



Calves fed pasteurized colostrum and waste milk were worth an extra \$8.13 in gross margin/calf.

In the ongoing quest for improved biosecurity and maximum dairy herd health, it stands to reason that pasteurizing calf milk would be a worthwhile and beneficial management practice. Yet in reality, conservative industry estimates indicate that far fewer than half of all dairies currently perform any type of heat treatment on waste milk fed to calves.

Is calf milk pasteurization effective? Does it address current disease and biosecurity concerns on the average dairy? And if so, what role can dairy practitioners play in promoting its adoption?

### Bacteria that pose transmission risks

The value of pasteurizing waste milk fed to calves must be evaluated on several fronts. Disease prevention potential, economics and practicality each play separate but important roles.

Mark Thurmond, DVM, PhD, veterinary epidemiologist at the University of California-Davis School of Veterinary Medicine, says there is little argument that the goal of purifying waste milk fed to calves is a good one. "We want to make sure we aren't inoculating young calves with bacteria in the process of trying to deliver good nutrition to them," says Thurmond. "Particularly on dairies that are having calf health problems that cannot be solved in other ways, heat treatment of waste milk to reduce the bacterial population in it makes sense."

Thurmond notes that the list of organisms potentially spread to calves via waste milk is a relatively long one. "Enteric diseases caused by *Salmonella* and *E. coli* are an immediate threat to the immature immune systems of neonates in the first four weeks of life," he says. "The resulting dehydration, de-

# Calf milk pasteurization

A closer look at an emerging dairy management practice.

By Maureen Hanson



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**Ken Mitchell, DVM, suggests preparing written protocols for pasteurization for employees.**

pressed appetite, shock and vulnerability to secondary pathogens caused by infection with these organisms all can be fatal to young calves.”

Bovine viral diarrhea virus (BVDV) and bovine leukemia virus (BLV) also can be transmitted via untreated waste milk, as can *Staphylococcus aureus*, *Streptococcus agalactiae* and other mastitis pathogens. While they may not pose an immediate threat to calf health, mastitis bacteria have proven to be amazingly hardy, surviving on the teat skin for months or even years and causing mastitis infections in pre-fresh and fresh heifers. These organisms can be especially troubling when calves are able to suckle one another, promoting transmission from the mouth of one animal to the mammary system of the next.

Two other horizontally transmittable organisms that are of particular concern are *Mycoplasma* species and *Mycobacterium paratuberculosis*.

*Mycoplasma* can have devastating effects on calf health in a variety of presentations. According to Thurmond, stubborn cases of pneumonia, ear infections and joint infections can be common results of feeding *Mycoplasma*-infected milk. What’s more, Thurmond says *Mycoplasma* bacteria also can seed themselves in infantile mammary tissue, lying dormant until freshening, then surfacing as clinical mastitis infections in fresh heifers. *Mycoplasma* mastitis is highly contagious and a serious threat to infected animals and their herdmates.

*M. paratuberculosis* — the organism that causes Johne’s Disease — is an obligate pathogenic parasite that is transmitted from dam to offspring via milk

and feces. This “wasting” disease typically does not become clinical until calves reach adulthood and is untreatable. Although not confirmed, there has been concern that *M. paratuberculosis* may play a role in the development of Crohn’s disease in humans.<sup>1</sup>

### **Efficacy studies examine key organisms**

Numerous studies support the theory that, when performed correctly, heat treatment of waste milk is effective in killing most “garden-variety” pathogens in milk such as *Staph. spp.*, *Strep. spp.*, *E. coli* and *Salmonella*. A 1997 study by Selim and Cullor at the University of California-Davis concluded that effec-

tive pasteurization of waste milk lessens the severity and duration of diarrhea in young calves.<sup>2</sup>

Whether a killing effect is achieved is dependent on the temperature to which the milk is heated, the duration it stays at that temperature and how quickly the milk is subsequently cooled. Current technology allows for two main methods of pasteurization:

**1 Batch pasteurization**, which entails heating a relatively large volume of milk to a minimum temperature for the minimum amount of time required to achieve a killing effect, and

**2 High-temperature, short-time (HTST) or flash pasteurization**, which is done by raising milk to a higher temperature for a few seconds, while passing it through a turbulent-flow system that rapidly reduces the temperature after heating. It is the process used

## **The veterinarian’s role**

Calf care can have a tremendous impact on a dairy’s long-term success, and it’s a management area in which many dairy veterinarians are starting to play a more in-depth role. Ken Mitchell, DVM, and Mark Thurmond, DVM, PhD, suggest these aspects of calf-milk pasteurization with which the veterinarian can assist dairies for a mutually beneficial outcome:

- Assessing the overall disease and management situation on the dairy and determining if calf-milk pasteurization is advisable.
- Evaluating and choosing pasteurizing equipment for the dairy.
- Conducting a cost:benefit analysis for the dairy to determine if the investment in equipment and labor will pay off.
- Working with a diagnostic lab to determine the ideal pasteurization time-temperature variable for the dairy’s pathogen challenge(s) and load.
- Assisting with employee training and periodic review sessions.
- Regularly collecting and culturing samples of pasteurized milk to monitor quality.
- Conducting ongoing health monitoring of calves, heifers and cows, including post-mortem analyses, to stay abreast of the organisms that are challenging the dairy, and possibly adjust pasteurization procedures accordingly.



## Calf milk pasteurization

to pasteurize milk for consumer consumption.

Thurmond says the time-temperature relationships for these two methods vary depending on the structure of the pasteurization system and the main organism being addressed. However, he cites general guidelines of 145°F (63°C) for 30 minutes for batch pasteurization, and 162°F (72°C) for 15 seconds for flash pasteurization.

A study specifically examining *Mycoplasma* sensitivity to pasteurization by Butler *et al.* at Iowa State and Cornell Universities in 2000 concluded that all *Mycoplasma* bacteria in milk were inactivated by heat treatment to 158°F (70°C) for three minutes. While some *Mycoplasma* species were susceptible at lower temperatures and/or treatment times, *M. canadense* did not succumb until this time-temperature ratio was achieved. The researchers suggest that when *Mycoplasma* is a concern, on-farm pasteurization protocols should be developed to inactivate *M. canadense*, because it proved to be the most heat-resistant of the *Mycoplasma* pathogens.<sup>3</sup>

The threat of *Mycoplasma* infections is the main reason why approximately one-third of the dairies and virtually all of the calf ranches served by Valley Veterinarians, Inc., Tulare, Calif., practice some form of heat treatment of waste milk. Ken Mitchell, DVM, recently conducted an on-farm *Mycoplasma bovis* screening evaluation on a client dairy that was experiencing severe *Mycoplasma* ear infections in month-old calves, plus periodic cases of *Mycoplasma* mastitis in fresh heifers.

The dairy had been heat-treating waste milk to 150°F for 10 minutes. They increased the temperature to 155°F and continued to heat the milk for at least 10



**BVDV and BLV can be transmitted to neonatal calves through waste milk.**

minutes. Periodic culturing under the old protocol never showed a positive *Mycoplasma* sample over a period of two months, but the ear infections persisted. When the temperature was raised, samples remained negative, and the ear infections stopped abruptly within two months.

"Some other management changes were adopted at the same time, so it's tough to say the higher pasteurization temperature was the cure-all," says Mitchell. "The inherent presence of *Mycoplasma* in cattle — particularly in the respiratory tract — also makes it impossible to prevent all *Mycoplasma* disease. But I do believe that 155-160°F should be the pasteurizing temperature goal for *Mycoplasma* and that reaching these levels will help prevent disease."

*M. paratuberculosis* also has been the subject of specific pasteurization efficacy studies. A recent study by Meylan *et al.* evaluated the effect on *M. paratuberculosis* when experimentally inoculated colostrum samples were heated to 145°F (63°C) for 30 minutes. The study



**Colostrum is more difficult to pasteurize, but it can be done.**

concluded that, at this time-temperature ratio, pasteurization lessened, but did not eliminate, growth of *M. paratuberculosis*.<sup>4</sup>

It appears that flash pasteurization may be more effective in eliminating the organism. A study by Stabel, *et al.* at the USDA National Animal Disease Center compared the results of batch vs. flash pasteurization on milk samples experimentally inoculated with two strains of *M. paratuberculosis*. The conclusions: While both procedures resulted in a dramatic reduction in bacterial load of *M. paratuberculosis*, the turbulent flow of milk during pasteurization aids in the complete killing of *M. paratuberculosis*, because the organism may clump more readily in a static environment and protect themselves from heat penetration.<sup>5</sup>

### Economic considerations

Feeding waste milk that otherwise would be discarded has obvious financial appeal to dairy producers and calf ranchers. But the disease side effects of feeding raw milk could quickly offset those savings in some cases.

Thurmond and a group of colleagues at the University of California-Davis conducted a large-scale economic study in 1996, to evaluate the cost:benefit ratio of pasteurizing waste milk and colostrum vs. feeding raw products. The study took into account a broad range

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of factors, including feed costs, health-related expenses, pasteurization-related costs, labor and energy. Batch pasteurization was used.

Results indicated that calves in the treatment group had significantly higher mean weight gain and fewer days in which they were affected with diarrhea and pneumonia. The investigators concluded that calves fed pasteurized colostrum and waste milk were worth an extra \$8.13 in gross margin/calf. They also determined that — using the pasteurization system employed in the study — the minimum number of calves on feed necessary to make pasteurization economically feasible was 315 calves per day, equivalent to a dairy of approximately 1,260 cows.<sup>6</sup>

Thurmond cautions that the economic benefit of pasteurization should be evaluated for each individual dairy. Different pasteurization units will make the capital equipment investment variable, and some disease conditions — particularly those that do not respond to treatment — will affect the relative value of pasteurization for individual herds.

He also notes that economic comparisons between pasteurized milk and milk replacer must accommodate more than the up-front cost of each feed source. “It’s hard to beat the real thing,” he says. “In every study I’ve ever conducted, productivity of calves is much better on whole milk, so any economic decision between milk and milk replacer must be based on the cost of the feed source and relative productivity.

“It’s also worth mentioning,” he adds, “that milk replacer is not necessarily bacteria-free. Simply choosing milk replacer does not eliminate the risk of bacterial contamination.”

### What about colostrum?

Colostrum is a more difficult product to handle in pasteurization because its high viscosity tends to “gum up” equipment, making cleaning difficult and unappealing to laborers. As a result, Mitchell says most of his clients do not pasteurize colostrum.

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Thurmond believes the process does have value, though, and is possible with a little fine-tuning. “The trick is to not exceed the time and temperature necessary for the desired killing effect,” he advises, “then cool it right back down.”

The Meylan study that examined pasteurization for *M. paratuberculosis* also evaluated the effect of pasteurization on IgG concentrations in colostrum. The researchers found that IgG levels were affected by pasteurization, and were impacted more in high-quality colostrum than colostrum of lesser quality. They concluded, however, that although colostral IgG concentrations were significantly decreased by pasteurization, the difference was not to an unmanageable level that would preclude use of the colostrum for passive immunity transfer.<sup>7</sup>

### Implementation is critical

Mitchell and Thurmond agree that the biggest pitfall of calf milk pasteurization is consistent implementation on the dairy. Training must be a priority, and quality control monitoring should be ongoing.

Mitchell offers these tips for helping dairies perform pasteurization consistently and accurately:

- Routinely culture samples of pasteurized milk to monitor product quality.
- Pull samples at random times so that implementation is consistent every day, not just on “sample day.”
- Conduct face-to-face training sessions with all employees responsible for pasteurization, emphasizing why the process is important.
- Keep a daily log of who prepared the milk and how long it reached the “goal” temperature — then correlate this to culture results.
- Prepare written protocols — in English and Spanish — for running the



**Advancements in new, on-farm pasteurization technology are producing units that make calf-milk pasteurization more efficient and practical for dairies of all sizes.**

pasteurizer, how to watch the thermostat, how to record in the log and how to clean the equipment.

- Conduct periodic, follow-up training and review sessions to reinforce procedures.
- Perform regular post-mortem and culture/sensitivity evaluations on bacterial causes of morbidity and mortality.

Mitchell notes that the last point is important as a guide to general hygiene, environmental challenges and antibiotic selection. The information also can serve as an indirect indication of pasteurizer function and milk delivery.

Thurmond adds that improper on-farm implementation can cause pasteurization to quickly go awry. “Just because milk has been pasteurized does not mean it is completely sterile, and its bacterial loads will not stay low indefinitely,” he cautions. Just as pasteurized milk from the grocery store will still spoil if left unrefrigerated, pasteurized calf milk will become contaminated again if it is not either fed immediately or chilled properly for storage.

### Equipment wish list

Both veterinarians have seen many different systems that work well for calf-milk pasteurization. Some are supplied by milking machine manufacturers, and

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often are custom-fitted to the dairy to utilize existing resources such as chilled waste water from the dairy's milking system for cooling. Others are being developed by suppliers that specifically manufacture pasteurizing equipment and that also may serve other sectors of the food-processing industry.

Regardless of the manufacturer, Thurmond and Mitchell say the "ideal" on-farm pasteurizing system should be:

- Easily or automatically cleaned, so that cleaning is readily performed by laborers and bacterial reservoirs do not build up.
- Fool-proof, with a system of checks and balances to guard against failures in the system.
- Capable of reaching the desired temperature and bringing it back down quickly, while handling a large volume of milk.
- Equipped with a temperature monitoring device or chart to allow management to track performance and employee compliance.
- Capable of pasteurizing colostrum without gumming up or damaging colostrum quality.

#### Managing the big picture

While pasteurizing waste milk provides clear benefits when done correctly and consistently, it should not be viewed as a panacea that will mask other management problems.

"Pasteurization is important, but it's not the only issue," says Mitchell. "I think the most important thing is to focus on hygiene in the milk delivery system in general. Also, don't overlook the simple things like the amount of nutrients provided to the calf. Make sure calves are fed enough to fulfill their needs. The milk can be totally sterile, but if a young calf doesn't get enough energy from the milk we feed them, they will become weak and get sick anyway."

Thurmond adds that pasteurization provides little to no protection against antibiotic residues in waste milk, which

can present their own set of challenges. Also, he cautions against allowing pasteurization to create a false sense of security on the dairy.

"It's easy to get a little sloppy in other procedures, thinking pasteurization will cover up our mistakes," he notes. "But pasteurization can only do so much. I like to equate it to scheduling an elective surgery. If everything else is in good shape, then the investment in the next improvement of pasteurization is a good decision. And, like most management practices, it's only as good as the ability to carry it out." ■

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