



#### It All Starts on the Farm: Raw Milk Parameters that Impact Pasteurized Dairy Product Quality

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USDA

United States Department of Agriculture National Institute of Food and Agriculture

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### What happens on the farm <u>does not</u> stay on the farm

- Pasteurization is not a magic bullet high quality raw milk is essential to manufacturing high quality processed dairy products
  - · Not all farm factors impact finished product quality in the same way
  - Raw milk testing should focus on key factors that impact finished product quality

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# Somatic cells impact on finished product quality

- Somatic cells are white blood cells produced as an inflammatory reaction (i.e., mastitis), typically in response to a bacterial infection.
  - Variation in levels of somatic cells is also associated with stage of lactation, parity and other intrinsic factors
- US pasteurized milk ordinance (PMD) limit for somatic cell count (SCC) is 750,000 cells/mL
  - Average healthy, non-infected quarter SCC is 70,000 cells/mL
  - Benchmark of 200-250,000 cells/mL used for indicator of infection



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# Somatic cells impact dairy product yield and quality

- Increased SCC results reduced yield and in alteration of raw milk composition
  - Decreases in casein, lactose, and calcium
  - Increases in albumin, sodium, chloride and enzymes
- Enzymes released through the breakdown of somatic cells in raw milk
  - Plasmin heat stable protease

Constituent	Normal milk	High-SCC milk	Percent of normal
		%	
Solids-not-fat	8.9	8.8	99
Fat	3.5	3.2	91
Lactose	4.9	4.4	90
Total protein	3.61	3.56	99
Total casein	2.8	2.3	82
Whey protein	0.8	1.3	162
Serum albumin	0.02	0.07	350
Lactoferrin	0.02	0.1	500
Immunoglobulins	0.1	0.6	600
Sodium	0.057	0.105	184
Chloride	0.091	0.147	161
Potassium	0.173	0.157	91
Calcium	0.12	0.04	33

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## Factors affecting somatic cell count levels in raw milk







### Total bacteria levels in raw milk influence finished product

- **Title Blackrite Sy**unt (TBC) is also known as Standard Plate Count (SPC), Total Viable Count (TVC)
- PMD limit of 100,000 cfu/mL for individual producers and 300,000 cfu/mL for commingled raw milk
- 10,000 cfu/mL is achievable by most farms



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#### High levels of psychrophilic bacteria in raw milk can lead to

**enzyme production** 

- Some strains may produce enzymes at much lower levels (10,000 cfu/mL)
- Heat stable proteases and lipases produced by psychrophilic and psychrotolerant bacteria in raw milk lead to:
  - Reduced yield (estimates of 3-4%)
  - Flavor, odor and body defects







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Cow	and	farm	n lev	vel :	factor	rs
infl	luenc	cing	key	raw	milk	quality

Test Result	Natural Flora	Mastitis	Dirty Cows	Dirty Equipment	Poor Cooling
SPC>10,000	Not Likely	Possible	Possible	Possible	Possible
SPC>100,000	Not Likely	Possible (rare)	Not Likely	Possible (likely)	Possible (likely)
				Adapted from Mu	roby and Boor 2000

Adapted from Murphy and Boor, 2000

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### Raw milk handling factors influencing total bacteria counts

- Total bacteria count testing most often at the farm or upon receipt at the processing facility in order to ensure compliance with PMD limits
- Unlike somatic cells, which do not multiply in raw milk, bacterial contaminants in raw milk will continue to grow

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#### Raw milk handling factors influencing total bacteria counts

• Raw milk with acceptable bacterial levels upon leaving the farm or upon receipt at the processing facility may reach levels high enough to cause reduced yield and quality in finished products, especially if held under ideal conditions (e.g., for long periods of time or at abuse temperatures)

Best practices for ensuring acceptable levels of bacteria in raw milk to prevent affects on cheese yield and quality require testing for total bacteria levels prior to processing

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#### Spores: Defense strategies for harsh environmental conditions



- Endospores are formed under stressful environmental conditions
- Allow bacteria to persist in environments that would otherwise he lethal
  - Heat (pasteurization)
  - Drying (powders)
  - Radiation •
  - Sanitizers
- Under favorable conditions, spores return to a metabolically active state







# Mesophilic and thermophilic spores limit export opportunities

containinant	Range of limit (CFU)
Mesophilic plate count	Max : <5,000 to 10,000/g
Thermophilic plate count	Max: <5,000/g
Aerobic spore, mesophilic	<500 to <1,000/g
Aerobic spore, thermophilic	<500 to <1,000/g
Bacillus Cereus	Max: <100/g
Clostridium perfringens	Max: negative /0.1g
Sulfite reducing clostridia	Max: <10 to <25/g
Source: USDEC Table 2. Typical example of Spo	ore-Formers-Recombined and UHT for
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Source: USDEC Table 2. Typical example of Spc Export Contaminant Mesophilic plate count Thermophilic plate count	re-Formers-Recombined and UHT for Limit (CFU/g) <10,000 <5,000 to <10,000
Source: USDEC Table 2. Typical example of Spc Export Contaminant Mesophilic plate count Thermophilic plate count Carobic spore, thermophilic	unit (CFU/g)           <10,000
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Source: USDEC Table 2. Typical example of Spc Export Mesophilic plate count Thermophilic plate count Aerobic spore, thermophilic Thermoresistant spore count Source: USDEC	Limit (CFU/g)           <10,000



*B. licheniformis* is the most common sporeformer found in raw milk



Factors affecting presence and levels of spores in raw milk











### Forestripping is associated with lower bulk tank spore levels

- Physical removal of spores from teat canal prior to milking
  - Previous studies have shown that spore levels in the first streams of milk are higher than in subsequent milk
- Better stimulation leading to unimodal milk curve



Figure 2: Milk flow curve showing a unimodal milk let-down. The blue area under the curve illustrates the amount of milk harvested within the first two minutes (two minute milk; lb). The red lines indicate time in low flow (seconds below 2.2 lb/min flow rate). Note the difference in two minute milk, time in low flow and unit on time compared to the milk flow curve in Figure 1.

between different cow char-



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### Farm related flavor and odor defects affect finished product

**qualsiday**rs may originate from the farm environment

- Absorbed
- Bacterial
- Chemical
- Common defects include:
  - Barny
  - Cowy
  - Feed/Weed
  - Maltv
  - Oxidized
- Most raw milk sensory defects will carry over into finished products

Table 5.6 Feed flavors transmitted to milk in relation to the quantity of roughage and length of interval prior to milking

No.	Feed	Amount of feed (lb)	Interval before	Flavor of resulting mill
1	Alfalfa hay	2-6	2	Objectionable feed
2	Alfalfa hay	2-6	4	Occasional feed
3	Alfalfa hay	2-6	5	No criticism
4	Alfalfa silage	5	1	Definite feed
5	Alfalfa silage	15-25	11	No criticism
6	Clover hay	6	2	Pronounced feed
7	Clover hay	15-20	11	No criticism
8	Clover silage	5	1	Definite feed
9	Clover silage	15-20	11	No criticism
10	Green corn	25	1 .	Slight feed
11	Green corn	25	11	No criticism
12	Dry beet pulp	7	1	Slight feed
13	Oat hay	12	2	No criticism

From: Hedrick (1955)

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### Screening raw milk for flavor and odor defects

- · Incorporate periodic raw milk flavor and odor screening in your raw milk testing program
  - Annually, quarterly, monthly or more frequently depending on needs
  - Screen trucks and/or individual farm milk
  - Focus on attributes that originate at the farm
- Perform laboratory pasteurization (63°C/30m) and cool quickly prior to screening
- Screening should be performed by at least three trained individuals (in-house or outside experts)

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#### Summary

- High quality raw milk is critical to the production of high quality finished dairy products
- · Key raw milk parameters should be controlled, including
  - Somatic cell levels
  - Total bacteria levels, with a focus on psychrophilic bacteria
  - Spores
  - Flavor and odor defects
- Cow, farm and processing facility factors affect these parameters and should be optimized to ensure high quality finished products

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### Upcoming raw milk quality workshop

- Free two-part virtual workshop on the impact of organic raw milk quality on pasteurized dairy product quality
  - 2 hour self-paced "Raw Milk Quality 101"
  - 5 hour live-virtual "Farm Management for Producing High Quality Raw Milk" on December 16, 2021
- Topics covered will include:
  - Mastitis Management
  - Teat and Udder Health
  - Milking System Management
  - Housing area/Bedding factors

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Cornelicals College of Agriculture and Life Sciences Registration details coming soon through eOrganic listserve



