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*Calf Note 207 – Waste milk for calves: opportunities and challenges**

Introduction

Waste milk, also called "hospital milk", "pot milk" and other colloquial names, is milk produced by dairy cows that is not suitable for commercial sale. Waste milk may be produced by cows immediately after calving or from cows with active mammary infections or those that have been treated with antibiotics. Most antibiotics have a withdrawal period wherein milk must be discarded for a period of time. We will refer to this product as "waste milk", implying that the product is not suitable for human consumption.

Waste milk is by nature a variable commodity. The amount of waste milk produced depends on the number of cows calving and production of colostrum and the number of cows being treated. In at least one research study (Moore et al., 2009), some of the samples of waste milk were very low in solids (<7%), indicating that the samples had been contaminated, likely with wash water from the milking parlor.

Composition

Nutrient composition of waste milk can vary from that of whole milk, depending on the contribution of colostrum and transition milk (which increases solids, protein and fat) and water (contamination from washing procedures; decreases all nutrients). Moore et al. (2009) reported that waste milk from calf ranches in California averaged 11.2% solids, which was significantly different from the average solid in saleable milk (12.5%).

Tempini et al. (2018) collected 25 samples of waste milk from dairy farms in the Central Valley region of California in the United States. These samples were then analyzed for nutrient content and presence of antibiotic residues. Results of the nutrient composition data are in Table 1. The wide range of nutrients suggests that calves fed waste milk may experience swings in nutrient intake even if the same amount of liquid is fed every day.

Item	Mean	SD	95% CI
Fat, %	4.24	1.41	3.66, 4.82
Protein, %	3.74	0.43	3.56, 3.92
Lactose, %	4.4	0.22	4.31, 4.49
SCC, 10^6 cells/ml	2.13	1.26	1.61, 2.65
Coliforms, cfu/ml	702	691	417, 988
SPC*, 10^3 cfu/ml	116	101	75, 158

Table 1. Nutrient composition of 25 waste milk samples collected from California dairy farms. From: Tempini et al., 2018.

*SPC = standard plate count; cfu = colony forming units.

High counts of total bacteria (standard plate count) in these samples is likely the result of the lack of refrigeration of the waste milk during collection and storage prior to feeding.

An important criterion in considering the use of waste milk is the lack of consistency often seen in waste milk composition. An important "Golden Rule" of calf rearing is that "calves crave consistency". Inconsistency in feed composition or feeding practices can result in poor performance.

Item	CMR #1 Fixed	CMR #1 Var	CMR #2 Fixed	CMR #2 Var	P*
ADG, g/d					
0-28 d	367	323	361	269	0.04
29-56 d	795	726	709	696	0.08
Starter intake, g/d					
0-28 d	110	91	95	88	0.05
29-56 d	1506	1396	1452	1407	0.02
Feed efficiency					
0-28 d	501	453	503	379	0.04
29-56 d	528	520	488	495	0.33

Table 2. Performance of calves fed Fixed or variable amounts of milk replacer. CMR1 = 27/17 protein : fat concentrations; CMR2 = 27/31.

*Probability of Fixed differing from VAR treatments.

Adapted from Hill et al., 2008.

For example, Hill et al. (2008) reported that feeding calves the same volume of milk every day or a varying amount of the same milk replacer. The researchers used two milk replacer formulas – one a 27/17 (CP/fat) formula similar to commercial CMR formulas fed in the U.S. and the second a 27/31 formula designed to be similar to whole milk on a DM basis. The milk replacers were fed at either a fixed amount (681 grams/day) or a rate that varied from day to day, but averaged 681 grams/day over the week. Amount offered varied from 545 to 817 grams/day depending on the day of the week. Calves were fed a fixed DM percentage – 14.8%, so the amount of liquid calves received daily varied. However, each calf received the same amount of nutrients at the end of each 7-day period. Calves were weaned from milk on this study on day 28. Calves fed the Fixed rate of milk replacer (same amount of powder every day) grew faster (Table 2), ate more calf starter and were more efficient prior to weaning. Effects on starter intake and ADG were maintained even after weaning.

Microbial contamination and pasteurization

Waste milk is, by its nature, a variable commodity. The composition of nutrients may vary, but also the degree of microbial contamination due to mastitis and other organisms that may be passed from cow to calf by the product. Precautions for using unpasteurized waste milk were outlined by Elizondo-Salazar and Heinrichs (2007) and are outlined in Figure 1.

Pasteurization of waste milk is necessary. Waste milk may contain potentially infectious organisms. Waste milk has been implicated in the vertical transmission of numerous disease causing organisms, including *Cryptosporidium parvum*, *Mycoplasma bovis* and *Mycobacterium paratuberculosis* among others.

Pasteurization is a process whereby milk is heated to a defined temperature for a specific period of time to reduce microbial load. For example, a common on-farm pasteurization process (batch pasteurization) is to heat milk to 63-65°C and maintain the temperature for 30 minutes. High temperature / short-time pasteurization (71.7°C for 15 seconds) is also effective. When milk is pasteurized correctly, counts of potentially pathogenic bacteria are reduced, including *Mycobacterium paratuberculosis* (responsible for Johne's disease), Salmonella, and Mycoplasma (Butler et al., 2000; Stabel et al., 2004).

Research done in the late 1990's (Jamaluddin et al., 1996) reported that on-farm pasteurization reduced diarrhea and pneumonia and improved weight gains and using unpasteurized milk increased the risk of transmission of disease (Selim and Cullor, 1997). Of course, post-pasteurization handling of waste milk is essential. Pasteurization is not sterilization, and regrowth of bacteria is possible if the waste milk is stored for extended periods (Elizondo-Salazar et al., 2010).

Considerations for successful pasteurization procedures were published by Elizondo-Salazar and Heinrichs (2007) and are in Figure 2.

Not all research has shown benefit to pasteurizing waste milk. For example, Edrington et al. (2018) reported little difference between the prevalence of Salmonella in fecal samples from preweaned calves fed pasteurized or unpasteurized waste milk. A total of 68% and 69% of fecal samples collected tested positive for one of several species of Salmonella, respectively.

Aly and Thurmond (2005) reported that cows with seropositive mothers were 6.6x more likely to be infected (seropositive) compared with cows of seronegative dams. Further, the 84.6% of seropositivity was due to being born to a seropositive dam and 15.4% to other exposures such as flush water that contained feces of adult cattle and was fed to calves.

In the United States, the Department of Agriculture National Animal Health Monitoring System (NAHMS) evaluated calf feeding practices during a nationwide survey in 2014-2015 (Urie et al., 2018). The researchers determined the types of liquid fed to calves prior to weaning. The researchers reported that the most common liquid diet type was whole or waste milk, which represented 40.1% of all calves (n = 2,545), whereas 34.8% of calves received milk replacer only and 25.1% received a combination of the two. When expressed as percentages of operations, 43.3% of operations fed whole or waste milk, 38.5% fed milk replacer only, and 38.5% of operations fed a combination of the two. Of all operations that fed whole milk, waste milk or a combination of the two, 36.5% pasteurized the milk and 21.2% evaluated milk bacterial counts (Urie et al., 2018). Clearly, there is an opportunity to improve on-farm management of waste milk and to reduce the risk of disease transmission to preweaned calves.

Precautions for feeding raw waste milk

- Determine the health status of the cows in your herd. Do not feed raw waste milk if the cows are shedding organisms that cause disease, such as Johne's and bovine viral diarrhea. If you are aware of the disease status of your herd and you and your veterinarian agree, it may be acceptable to feed raw milk and limit risk by feeding only milk from test-negative cows. However, the risk remains that you may spread diseases that exist in the herd but are not identified.
- Do not feed waste milk to newborn calves on the first day of life. The intestinal wall is permeable to bacteria that could cause illness.
- House calves fed waste milk individually to prevent them from suckling one another. This should reduce the transmission of infectious microorganisms that cause mastitis. Maintain individual pens for a few weeks after weaning to reduce cross sucking at that time as well.
- Do not feed milk that is excessively bloody or has an unusual appearance since it can contain active pathogens and white blood cells, which are difficult for a calf to digest.
- Feed waste milk to herd replacements or to calves being kept at least eight to twelve weeks after the last feeding of waste milk.
- Use caution when feeding waste milk from antibiotic-treated cows to calves intended for meat production. Antibiotic residues from the milk could be deposited in the calves' tissues.

Figure 1. From: Elizondo-Salazar and Heinrichs, 2007

Waste milk supplementation

Although milk (whole or waste milk is normally considered a "perfect" food, there are some imbalances compared to published nutrient requirements (Table 3). In management schemes wherein calves are fed only limited amounts (400-500 g of DM/day) of milk for a short time (<42 days), the nutritional effects of these imbalances are usually limited. This is particularly true when calves are offered calf starter from an early age. However, more modern strategies of feeding greater amounts of milk for longer periods of time may exacerbate the nutritional deficiencies in waste milk.

Tips for pasteurization success

- Monitor pasteurizer function by routinely culturing samples of pasteurized milk.
- Train all employees that will be using the pasteurizer to be sure they understand how to operate the unit and what the concepts of pasteurization are.
- Conduct follow-up training and review for employees.
- Do not pasteurize extremely abnormal milk because nutritional characteristics may be altered.
- If calf death loss occurs, diagnose calf morbidities and mortalities.
- Know how to manually check the temperature of pasteurized milk to ensure proper temperatures are being met.
- Visit other operations successfully using on-farm waste milk pasteurization systems.

Figure 2. From: Elizondo-Salazar and Heinrichs, 2007.

Supplementing waste milk with vitamins and minerals, and changing the protein : energy ratio has been shown to improve growth and feed efficiency (Glosson et al., 2015; Figure 3). Several commercial products are available to change the protein : energy ratio (usually, increasing the amount of protein in the blend) and add essential vitamins and minerals. These products may also contain functional additives that support immune response (yeast components, antibodies, essential oils) and reduce the risk of disease.

Antibiotic residues

When waste milk is obtained from cows treated with antibiotics, the amount of antibiotic residue secreted into the waste milk may be high enough to exert an influence on the gut microflora, the calf, or both. A significant risk is the development of antibiotic resistant bacteria in the intestine of young calves fed antibiotic-containing waste milk.

A significant risk of using waste milk is the potential transmission of antibiotic residues that can cause antibiotic resistance in bacteria in the calves fed the waste milk. These antibiotic resistant bacteria will then be much more difficult to treat with available antibiotics and making on farm management much more difficult in general.

Recent evidence (e.g., Randall et al., 2014; Maynou et al., 2017) suggests that feeding waste milk fosters the presence of resistant bacteria in the lower gut and respiratory tracts of dairy calves. Thus, organizations in some parts of the world have recommended that waste milk containing antibiotic residues. For example, in the UK, the non-profit agricultural organization Responsible Use of Medicines in Agriculture Alliance recently published the following position statement regarding the use of waste milk on dairy farms:

"Waste milk (excluding colostrum) from cows under the statutory withdrawal period for antibiotics should not be fed to youngstock. Based on current evidence it is recommended that a practical solution for on-farm disposal is to dispose of waste milk in the slurry pit. RUMA encourages further research into disposal options to identify practical

alternatives and to gain a better understanding of any potential environmental interactions associated with disposal via this route." (https://www.ruma.org.uk/ruma-position-on-feeding-waste-milk-to-calves/).

The question of whether antibiotics in waste milk might affect rumen development or growth of calves was addressed by a manuscript by Li et al. (2019). The authors concluded that antibiotics in waste milk had no significant effect on growth of calves. However, there were changes in rumen microflora and rumen VFA concentrations in the rumen.

Item	Whole milk	Calf reqt.
Protein, g/kg	32	31
Fat, g/kg	40	28
Minerals, % DM		
Ca	0.95	1.0
P	0.76	0.70
Mg	0.10	0.07
Trace minerals, mg/kg DM		
Iron	3	100
Mn	0.3	40
Zn	15-38	40
Cu	0.1-1.1	10
I	0.1-0.2	0.5
Se	0.02-0.05	0.3
Vitamins, IU/kg DM		
A	11,500	9,000
D	300	600
E	8	50

Table 3. Comparison of composition of whole milk and NRC nutrient requirements for young calves (NRC, 2001).

Summary

Waste milk has been used for many years as a viable source of nutrition for young dairy calves. Although the nutritional content of waste milk often mirrors that of saleable milk, there are many risks associated with waste milk – namely, variation in nutrient content, potential pathogens, and antibiotic residues. Future use of waste milk may be limited, either by government regulation or consumer demand, to minimize the risk of developing more antibiotic resistant bacteria in the environment.
Pasteurization of waste milk is essential to reduce the risk of transmitting pathogenic organisms to calves.

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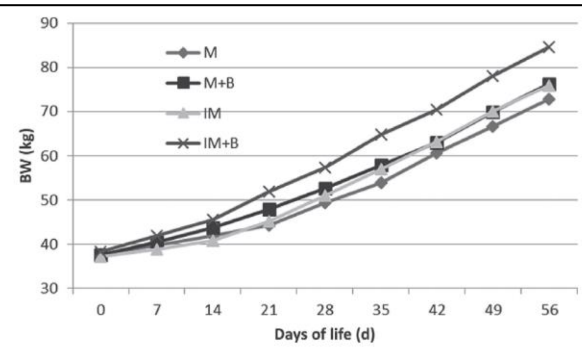

Figure 3. Body weight of calves fed 0.45 kg/d of milk DM without (M) or with (M+B) 0.23 kg/d of DM from milk balancer to 56 d, or 0.45 kg/d of milk DM to d 14, then 0.68 kg/d to d 49, then 0.34 kg/d to d 56 without (IM) or with (IM+B) milk balancer. From: Glosson et al., 2015.

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