A BAMN Publication

Managing a Pasteurizer System for Feeding Milk to Calves

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.

Non-saleable milk (NSM)

The use of NSM as feed for calves has gained popularity in recent years. Although calves can thrive on NSM, significant factors should be considered to ensure long-term, positive benefits from feeding NSM. These factors are related to NSM consistency and calf health. They include bacterial contamination, pasteurizer operation, variable nutrient content, antibiotic content, variable supply of nonsaleable milk, pasteurizer operation and post pasteurizer operation. Potential benefits and risks associated with use of pasteurized NSM have been reviewed in a previous BAMN publication, "Feeding Pasteurized Milk to Dairy Calves".

Successful use of NSM in a calf-feeding program is dependent upon establishing protocols that minimize risks and ensure delivery of a consistent supply of milk with acceptable nutrient content and low levels of bacterial contamination.

Critical areas of concern are handling milk prior to pasteurization, pasteurizer operation, sanitation, and developing strategies that manage variations in supply and ensure the quality of NSM.

Pre-pasteurization procedures

- **NSM should be handled using the same procedures recommended for saleable milk.**
- Receiving vessels must be clean, and milk should be refrigerated if it is to be held for more than one hour prior to pasteurization. Small stainless steel refrigerated bulk tanks (<400 gallons) have been used successfully on many farms.
- Cool milk to less than 40°F within one hour of milking, and hold at this temperature until pasteurization is completed.
- Flush receiving and storage tanks with potable water immediately after emptying. Thoroughly scrub milk contact surfaces with the detergent used to clean the bulk tank and sufficient sodium hypochlorite to provide 110 ppm chlorine in 160 to 170°F water. Temperatures exceeding 172°F may result in residues on surfaces which are difficult to clean. Surfaces should be cleaned with a tank washer or scrubbed by hand for at least 10 minutes, preferably longer. Remove any gaskets and clean by hand. Rinse with potable water and follow with an acid sanitizer and allow to drain.
- Cover and seal receiving vessels at all times to prevent exposure of milk surfaces to flies and other insects.
- Use an acid sanitizer rinse immediately before filling tank with milk.
- Ensure that NSM is thoroughly agitated to distribute fat prior to pasteurization.

Pasteurization

Pasteurization does not sterilize milk. In a properly operating system, a pasteurizer destroys 98 to 99% of bacteria. Successful pasteurization is indicated when the standard plate count (SPC) is less than 20,000 colony forming units (cfu)/ml. Alternately, the reduction of the enzyme alkaline phosphatase to less the 500 mU/ml indicates that the correct time and temperature relationship has been achieved. However, if pre-pasteurization SPC exceed 2,000,000 cfu/ml, a post-pasteurization SPC goal of 20,000 cfu/ml may not be achieved.

Most pasteurization systems on dairies are either batch or high temperature/short time (HTST) units. Batch pasteurizers consist of a tank with a heating element or jacket that heats milk to 145°F and maintains

this temperature for 30 minutes. Milk must be agitated to eliminate "cold" spots and ensure that the head space above the milk reaches and remains at 145 °F for 30 minutes. Batch systems available commercially are programmed to agitate milk and control heating and cooling cycles. Batch pasteurizers are generally less expensive to purchase and install than HTST systems. They are also simpler to operate, but must be cleaned manually.

HTST systems operate similarly to plate coolers—which are used to pre-cool milk entering the bulk tank—except that they first heat the milk and then cool it for feeding or further storage. Most on-farm HTST systems achieve pasteurization when milk reaches 161°F for 15 seconds. These systems process milk more rapidly than batch systems, and heating, cooling and cleaning processes are more readily automated. However, HTST units cost more than batch units, and an adequate supply of hot water is more critical to their successful operation.

More advanced HTST systems have in-line sensors that monitor the temperature of the NSM and will re-circulate the milk through the heat exchanger if pasteurization temperature was not reached. Some HTST units also have flow sensors that shut down the system when milk flow stops, which prevents the milk from "cooking" on the heat exchange plates. A filter in the inlet line is recommended to keep particulate matter from clogging heat exchange plates. In addition, do not let the machine sit idle with milk in the system or fouling of the plates can occur.

Sanitizing the pasteurizer is an important step and should be done immediately after pasteurization has been completed. Most batch pasteurizers are cleaned manually with a water rinse, followed by alkaline detergent and an acid rinse. Although cleaning HTST units can be automated, several important factors should be considered to keep equipment operating to its designed capacity.

- Clean after each use.
- Use cleaners and sanitizers in accordance with manufacturer's instructions.
- Water temperatures when cleaning should remain between 170 and 180 °F.
- Once pasteurization is complete, immediately flush the system with water until water runs clear. Follow manufacturer's instructions, which generally recommend cleaning with alkali detergent for at least 30 minutes, draining and following with an acid rinse.

Sanitizing feeding buckets, bottles and tanks used to hold pasteurized milk is also critical and is accomplished using similar procedures described previously for all containers receiving raw milk. Bacterial growth can be rapid and exceed 100,000 cfu/ml or more within one hour if pasteurized milk enters unsanitized buckets, bottles or transfer tanks.

Quality assurance

Pasteurizers should be equipped with time-temperature recording charts to make sure they are functioning properly. It is also advisable to maintain an accurate thermometer in the area to check the accuracy of the recording thermometer and monitor milk temperature prior to feeding. A testing program should be instituted to ensure that protocols are being followed and that the pasteurizer is operating correctly. Work with a laboratory capable of testing milk for total solids, fat percentage, protein percentage and SPC.

Quality goals for pasteurized samples are:

- SPC < 20,000 cfu/ml
- Total solids > 12%
- Fat percentage > 3.5%
- Protein percentage $\geq$ 3.0%

These tests should be done on samples collected immediately after pasteurization and again at the end of the feeding cycle. Samples should be collected as follows:

- Thoroughly agitate NSM.
- Aseptically collect milk samples into vials or bags provided by the laboratory.
- Immediately cool samples.
- Package and ship to the laboratory to arrive within 48 hours at less than 40°F.

There is no established standard for testing frequency. However, startup operations should institute a rigorous schedule (at least weekly) during the first month of operation. Thereafter, a monthly schedule would be the minimum advisable frequency for testing. Periodically, milk samples should be obtained prior to and immediately after pasteurization and after the last calf has been fed to monitor quality control within each step of the NSM feeding program.

Supplementing pasteurized NSM

Farm protocols must address variation in the quality and quantity of NSM. Total solids can be estimated using a digital refractometer. Low solids (less than 12%) may indicate excessive rinse water has entered the supply while flushing milk lines. Additional solids can be added via milk-replacer powder, whey proteins and fat supplements. Managing variations in the quantity of NSM is more difficult, especially when there are large daily variations.

There are several strategies used to cope with a variable NSM supply:

- Feed calves pasteurized saleable milk.
- Feed younger calves NSM and older calves milk replacer (if pasteurizer management is excellent).
- Feed the youngest calves with sensitive digestive systems milk replacer and feed older calves NSM. Research has shown that when diets contain equal amounts of energy and solids, calves can be successfully switched from one diet to another with little trouble. However, it is advisable to make this change only once, and preferably when calves are older than 3 weeks.
- If the producer is willing to frequently estimate total solids, formulations can be developed that incorporate available NSM, milk-replacer powder and water.

Economics of NSM pasteurizer systems

Determining the true cost of pasteurized NSM feeding systems is difficult due to the fluctuations in supply of NSM, numbers of calves, and relative costs of feeding either milk replacer or raw NSM. Other variables will include capital and operating costs for the pasteurization system, and relative health and performance of calves. The profitability of a system is dependent upon labor, equipment, installation, and energy costs as well as number of calves, amount of NSM available and cost/amount of milk replacer fed. Tools are available to help determine whether a pasteurizer will be profitable based on individual farm situations (James, 2007).

Additional factors to evaluate when considering the use of an on-farm pasteurizer for NSM include:

- Personnel available to manage pasteurizer system.
- Facilities for housing pasteurizer, storage tanks, and hot water heaters.
- Availability of reliable maintenance service for pasteurizer.
- Herd health and biosecurity. If not properly pasteurized, milk from cows with Johne's disease, *Mycoplasma* or *Staphylococcus aureus* mastitis may transfer disease. Field studies demonstrated that pasteurizers failed to achieve goals of reducing SPC to less than 20,000 cfu/ml 10% of the time on some dairies. Using NSM may pose unacceptable risks if sourced from herds with a high incidence of mastitis or other diseases. On-farm pasteurizer management is unlikely to be perfect.

The decision whether or not to use pasteurized NSM should be made after a thorough consideration of the factors described. Once the decision has been made, protocols that address the following should be established:

- Sanitation of receiving and holding tanks as well as pasteurizer.
- Monitoring of NSM handling and pasteurization
    - Temperature in holding tanks, the pasteurizer and the milk being fed to calves.
    - SPC, total solids, fat percentage and protein percentage.
- Timely delivery of milk to calves after pasteurization.
- Sanitation of calf feeding tanks, buckets or bottles.

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References

Godden, S., J. Fetrow, J. M. Feirtag, L. R. Green, S. J. Wells. 2005 Economic analysis of feeding pasteurized nonsaleable milk versus conventional milk replacer to dairy calves. J. Am. Vet. Med. Assoc. 226: 1547-1554.

James R., M. Scott. 2006. On-farm Pasteurizer Management for Waste Milk Quality Control. Proceedings 10th Calf and Heifer conference. Visalia, CA. March 21 - 23, 2006.

James R., M. Scott. 2007. Management and Economics of On Farm Pasteurizers http://www.vtdairy.dasc.vt.edu/pdf/Management%20and%20Economics%20of%20On%20Farm%20Pasteurizers.pdf

Jorgensen, M., P. C. Hoffman, A. Nytes. 2005. Efficacy of On-farm pasteurized waste milk systems on upper Midwest dairy and custom calf rearing operations. Proc. Managing and marketing quality Holstein steers. Rochester, MN Nov. 2-3, 2005. pp. 53 – 60.

Scott M., R. James, M. McGilliard. 2006. Performance of calves fed whole milk and milk replacer in different sequences. J. Dairy Sci. 89 (Suppl.1):32.

Scott M., R. James, M. McGilliard, B. Hopkins. 2006. Waste milk supply and pasteurizer performance on three North Carolina dairy farms. J. Dairy Sci. 89 (Suppl. 1):128.

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