

Free-Access Feeding of Acidified Milk Setting Up the System Using Formic Acid

Neil Anderson

Infosheet

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1. Introduction and Concepts

Choices in feeding systems, housing and management affect health, growth and behaviour of calves/kids and profit of a farm. Ontario producers commonly rear suckling dairy calves in individual pens and restrict milk feeding to two or three meals per day. In Finland, 30% of larger dairy farms and 90% of veal operations choose group housing and free-access feeding. Finnish farmers have ten years of practical experience with free-access feeding of milk acidified with formic acid to preserve it for one to three days. They claim less labour, inexpensive equipment and efficient use of surplus colostrum, transition cow milk or milk from cows under treatment. They also report calves stay healthy, have few bouts of diarrhea and rarely suck on navels or ears. For Finnish farmers, free-choice feeding is an easier feeding method for substitute workers. It allows calves to eat to appetite and satisfies the calves' biological need to suckle. Of course, calves have good growth and weight gains.

The basic components of a Finnish free-access feeding system include a reservoir to contain the milk or milk replacer and a plastic tube with a one-way valve to carry milk to a rubber nipple. (Figure 1) Acidification with formic acid preserves the milk for storage at room temperature and allows them to mix batches at one- to three-day intervals to save labour. In addition, the milk is fed cool (20-24°C in winter) to limit intake. Ontario producers began using the system in June 2005. They have been very successful at finding what does and what does not work.

Observations from their farms are in this document. Researchers are studying the effects of formic acid (pH, contact time) on selected bacteria, and on immunoglobulins in colostrum. Other studies include calf health and economics of the feeding system.

2. Goals

On average, with free-access feeding, dairy calves eat seven meals per day and a meal lasts seven minutes for a total of 49 minutes suckling per day. Meals are generally at four-hour intervals and cluster in evening and morning hours. This document describes ways to implement an inexpensive free-access feeding system modeled on Finnish guidelines, using formic acid as a milk preservative. The system mimics natural suckling and group social behaviour. It allows for accelerated growth and reduces farm labour. Anecdotally, Ontario producers report less clinical cases of diarrhea and use of drugs for rearing milk-fed calves and kids.

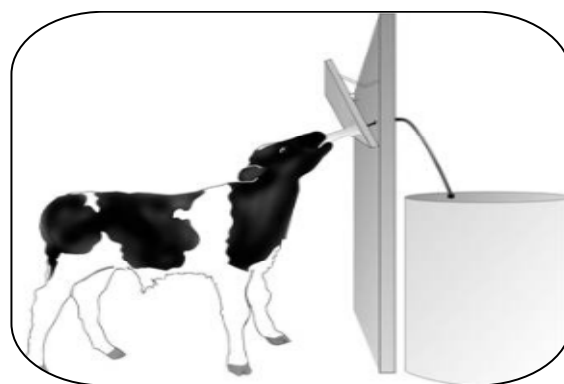


Figure 1. Courtesy Valio Dairy, Finland

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3. Cautions and Safety

Formic Acid 85% is hazardous to skin, eyes and lungs. For safety, dilute one part acid into nine parts water and work with weaker acid. Store acids safely and keep them out of reach of children. A commercially prepared, dilute (9.8%) formic acid is available.

4. How to Prepare Formic Acid 85% for Use

- Use goggles, face shield, gloves, apron, and respirator. Work in a well-ventilated area.
- Dilute 1 Part Acid into 9 Parts Water

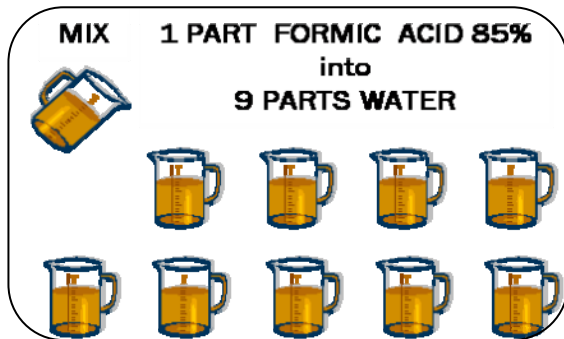


Figure 2. Pour 20L of concentrated Formic Acid 85% into 180L of water to make a solution that is safer to handle and mixes into milk with less curdling.

- ✓ Use dilute acid – for safety of workers and to avoid clot (cottage cheese, curds) formation.
- ✓ Use a measuring cup with metric units for volumes.
- ✓ ALWAYS add acid to water.
- Mix 1 part Formic Acid 85% into 9 parts water.
- For example: put 180 L water into a barrel, then add 20 L of Formic Acid 85%. Mix.
- Label the container of dilute acid clearly.
- Dilute Formic Acid
- Caution: Irritating to skin, eyes and lungs.
- Keep out of reach of children.
- Mixing Directions: While stirring vigorously, add 30 mL to 1 litre whole milk or milk replacer.
- Mix 40 to 45 mL to 1 litre colostrum.
- Check pH 4.0 to 4.5.

Formic Acid 85%	Water	Total
1 litre	9 litres	10 L
2 litres	18 litres	20 L
3 litres	27 litres	30 L
4 litres	36 litres	40 L
20 litres	180 litres	200 L

5. Preparing and Feeding Acidified Whole Milk or Colostrum or Milk Replacer

- Use cool (10-24°C) or cold ($\leq 15^\circ\text{C}$) milk to avoid coagulation or clot formation.

- Use dilute acid. Add 30 mL (cc) into each litre (1000 mL) of milk.
- Stir vigorously while adding the acid into the milk; again within the first hour, and 3 times each day.
- Check for target pH 4.0-4.5. Use narrow range (3.0-5.5) litmus paper or pH meter.
- Feed at ambient temperature in summer *and* 20°C in winter.
- Provide free-choice water and calf starter.
- Clean nipples, valves, lines and containers with warm water and detergent.
- Mount nipples at calf's / kid's shoulder height.

Table 2. Guidelines for mixing dilute Formic Acid into milk or milk replacer.

Dilute Acid	Milk or Milk Replacer
30 mL	1 litre (1000 mL)
300 mL	10 litres
600 mL	20 litres
900 mL	30 litres
1800 mL	60 litres
3000 mL	100 litres
4000 mL	133 litres

6. Use More Formic Acid with Colostrum

Mix 40 to 45 mL of dilute acid into one litre of colostrum to achieve a pH less than 4.5. Check pH is within the range 4.0 to 4.5.

7. NOTES about Fresh or Hot/Warm Colostrum or Milk or Milk Replacer

- Hot (greater than 30°C) milk forms a hard, cottage-cheese-like curd that will not stir back into solution.
- Warm ($>24^\circ\text{C}$) milk separates quicker and more often.
- Add dilute acid to cool (20-24°C) milk while stirring vigorously. Agitate a few times each day.
- Best results are from adding acid to cool (20-24°C) or cold ($\leq 15^\circ\text{C}$) milk or colostrum.
- Use a mix of 20% milk replacer plus 80% whole milk to minimize separation of fat in whole milk.

8. How to Prepare Milk Replacer with Dilute Acid

- Use milk replacer made with all milk products *and* with skim milk powder. Replacers may contain some plant protein. Try before buying in quantity.
- Use 150 grams of powder per litre.
- Mix the powder with about one-half the water (HOT at 50-60°C). Stir (mix) vigorously.
- Add COLD water.
- Mix. The final temperature should be 20-24°C.
- (Experiment with hot: cold ratio to get 20-24°C.)
- Add dilute acid. Stir vigorously.
- Check the target pH is 4.0-4.5.

- Feed at room temperature in summer AND at 20-24°C in winter. Objectives are to prevent curd formation, to limit intake per meal and to prevent gorge feeding. Do not heat (>24°C) the milk or leave it exposed to the sunlight to heat.
- Agitate the milk replacer again within the first 30–60 minutes and, then, three times each day because it has a natural tendency to separate.

Table 3. Powder, water and acid needed to prepare 15% solids (approximately) milk replacer mixture.

Powder Weight	Hot Water	Cold Water	Dilute Acid
150 g	500 mL	500 mL	30 mL
1500 g	5 litres	5 litres	300 mL
3000 g	10 litres	10 litres	600 mL
4500 g	15 litres	15 litres	900 mL
6000 g	20 litres	20 litres	1.2 L
9000 g	30 litres	30 litres	1.8 L
20 kg	66 litres	66 litres	4.0 L



Figure 3. Batch mixers save time and improve the quality of mixtures. This 300 L mixer has a bottom-mount motor that spins an impeller. It easily handles the 133-166 L needed to mix a 20-25 kg bag of powder. A pump transfers the milk to a bulk milk tank. Brian St. Denis is the Ontario distributor – 450-451-0078.

9. Feed Cool Milk or Milk Replacer. Do Not Expose to Sunlight.

- In winter, aim for a milk temperature of 20-24°C and, in summer, feed at ambient temperatures.
- Do not expose milk containers to direct sunlight because the milk can quickly get too hot.
- Keep milk containers in the shade.
- Hot milk predisposes to over-consumption and diarrhea.

10. Keeping Milk at 20-24°C in Cold Barns

- Calves will drink milk colder than 20°C. However, feed conversion, intake and calf performance decline with consumption of cold (<15°C) milk.
- Mark used an aquarium heater to warm water within a 3-inch plastic pipe submersed in the milk. Another variation is to place the container of milk into a water bath warmed by the aquarium heater.
- An Eastern Ontario producer used a waterbed heater as a band heater around the milk barrel and adjusted the thermostat to achieve the desired milk temperature.



Figure 4. A chest-type food freezer is an insulated box with a sealed lid.

- Producers keep the chill off milk by placing containers inside insulated boxes and adding supplemental heat to warm the miniature room. Figure 4 shows a freezer adjacent to a calf pen. Nipples could be mounted directly to the wall or recessed inside the freezer wall using PVC end caps for mounting as shown in Figure 8. Within the chest, heat lamps or thermostatically-controlled electric heaters will keep the chill off milk. The freezer contains short barrels for milk.
- A central warm room is convenient for milk preparation, storage and utilities. Harold has a warm room with two abutting pens in a curtain-wall calf barn. An in-floor heating system keeps the room and the milk in the reservoir and milk line at about 20°C. A one-inch milk line exits the bottom of the reservoir, travels around the room to milk bars on the wall and back into the milk reservoir. Harold's system is gravity flow and has plumbing for washing. To prevent nipples from freezing, mount them in 4-inch PVC end caps and recess the end caps into the warm room. See Figure 8.

- Brad uses a piglet warmer (Figure 5) to keep the chill off milk. His calves are in individual pens. His barn temperature gets near freezing on some nights. In the morning, he turns the pump on to circulate warm milk. Otherwise, it's a gravity flow system. He has check valves that leak under pressure, so he put the pump on the return line.

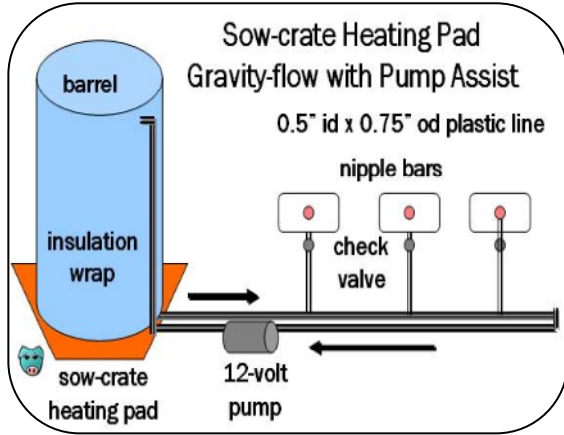


Figure 5. A milk barrel sitting on an electric sow-crate blanket (piglet warmer).

- A heat exchanger can warm milk to 20°C for feeding calves. It also can cool fresh whole milk to 15-20°C before adding formic acid. Some producers collect cool milk after it passes through the plate cooler.
- Two producers near Elginfield, Ontario have milk lines for feeding calves in cold barns. They use a heat exchanger to take the chill off acidified milk returning to a milk-storage tank. A diagram of their system appears as Figure 11 on page 6. A temperature probe, located near the pump, senses milk temperature in the line going to the nipples. When the milk temperature drops below 20°C, a thermostat starts a pump that circulates hot water through the counter-flow heat exchanger. Their heat exchangers varied in length and were made locally using one-inch stainless steel pipe inside two-inch stainless pipe.

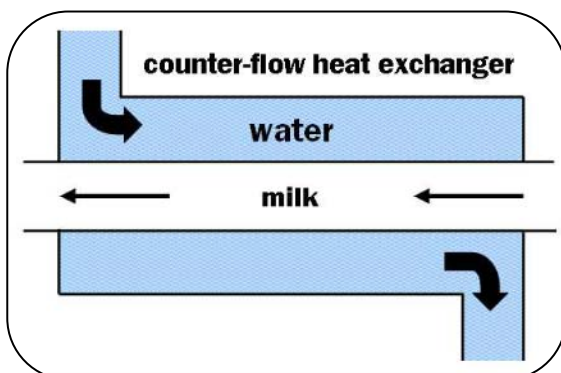


Figure 6. A counter-flow heat exchanger.

- Kevin devised the free-flowing milk warmer shown in Figure 7. The target temperature is 20-24°C for milk, so adjust the thermostat accordingly. An air-bleeder rids the line of gas (air) bubbles that form and stop the siphoning action.

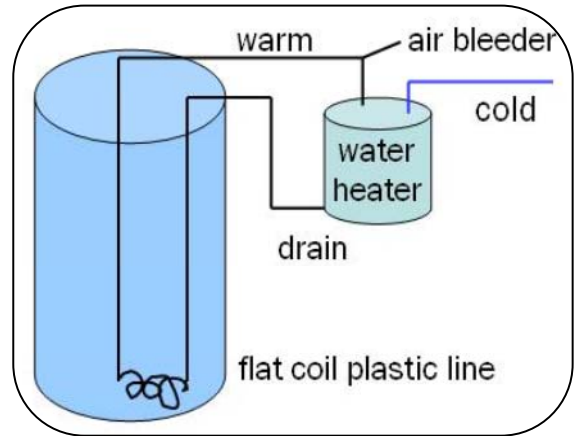


Figure 7. An electric water heater system.

- Despite the thermostat control, a band heater for steel barrels successfully melted plastic barrels
- A producer in Northern Ontario built a milk container and placed it within a warm water bath.
- Stock-tank heaters prevent freezing but do not heat to 20°C. Pail heaters are too hot and cook milk on the element.
- Warm water, from a small water heater, circulating through the cooling coils of a bulk milk tank will keep the chill off milk. On one Ontario farm, a producer uses a pump to circulate warm water from the hot outlet through the cooling coils and returns the water to the cold water supply inlet of the water heater. There is a temperature sensor in the bulk tank and a thermostat to start and stop the circulating pump. The coils in the bulk tank will burst if allowed to freeze when full of water.
- A Paladin® cable from Heat Line (705)754-4545 or (800) 584-4944 Info@heatline.com (or other suppliers) prevents a milk line (wrapped with insulation) from freezing. However, heat cables, in general, do not keep milk in the line at 20°C.
- Some producers use a heat lamp hung over the milk barrel and claim good results. However, the milk at the bottom of the barrel may be much colder than that at the top. An agitator would remedy the problem of uneven heat distribution in this system.

- In Nova Scotia, family members designed and built a complete milk bar feeding system for cold housing. See Figures 8, 9, and 10.



Figure 8. A calf nurses from a nipple that is recessed within a warm-box to protect it from freezing.

- The milk bar includes three nipples mounted at about calf-shoulder height.
- Plastic coated plywood forms the 32-inch wide wall for the milk bar.
- 4-inch PVC end caps serve as mounts for nipples.
- End caps fit flush with the wall and recess inside the warm box. This technique bathes the end caps in warm air.
- Warm end caps radiate heat around the nipples. Although it has not been necessary, holes could be drilled in the end caps to allow warm air to escape around the nipples.
- A 300-watt baseboard heater with thermostat control keeps the interior of the box and the milk at about 20°C.



Figure 9. The interior of the warm box provides spacious accommodation for a 200L barrel, nipple bar, agitator, timer, heater, fan, light and thermometer.

- A metal heat shield between the heater and barrel protects the milk from overheating.
- Styrofoam insulates the box for heat retention.
- A small fan mixes air inside the box for even heat distribution.
- A 1/20-HP gear-motor turns the agitator at about 100 rpm - e.g. Dayton Gearmotor 1LPV1
- A timer starts and stops the agitator every hour for a short mixing cycle.
- The agitator is a stainless rod with two stainless paddles welded at 25 degrees. It attaches to the 5/16-inch gearmotor shaft with rubber tubing and stainless hose clamps.
- A plastic conduit contains the milk lines within the barrel so they do not tangle with the mixer.
- A light and thermometer complete the equipment list.
- Electrical wiring met inspection criteria and permits easy removal of the barrel for cleaning or moving the entire unit to another pen.
- To remove the barrel, unplug the power source for the mixer-motor and disconnect the milk lines from the nipples.



Figure 10. Self-contained warm boxes can be unplugged from the power source and moved to other locations.

- Warm-air duct as a milk line conduit. Ideas from the Nova Scotia warm box feeder could be used for a milk line in a cold barn. The milk line could travel within an insulated warm box. At each pen, there could be a milk bar with nipples mounted to end caps recessed into the warm-air duct. A lid would provide access to the nipples. All other components would be in a warm room within the cold barn.

11. Automation and Milk-line Systems

- A milk-line system could include:
 - Storage tank for milk
 - Agitator for milk
 - Timer for the milk agitator
 - Milk line – one-inch plastic for most farms
 - Pump for milk e.g. TACO model 003 or 006
 - Nipple bars at each pen
 - Heat exchanger for taking chill off milk
 - Hot water heater
 - Pump for heat exchanger e.g. TACO model 003
 - Temperature sensor and thermostat
 - Mixer - preparing milk replacer and agitating acid
 - Mixer for whole milk and adding acid
 - Transfer pump from mixer to storage tank
 - Digital pH and temperature meter
 - Valves and taps
 - Air relief valves – milk and water lines

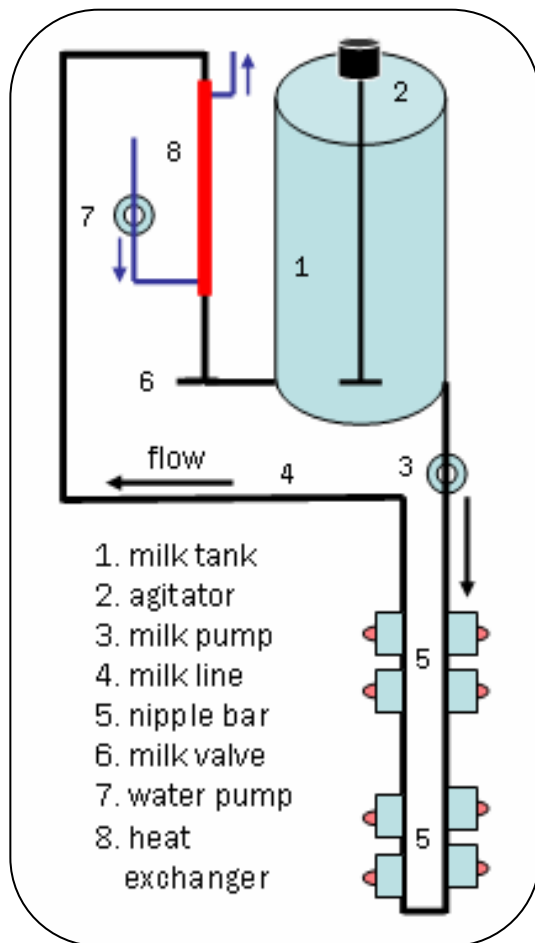


Figure 11. The drawing shows components of a milk-line system for free-access feeding of acidified milk.

- Suckling volume may be 0.25 litres per minute per calf (nipple). With 16 nipples suckled simultaneously, pump capacity should be 4 litres per minute or 60 gallons (US) per hour.

- After initial priming with an inline pump, the siphon principle should take over. The end of the milk line must be below the level of milk in the bulk tank for the siphon to operate.
- The system shown in Figure 11 is in place on two farms. One farm has a high line (eight feet above the floor) with drop lines to the nipples. The second farm has a low-line along the floor with T's and risers to the nipples. In cold (below freezing) barns, the milk line could pass through a warm-air duct and nipples could be recessed into the duct.
- The time to mix either milk replacer or acid into milk / milk replacer can be reduced significantly with a well-equipped mixing-centre.
- A digital pH and temperature meter gives fast readouts and is very helpful to those who cannot differentiate colours on litmus paper.
- A water meter assures correct portions of hot and cold water for mixing milk replacer.

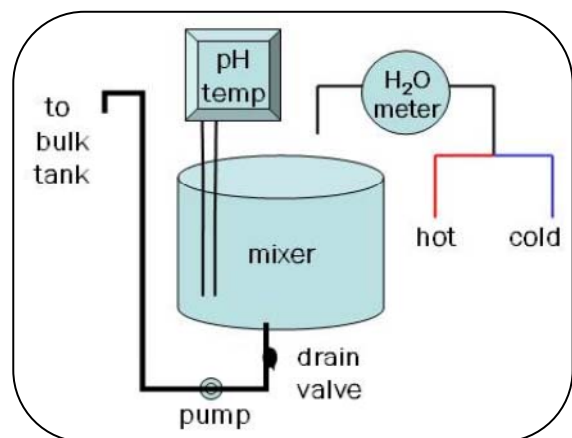


Figure 12. A mixing centre for preparing milk replacer and / or adding acid to milk / milk replacer. (See Figure 3)

12. Cleaning the Equipment

- Wash nipples, hoses, valves and pails every three days. Use warm water and dish washing detergent.
- A black, green or pink slime in clear plastic lines is an indication of inadequate acidification. In general, slimes and moulds do not grow at pH 4.0 - 4.5.

13. Nipples, Nipple Height, Check Valves

- Mount nipples at shoulder level of a calf, kid or lamb. For calves, the height is about 24 to 30 inches above the floor level.
- Provide 3 or more nipples for 6 - 8 calves because they tend to suckle as a group at regular intervals.
- A simple pail or barrel system works well with nipples, a plastic line, and a check valve on the line submerged in milk
- Peach Teats™ and lamb nipples work very well.

- In bucket systems, use a check valve on the end of the plastic line to keep the line full of milk.
- Nipples mount easily to plastic pails and barrels. A lid from a 20-litre plastic pail makes an inexpensive mount for the side of a pen.



Figure 13. A lamb nipple, plastic line and one-way valve to keep milk in the line.

- Gravity flow systems or pump systems with high head pressure may require a check valve at the nipple to prevent milk leaking. The photo in Figure 14 shows a Peach Teat™ with a polypropylene check valve inserted into it. The valve has a stainless steel ball and spring and a seat for the ball. It withstands 1.5 PSI but opens with the vacuum created by a suckling calf. The valves have been in use at a farm for about two years.
- A 360-degree loop in the plastic milk line, just before it enters the nipple, should act as a check valve to prevent leaks.



Figure 14. Peach Teat™ with a check valve to overcome leakage caused by high head pressure in a milk tank. The check valve in the photo has stainless steel and plastic components that resist the effects of acidified milk.

14. How to Avoid Making Cottage Cheese or a Cesspool of Bacteria

- With inadequate acidification (pH>4.5), in a few hours at ambient temperature, your milk will become a filthy cesspool containing billions of bacteria. A foul odour indicates bacterial growth.
- You will make cottage cheese if you use hot (>24°C) milk, add concentrated formic acid, add

too much dilute acid, or do not stir the milk while adding acid.

- Use cool (15-24°C) milk or milk replacer.
- Use dilute formic acid. Please see Figure 2 and Tables 1 and 2 on page 2.
- Stir vigorously while adding acid to milk.
- Get to the target pH of 4.0 to 4.5.
- Agitate a few times daily after acidification. Acidified milk, colostrum and milk replacer will separate within a few minutes to 30 minutes after adding acid. Simply mix it again to put it back into solution. Agitate at least three times the first day. Agitators on timers relieve you of this chore.
- Mix 20% milk replacer with 80% whole milk to prevent cream (fat) separation in acidified whole milk.

15. pH and Contact Time for Killing Bacteria

- pH meters lose their calibration. They should be checked and calibrated often.
- Acidification does not kill all bacteria.
- Acidification at a target pH of 4.0 – 4.5 and contact time of 8 – 12 hours will produce milk that meets or exceeds quality targets. For pasteurizers, the target is 20,000 cfu per mL.
- With milk replacer, acidify and feed immediately. Coliforms will be the most common contaminant and they die quickly (1-2 hours) with formic acid.
- In experiments with whole milk from a few cows, we found no growth of coliforms after a contact time of one hour at pH 4.1 in whole milk acidified with formic acid. We found no growth of *Staphylococcus aureus* after a contact time of 4 – 6 hours at pH 4.1 in whole milk acidified with formic acid.
- During our study of 24 farms feeding acidified milk during the summer of 2006, we found 81% of 46 milk samples were in the target pH range of 4.0 – 4.5. On bacterial culture, the majority of samples had no growth or less than 1000 colony-forming units per millilitre (cfu/mL) of milk. Thirty-one of 48 samples had no coliform growth. We found environmental *Staphylococcus* and *Streptococcus* in less than half the samples and at levels of 1 – 5,000 cfu/mL.
- Formic acid kills 90% of *Mycobacterium avium subsp. Paratuberculosis* (MAP) (Johne's bacterium) with 8 hours contact time at pH 4.0 and 100% at 48 hours. (unpublished research, University of Guelph, October 2007) See Figure 15, next page.

Acidifier	Percent Viable MAP (Madonna strain) After 8 h and 48 h in Acidified Raw Milk		
	pH	8 hours	48 hours
Hydrochloric Acid	5.0	100	100
	4.5	100	100
	4.0	100	64
	3.5	100	54
AgriAcid	5.0	100	100
	4.5	100	100
	4.0	100	40
	3.5	100	10.1
Formic Acid	5.0	91	100
	4.5	89	11.6
	4.0	16	0
	3.5	3.4	1.25

Figure 15. Choice of acid, pH and contact time are important considerations as shown by recent Guelph research using a field strain of *Mycobacterium avium subsp. Paratuberculosis* (MAP) (Johne's bacterium). Data from L. Mutharia, Guelph.

16. Agitating Acidified Milk or Milk Replacer

- Since acidified milk separates, agitation is essential. Vigorous stirring for a short duration will achieve excellent mixing. Over mixing will produce butter. Slow, frequent agitation is preferred.
- Susan is using free-access feeding for calves in hutches during summer months. The acidified milk is in a pail hanging on a hook suspended from the top of the hutch. Calves shake the pails while suckling. In addition, Susan simply gives the pails a vigorous shake a few times a day.



Figure 16. An electric drill and a paint stirrer attachment do a very good job of mixing. Several producers made mixers to insert into their electric drills. It is essential to select a mixer for the size of the container and volume of milk.

- Stefan fit a 1/3-hp motor and stirring attachment to the lid of his milk barrel. His electrician wired in switches for manual and automatic. The automatic mode uses controllers to activate the motor and stir the milk for 10 seconds every hour.
- At Winding River Farms, a 1/20-HP Dayton Gearmotor turns an agitator at about 100 rpm. A

timer starts and stops the agitator every hour for a short mixing cycle. See Figure 9 on page 5.

- Mark uses a pond pump to continuously stir milk replacer in a barrel. Pond pumps are available at garden centres, come in various sizes, and have a pre-filter to prevent clogging of the pumping mechanism. Others have tried these pumps and found they make butter in the container.

17. Feeding Protocols – Birth to Weaning

a) Feeding newborn calves/kids – birth to two to four days

- Within one hour of freshening
 - Harvest colostrum from the fresh cow / doe.
 - Feed the newborn calf at least two litres of fresh colostrum. Feed kids about 250 mL.
 - Use a nipple bottle.
 - Cool (10-24°C) the remaining colostrum.
 - Acidify the remaining colostrum with dilute formic acid.
 - Store the acidified colostrum in containers with lids
- two to four hours after being born – feed the first feeding of acidified colostrum by nipple
- Move the calf/kid to its individual or group housing pen
 - Provide free-access to acidified colostrum
 - Be sure the calf/kid is suckling the acidified colostrum
 - Feed acidified colostrum for two to four days
 - Provide free-choice water and grain



Figure 17. Kids suckling acidified colostrum.

b) Feeding Post-colostrum to Weaning - Whole Milk or Milk Replacer

- House calves/kids in groups
- Put 2- to 4-day-old calves/kids (off colostrum) into group pens.

- Prepare the milk with dilute formic acid as per instructions.
- Mix enough milk for one to three days.
- Calculate 8 to 12 litres per calf per day for pens of calves of mixed ages. Calculate about one to 1.5 litres for kids.
- Stir the milk for 10 to 15 seconds at least three times per day.
- Be sure each calf/kid is nursing the nipple.
- Use containers with lids. Keep out flies and cats.
- Clean the equipment with warm water and dish washing detergent.
- Provide clean, fresh water free choice.
- Provide fresh grain free choice.
- Start weaning at 42 days and complete by 49 days.
- Provide one teat per three calves, minimum recommendation. (Use more nipples for kids.)
- Restrict group size to 8 calves maximum or 10 kids or lambs, maximum.
- Soft feces should be considered normal for calves/kids/lambs fed free-choice liquid diets.
- Weaning may be abrupt or gradual (preferred method).
- 5-Day Weaning. Dilute the milk or milk replacer by 20% each day for five days until only water is available from the nipples.
- Water and grain consumption increase rapidly at weaning.

18. Sources of Equipment and Formic Acid

- **Peach Teats, One-way Valves, Plastic Tubing**
 - Rodger Industries Inc., P.O. Box 40, Blenheim, ON N0P 1A0
(519) 676-3244 or toll free (877)-584-8944, or Fax: (519) 676-4955
 - FIL Agritech LLC, P.O. Box 490, Little York, NY 13087-0490
(607) 749-3931 or Fax: (607) 749-3266
 - Interpump, Fergus, ON. Check valve.
(519)-843-4232
 - Milking Equipment Dealer, Farm Supply Store, Veterinarian, or Feed Company
- **pH Paper # 325 with range of pH 3.0 to 5.5 (Figure 18)**
 - VWR International, 2360 Argentia Road, Mississauga, ON L5N 5Z7 (800)-932-5000
 - Sold in boxes of 10 roll dispensers
- **pH Meters**
 - Hoskin Scientific Limited, 4210 Morris Drive, Burlington, ON L7L 5L6 (905) 333-5510 sales@hoskin.ca

- pH meters are sold by Hydroponics supply stores. Look in the Yellow Pages of your telephone book or search the web.



Figure 18. Narrow range (3.0 to 5.5) pH paper.

- **Formic Acid 85%**
 - AnChem Sales, 120 Stronach Crescent, London, ON N5V 3A1 - (519) 451-1614
 - Univar Canada Ltd.
London: 153 Towerline Place, London, ON N6E 2T3 - (519) 668-3007
Mississauga: 64 Arrow Road, Toronto, ON M9M 2L8 - (416) 740-5300
Check Univar's website for other National and International locations.
- **Formic Acid 9.8%**
NOD Apiary Products Ltd., P.O. Box 117, 2325 Frankford Rd. Frankford, ON K0K 2C0 (866)-483-2929. This ready-to-use product lets the user avoid the hazards of working with concentrated acid. You do not have to dilute it. You will use about 30 mL of ready-to-use acid in one litre of milk or milk replacer and about 45 - 50 mL per litre of colostrum.
- **Formic Acid 65%**
Formic Acid 65% is available from beekeepers' suppliers. It is more expensive to buy than 85% Formic Acid. When diluted 1 part into 9 parts of water, you will use about 38 mL dilute acid in one litre of milk or milk replacer.
- **Safety Equipment**
 - Goggles and / or face shield
 - Respirator
 - Chemical rated gloves
 - Boots
 - Apron

19. Need-to-Know Safety Information when Working with Formic Acid 85%

The following information comes from the BASF Safety Data Sheet for 85% Formic Acid. Version 2.1 revised June 12, 2007. This is not intended as a substitute for reading the complete Manufacturers Safety Data Sheet document. Please read and follow all label instructions.

a) Hazard Identification – Emergency Overview

• **Danger**

- Combustible liquid
- Corrosive to eyes and skin
- Risk of serious damage to eyes
- Harmful if swallowed; ingestion may cause gastric disturbances
- Causes respiratory tract irritation

• **General Safety and Hygiene Measures**

- Avoid contact with eyes and skin.
- Avoid inhalation of vapour.
- Remove contaminated clothing immediately and dispose of safely.
- When using, do not eat, drink or smoke.

- **Room Design** Provide adequate exhaust ventilation to control work place concentrations.

• **Personal Protective Equipment and Exposure Controls**

- **Breathing Respirator** Wear a NIOSH-certified (or equivalent) organic vapour respirator.
- **Eye Goggles** NIOSH-certified chemical, tightly fitting safety goggles and face shield
- **Hand Gloves** Neoprene rubber, butyl rubber, protective gloves. Chemical resistant.
- **Body Apron** Body protection must be chosen depending on activity and possible exposure, e.g. *head protection, apron, protective boots, and chemical-protection suit.*

b) Potential Health Effects and Primary Routes of Exposure

Routes of entry include eye and skin contact, ingestion and inhalation.

• **Acute**

- **Swallowed** May cause acute local tissue damage, with other effects ranging from nausea and dizziness to unconsciousness.
- **Eye** May cause severe irritation or burns.
- **Skin** May cause severe irritation or burns.

- **Inhaled** May cause severe irritation to the respiratory system. May cause coughing, chest pains, nausea and vomiting.
- **Chronic** Prolonged vapour exposure may produce conjunctivitis of the eyes and irritation and dermatitis of the skin.



Figure 19. A padlock used with the yellow strap-lock prevents unauthorized dispensing of formic acid.

c) First-aid Measures

- **General** Immediately remove contaminated clothing. If danger of loss of consciousness, place patient in recovery position and transport accordingly. Apply artificial respiration if necessary. First aid personnel should pay attention to their own safety.
- **Swallowed** Rinse mouth and then drink plenty of water. Do not induce vomiting. Never induce vomiting or give anything by mouth if the victim is unconscious or having convulsions.
- **Eye** Rinse immediately for at least 15 minutes with plenty of water.
- **Skin** Wash affected areas with water while removing contaminated clothing.
- **Inhaled** Remove the affected individual into fresh air and keep the person calm. Assist in breathing if necessary.
- Immediate medical attention required.
- **Facilities** Eye wash fountains and safety showers must be easily accessible.

- **Advice to Doctor** No specific antidote. Treat symptomatically and supportively.

d) Precautions - Accidental Release Measures

- **Personal** Breathing protection required. Avoid contact with the skin, eyes and clothing.
- **Environmental** Do not empty into drains.

e) Handling and Storage

- **Handling**

- **General Advice** Ensure thorough ventilation of stores and work areas. *Sealed containers should be protected against heat as this results in pressure build-up.*
- **Fire and Explosion** Keep well clear of sources of ignition.

- **Storage**

- **General Advice** Danger of bursting when sealed gastight.
- **Incompatibility** Segregate from alkalis and alkalizing substances.
- **Storage Stability** Storage temperature: < 30 °C
Storage duration: <= 36 Months

20. Checklists

1. Prepare Dilute Formic Acid

1. Use safety goggles or face-shield, gloves, apron, respirator, ventilation
2. Pour 20 litres Formic Acid 85% into 180 litres water. Mix.
3. Label with cautions and directions
4. Install a pump or valve lock
5. Keep out of the reach of children

2. Prepare Milk Replacer

1. Use 150 gm powder per litre water e.g., 20 kg powder into 133 litres water
2. Put part volume hot (50°C) water into mixer.
3. Put full weight of powder into mixer
4. Turn mixer ON. Mix. Turn mixer OFF.
5. Top up with cold water.
6. Turn mixer ON. Mix. Turn mixer OFF.
7. Check final temperature = 20-24°C.

3. Prepare Whole Milk

1. Cool to 10-20°C before adding acid, e.g., collect milk after plate cooler; dilute warm milk with cold (4°C) milk
2. Dilute whole milk with milk replacer (20% by volume) to minimize cream separation
3. For some bacteria, contact time may be about 8 hours for whole milk.

4. Add Dilute Formic Acid to Milk

1. Wear gloves, goggles
2. Check milk replacer = 20-24°C
3. Check whole milk = less than 24°C
4. Turn the mixer ON
5. Add dilute acid – 30 mL per litre milk e.g., 4 litres dilute acid into 133 litres milk
6. Check pH is 4.0 – 4.5
7. Turn mixer OFF

5. Feed Cool

1. Keep the chill off milk in cold months
2. Milk temperature = 20-24°C in cold months
3. Feed at ambient temperature in warm months
4. Keep milk out of sunlight in warm months

6. Agitate the Mixture

1. Agitate three times daily (minimum)

7. Clean the Equipment

1. Clean containers twice per week

8. Restrict Group Size

1. Restrict group size to 6 - 8 calves
2. Provide 2 - 3 nipples per group

9. Provide Good Housing

1. Ventilate calf housing but avoid drafty barns
2. Keep pens bedded with dry and clean straw and shavings

10. Provide Free-choice Water and Feed

1. Keep fresh calf starter / grain available at all times
2. Keep water available at all times
3. Place very good quality hay in the feeders

11. Keep Records

1. Use individual calf identification
2. Record health / sickness events

12. Review Records

1. Consult with your veterinarian
2. Consult with your nutritionist

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Author Credit

Neil Anderson, Lead Veterinarian,
Disease Prevention - Ruminants
Animal Health and Welfare Branch
Ontario Ministry of Agriculture, Food and Rural Affairs
Wellington Place, 0536 Wellington Road 18,
R. R. # 1, Fergus, Ontario N1M 2W3
Tel.: (519) 846-0941, Fax: (519) 846-8101
E-mail: neil.anderson@ontario.ca
Webster: www.ontario.ca/omafra
<http://www.omafra.gov.on.ca/english/livestock/>

Agricultural Information Contact Centre:
1-877-424-1300

E-mail: ag.info.omafra@ontario.ca

Northern Ontario Regional Office:
1-800-461-6132

www.ontario.ca/omafra/livestock
<http://www.omafra.gov.on.ca/english/livestock/>

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