easier to feed more without stressing the calf with large meal sizes or higher percentages of milk solids required for intensive feeding systems confined to twice a day feeding of three quart bottles.

The survey of Virginia and North Carolina farms using this technology emphasizes the need for routine monitoring of temperature, solids delivery calibration and sanitation. Although SPC were higher than expected in the farms surveyed in this study, calf health did not appear to be impaired. Future studies are planned to identify the predominant organisms and the impact of cleaning and sanitation on bacterial growth.

Although they are marketed for their labor saving, this field study indicated that although routine labor is reduced, increased emphasis needed to be placed on monitoring the equipment, evaluating calf consumption, sanitation and in monitoring calf health.

References

Anderson, N. 2008. Free-Access Feeding of Acidified Milk - Setting Up the System Using Formic Acid. http://www.omafra.gov.on.ca/english/livestock/dairy/facts/formicacid.htm. Accessed 12/24/2012.

Chua, B, E. Coenen, J. van Delen and D. M. Weary. 2001. Effects of pair versus individual housing on the behavior and performance of dairy calves. J. Dairy Sci. 85:360-364.

Godden, S. M., J. P. Fetrow, J. M. Feirtag, L. R. Green and S. J. Wells. 2005. Economic analysis of feeding pasteurized nonsalable milk versus conventional milk replacer to dairy calves. J.A.V.M.A. 226:1547-1554.

Jensen, M.B. 2003. The effects of feeding method, milk allowance and social factors on milk feeding behavior and cross-sucking in group housed dairy calves. Appl. Animal Behav. Sci. 80:191-206.

Jensen, M. B. 2004. Computer-controlled milk feeding of dairy calves: The effects of number of calves per feeder and number of milk portions on use of feeder and social behavior. J. Dairy Sci. 87:3428-3438.

Jensen, M.B. 2004. Computer-controlled milk feeding of dairy calves: The effects of number of calves per feeder and number of milk portions on use of feeder and social behavior. J. Dairy Sci. 87: 3428-3438.

Jensen, M. B. 2005. Computer-controlled milk feeding of group-housed calves: The effect of milk allowance and weaning type. J. Dairy Sci. 89:201-206.

Moore D.A., J. Taylor, M.L. Hartman, W. M. Sischo. 2009. Quality waste milk assessments on a calf ranch. J. Dairy Sci. 92:3503-3509.

Kmicikewycz, A. D., D. N. da Silva, and N. B. Nitherland. 2011. Effects of a modified intensive milk replacer program fed two or four times daily on nursery calf performance. J. Dairy Sci. 94(E-Suppl.1):264.

Sockett, D. C., C. E. Sorenson, N.K. Betzold, J. T. Meronek, and T. J. Earleywine. 2011. Impact of three times versus twice a day milk replacer feeding on calf performance, likelihood to reach lactation and future milk production in a commercial dairy herd. J. Dairy Sci. 94(E-Suppl1):264.

Svennson, C. and P. Liberg. 2005. The effect of group size on health and growth rate of Swedish dairy calves housed in pens with automatic milk –feeders. Prev. Vet. Med. 73:43-53.

van den Borne, J.J. G.C, M. W. A. Verstegen, S. J. J. Alferink, R. M. M. Giebels and W. J. J. Gerrits. 2006. Effects of feeding frequency and feeding level on nutrient utilization in heavy preruminant calves. J. Dairy Sci. 89:3578-3586.

von Keyserlingk, M. A. G., L. Brusius and D. M. Weary. 2004. Competition of teats and feeding behavior by group-housed calves. J. Dairy Sci. 87:4190-4194.