A BAMN Publication

# Feeding Pasteurized Milk to Dairy Calves

Bovine Alliance on Management & Nutrition

## Introduction

This guide is published by the Bovine Alliance on Management and Nutrition (BAMN), which is comprised of representatives from the American Association of Bovine Practitioners (AABP), American Dairy Science Association (ADSA), American Feed Industry Association (AFIA), and United States Department of Agriculture (USDA). The BAMN group is charged with developing timely information for cattle producers regarding management and nutritional practices.

Common liquid feeding programs include commercial milk replacer, saleable whole milk and non-saleable (waste) milk. Non-saleable milk typically includes transition milk from the first six milkings, abnormal milk and milk from treated cows. Factors to consider when selecting a liquid feeding program include 1) targets for nutrient intake in relation to goals, 2) ease of managing the program, 3) economics and 4) potential disease risks. An important risk associated with feeding raw milk is the potential exposure to pathogenic bacteria such as *Mycobacterium paratuberculosis*–the bacterium causing Johne's disease, *Salmonella* spp., *Mycoplasma* spp., and *Escherichia coli*. Some pathogens may be introduced directly from an infected udder, while others are introduced through manure contamination or bacterial growth in milk improperly collected, stored or handled. Because of these concerns, it is often recommended that producers avoid feeding raw (saleable or non-saleable) milk to calves. Two alternatives include feeding commercial milk replacer or pasteurized milk. The objective of this paper is to discuss some of the potential benefits and disadvantages of feeding pasteurized milk, as compared to traditional milk replacer. A companion BAMN paper "Managing a pasteurizer system for feeding milk to calves" discusses the management of a pasteurizer feeding system.

## Milk Replacer Feeding Programs

In 2007, milk replacer was fed on approximately 70% of U.S. dairy farms (USDA, 2007). When properly mixed, handled and delivered, high quality milk replacers provide several benefits including consistency of product, ease and flexibility of storage and management, infectious disease control and good calf performance. However, milk replacers are not sterile and can become contaminated and support bacterial growth. Also, the quality and price of milk replacer programs can vary significantly due to factors such as ingredient quality, manufacturing techniques and nutritional composition. More information on milk replacers can be found in other BAMN publications at http://nahms.aphis.usda.gov.

## Pasteurized Milk Feeding Programs

Pasteurized milk is an economical and highly nutritious liquid feed for calves. Pasteurization reduces or eliminates disease-causing bacteria by achieving a selected temperature for a defined period of time. In 2007, pasteurized milk was fed on 2.8% of U.S. dairy farms: 28.7% of large operations (500 or more cows), 3.0% of medium operations (100-499 cows) and 1.0% of small operations (fewer than 100 cows) (USDA, 2007).

## Benefits of Feeding Pasteurized Milk

***Reduced bacterial transmission in pasteurized vs. raw milk.*** Bacterial counts in raw milk are variable and can be extremely high. Studies from 51 farms in 4 states had total bacteria counts in raw non-saleable from 0 to 1 billion bacteria per ml of milk (Table 1). Laboratory and on-farm studies have reported that both batch and continuous-flow pasteurization techniques are effective in significantly reducing or eliminating disease-causing bacteria. In on-farm studies, pasteurization reduced or eliminated bacteria counts in non-saleable milk by 98 to 99% (Table 1). One field study of 300 calves reported lower rates of illness and death loss as well as improved rates of weight gain in preweaned calves fed pasteurized colostrum and pasteurized non-saleable milk, as compared to calves fed raw colostrum and raw non-saleable milk (Jamaluddin et al., 1996). These benefits were attributed to reduced bacterial exposure.

***Improved rate of weight gain for calves fed pasteurized milk vs. traditional milk replacers.*** On a dry matter basis, whole milk has higher concentrations of protein and fat (25.4 and 30.8%, respectively) compared to traditional milk protein-based milk replacers in which protein concentrations range from 18 to 20% and fat concentrations range from 15 to 20% (NRC, 2001). Thus, when fed on an equal volume basis (traditionally 2 quarts a day), a milk-fed calf is expected to have a higher rate of gain than a calf fed milk replacer (Table 2). The impact on calf growth of this nutrient intake difference was demonstrated in a 10-month study of 438 Minnesota dairy calves in which calves were fed on an equal volume basis either pasteurized non-saleable milk or a commercial 20:20 milk-protein based milk replacer (Godden et al., 2005). Calves in the study fed pasteurized non-saleable milk gained 1.0 pounds a day and calves fed 20:20 milk replacer gained 0.77 pound per day (Table 3). However, daily gains should be equal if the level of nutrient intake in the milk replacer diet were increased to match that of a milk diet (Scott et al., 2006). Since 2000, commercial milk replacers containing higher levels of nutrients more similar to milk have become available.

***Improved health for calves fed pasteurized milk vs. traditional milk replacers.*** Meeting nutritional requirements is essential for adequate immune system function and calf health (Pollock et al., 1994). The impact of nutrient intake differences on health was demonstrated in Minnesota dairy calves fed either pasteurized non-saleable milk or a commercial 20:20 milk replacer (Godden et al., 2005) (Table 3). Improved health in milk- fed calves was primarily attributed to higher levels of nutrient intake. Additionally, immunoglobulins and non-specific immune factors found in milk (e.g. interferons, cytokines, growth factors, hormones, lactoferrin and lysozyme) also promote calf health (Nonnecke et al., 2003).

***Economic efficiency and disposal of a waste product.*** Between 5 and 22 pounds of non-saleable milk per calf per day is produced on dairy operations (Scott, 2006). Using this milk as feed for calves allows producers to avoid potential economic loss, disposal challenges and environmental concerns. When considering fixed and variable feeding costs, improved rates of gain, reduced treatment costs, and reduced preweaning death loss, a partial budget model estimated a $34 per calf advantage at weaning for calves fed pasteurized non-saleable milk as compared to calves fed a 20:20 milk replacer (Godden et al., 2005). Economic results will vary from farm-to-farm depending on fixed and variable costs of the feeding program, calf health, and other factors.

***Toxin concerns in mastitic milk.*** One concern of feeding mastitic milk mixed with non-saleable milk is whether bacterial toxins are harmful to calves. Most bacterial toxins produced by mastitis pathogens will not survive pasteurization. In addition, many of these toxins are digested in the stomach before reaching the small intestine. Of the common mastitis pathogens, only *Staphylococcus aureus* toxin is known to survive pasteurization. However, even if this toxin is present it should be greatly diluted by milk from other cows. A comprehensive review by Kesler (1981) recommended that mastitic milk not be fed to newborn (day old) calves because their intestines are very permeable to bacteria and toxins. However, the gut barrier is intact in the older calves, preventing the absorption of toxins. This has been verified in studies in other species including mice and pigs. Feeding pasteurized mastitic milk to older calves is probably not a health concern, although grossly abnormal milk should not be fed.

## Disadvantages of Feeding Pasteurized Milk

***Intensive management.*** A pasteurized-milk feeding program requires more intensive management than a milk-replacer feeding program. Producers must research the type of pasteurization system most suited to the farm prior to its purchase and installation. Producers must also create the infrastructure needed to correctly harvest, store and transport both pre- and post-pasteurized milk to avoid contamination and bacterial growth. Finally, requirements for daily use include adhering to protocols of pasteurization, sanitizing equipment, routine equipment maintenance and monitoring of the system.

***Pasteurization failure.*** Pasteurization failure can be caused by human error, unclean or malfunctioning equipment, inadequate hot water supply, excessively high bacteria counts in pre-pasteurized milk and recontamination of pasteurized milk. Producers should not pasteurize soured milk because this can result in coagulation (curd formation) and soured milk typically has excessively high bacteria counts. Routine monitoring is necessary so that if pasteurization failure occurs it can be quickly detected and corrected.

***Variable supply of non-saleable milk.*** The supply of non-saleable milk on a farm may not always be adequate to feed all calves. The volume needed will depend on the number of calves raised, volume of milk fed, weaning age, and number of fresh and treated cows in the herd. In addition, large fluctuations occur in the supply of non-saleable milk on some dairies (Figure 1). In a 7 month study of 3 herds, the average volume of non-saleable milk ranged from 6.2 and 22.7 pounds per calf per day (James and Scott, 2006). Producers must have a strategy for periods when non-saleable milk supplies are inadequate. Options include using saleable milk, using milk from high-somatic-cell-count cows, or adding high quality milk replacer to pasteurized milk. Producers often add some milk replacer to pasteurized milk—even when adequate supplies of milk are available— to acclimate calves to the different taste and smell. A final option is to feed pasteurized milk to some calves and high quality milk replacer to other calves. Avoid switching calves from replacer to non-saleable milk or vice versa more than once. Older calves are more tolerant of diet changes than younger calves.

***Maintaining consistent nutrient composition***. On an as-fed basis, saleable whole bulk- tank milk typically contains 3.17% crude protein and 3.85% crude fat (NRC, 2001). However, because non-saleable milk consists of milk pooled from both fresh and treated cows, some variability in nutrient composition is inevitable. Minnesota studies (Foley and Otterby, 1978) showed that normal day-to-day variation in non-saleable milk composition did not affect the incidence or severity of scouring or overall rates of gain. Studies of Wisconsin and North Carolina dairies reported average protein in non-saleable milk to be 3.4 and 3.5%, respectively, and average fat to be 3.6 and 3.9%, respectively (Jorgenson et al., 2005; James and Scott, 2006).

***Antibiotic residues.*** Pasteurization does not alter the activity of many antibiotics, causing concern that exposing calves to low concentrations of antibiotic residues in non-saleable milk may result in violative meat residues or increased shedding of antimicrobial-resistant bacteria. However, one study conducted under natural feeding conditions showed no increase in antibiotic resistance of intestinal bacteria in calves fed non-saleable milk (Wray et al., 1990).

## Summary

When managed correctly, pasteurized milk is an economical and highly nutritious liquid feed for calves. The advantages and disadvantages are summarized below.

**Advantages:**
1. Reduced disease transmission
2. Improved rate of weight gain
3. Improved calf health
4. Improved economic efficiency
5. Utilization of non-saleable milk

**Disadvantages:**
1. Intensive management required
2. Failure of pasteurization
3. Inadequate non-saleable milk supply
4. Inconsistent nutrient composition
5. Potential antibiotic residue concerns

**Table 1. Mean Bacteria Counts and Ranges in cfu/ml for Raw and Pasteurized Non-Saleable Milk on Commercial U.S. Dairy Farms.**

| States (# farms) | Raw Non-Saleable Milk Mean | Raw Non-Saleable Milk Range | Pasteurized Non-Saleable Milk Mean | Pasteurized Non-Saleable Milk Range |
|---|---|---|---|---|
| Wisconsin (31) | 8,822,000 | (6,000 - 72,000,000) | 35,000 | 0 - 420,000) |
| North Carolina (3) | 17,000,000 | (300,000 - 1,000,000,000) | 105,000 | (19,000 - > 1,000,000) |
| California (10) | 1,600,000 | (3,000 - 5,900,000) | 19,400 | (2,000 - > 500,000) |
| New York (7) | 82,512 | (0 - 1,220,000) | 5,182 | (0 - 140,000) |

*(Jorgensen et al., 2005; Capel et al., 2006; James and Scott, 2006)*

**Table 2. Estimated Daily Gain for a 100 lb Calf Fed Whole Milk or a Milk Protein-based 20:20 Milk Replacer (Assumes Ambient Temperature of 68.0 °F)**

| | Energy Allowable Gain | Protein Allowable Gain |
|---|---|---|
| Milk Replacer – 1 lb/day | 0.39 lb/day[1] | 0.52 lb/day |
| Milk Replacer – 1.5 lb/day | 1.15 lb/day | 0.91 lb/day[2] |
| Whole milk – 1 gallon/day | 0.78 lb/day[1] | 0.84 lb/day |
| Whole milk – 1.5 gallon/day | 1.63 lb/day | 1.38 lb/day[2] |

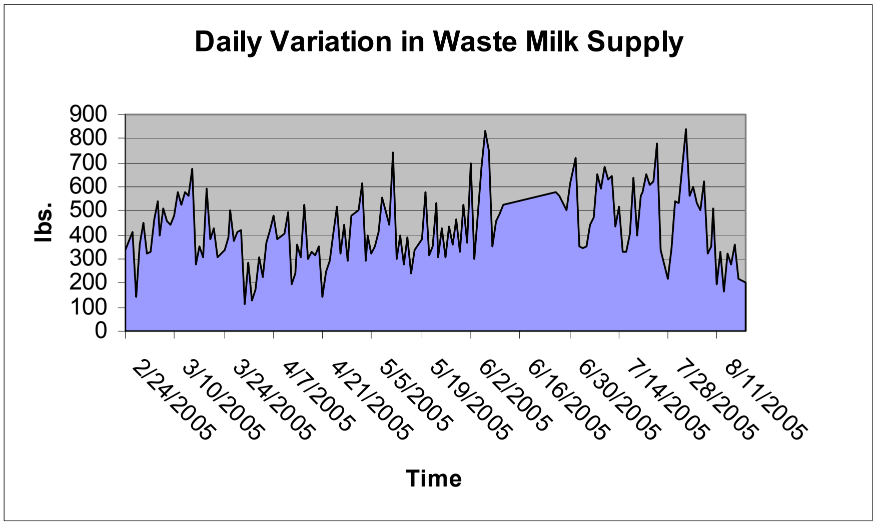
*[1] Gain predicted. Energy is the growth-rate limiting nutrient in this diet.*
*[2] Gain predicted. Protein is the growth-rate limiting nutrient in this diet.*
*(NRC, 2001)*

**Table 3. Preweaning Growth and Health of Commercial Minnesota Dairy Calves Fed Equal Volumes of Pasteurized Non-saleable Milk or a Milk Protein-based 20:20 Milk Replacer**

| | Pasteurized Non-Saleable Milk Diet | 20:20 Milk Replacer Diet |
|---|---|---|
| Average Daily Gain | 1.0 lb/day | 0.77 lb/day |
| Proportion Treated | 11.6 % | 32.1 % |
| Proportion Died | 2.2 % | 12.1 % |

*(Godden et al., 2005)*

**Figure 1. Daily variation in non-saleable milk supply on one North Carolina dairy**

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