THE DAIRY PRACTICES COUNCIL®

GUIDELINE FOR
RAW MILK QUALITY TESTS

Publication: DPC021

APRIL 2021

Prior Version – March 2014

APPROVED COPY
EXCEPTIONS FOR INDIVIDUAL STATES NOTED IN TEXT OR FOOTNOTES
Additional Guidelines may be ordered from:
https://www.dairypc.org
evp@dairypc.org

Guideline Preparation and Review Process

Guideline development within Dairy Practices Council (DPC) is unique and requires several levels of peer review. The first step in the process of guideline development starts with a Task Force subcommittee comprised of individuals from industry, regulatory and education interested in and knowledgeable about the subject to be addressed. Drafts, referred to as 'white copies,' are circulated until all members are satisfied with the text. The final white copy may then be distributed to the entire Task Force, DPC Executive Vice President and whoever the Task Force Director feels would add to the strength of the review. Following final white copy review and correction, the next step in the process requires a yellow cover draft that is circulated to the member Regulatory Agency representatives that are referred to as "Key Sanitarians." The Key Sanitarians may suggest changes and insert footnotes if their state standards and regulations differ from the text. After final review and editing the guideline is distributed in the distinctive DPC green cover to people worldwide. These guidelines represent the state of the knowledge at the time they are written.

Disclaimer

The DPC is not responsible for the use or application of the information provided in this Guideline. It is the responsibility of the user to ensure that the information addresses their needs and that any action taken complies with appropriate regulations and standards.

TABLE OF CONTENTS

INTRODUCTION

Good quality raw milk is essential for the production of high quality dairy products with consumer acceptance. There are many factors that can influence the quality of raw milk, many of which are tested for by raw milk handlers. While odor, flavor, texture and appearance are considered the most important tests for food quality, these are directly or indirectly influenced by other factors that can also be evaluated or measured, such as holding temperature, adulteration, or microbial contamination and growth. Currently, raw milk tests required by state and federal regulatory agencies are limited to a few routine procedures with acceptable standards that may not be considered to be in the realm of "high quality." However, the dairy industry has recently taken the lead in demanding and paying for (i.e., premiums) higher quality raw milk with increased testing and standards that better reflect the overall quality of the raw milk and the production efforts of farmers/ producers.

This guideline will give an overview of the tests and procedures used by regulatory agencies and the dairy industry to evaluate raw milk quality such as, various microbiological methods (i.e., bacteria count procedures), herd health parameters (i.e., somatic cell counts), and adulteration and contamination (i.e., drug residues, water, sediment, etc.). For more specific information on laboratory procedures, most of the tests covered in this guideline can be found in the most recent edition of Standard Methods for the Examination of Dairy Products –(SMEDP- American Public Health Association). Where appropriate, the reader will be referred to other Dairy Practices Council (DPC) Guidelines, specific regulations cited in the most recent version of the Grade "A" Pasteurized Milk Ordinance (PMO) – Public Health Service/Food and Drug Administration (FDA), Publication 229) or to other sources of information.

A discussion of each quality test will include the purpose of the test and general procedures for performing the analyses, how product quality is influenced by the results, regulatory and recommended quality standards, and practical steps used to achieve compliance with these standards.

DEFINITIONS

SPC – Standard Plate Counts.

DMSCC – Direct Microscopic Somatic Cell Counts.

PMO – Pasteurized Milk Ordinance.

SPC – Standard Plate Count.

LPC – Laboratory Pasteurization Count.

PIC – Preliminary Incubation Count.

PAC – Petrifilm Aerobic Count.

PLC – Plate Loop Count.

VRBA – Violet Red Bile Agar.

NMC – National Mastitis Council.

FP – Freezing Point.

AOAC – Official Methods of Analysis of the Association of Official Analytical Chemists.

GUIDELINE CONTENT

High quality raw milk is required for high quality dairy products. Therefore, it is imperative that raw milk be produced and handled, from farm to plant, under conditions that do not alter its quality or consequently, the quality of the finished product. A number of quality tests are available to evaluate raw milk that includes microbiological, chemical and physical testing methods. This document described how to interpret the results of these tests and the practical implications of these quality parameters. Specific procedures for most of these tests can be found in the latest edition of Standard Methods for the Examination of Dairy Products and other referenced documents. This document also lays the groundwork for a number of other DPC Guidelines that give more detailed information on the specific milk quality areas covered.

Proper Mixing, Sampling, and Handling Of Raw Milk

Milk haulers are required to collect a representative universal sample at each farm when milk is picked up. Make sure that the contents of the bulk tank or tank truck have been thoroughly mixed immediately prior to sampling, to ensure that the entire contents are homogeneous at the time of sampling. The contents shall be mixed in a manner that is known to ensure homogeneity. When using an approved aseptic sampler, be sure it is working according to the manufacturers recommendations. Raw milk quality standards assume that test results are representative of the entire raw supply collected. A valid testing program must ensure that samples are taken and handled properly from initial collection until analyzed in the laboratory. This will ensure that a representative sample of the milk collected will reflect the quality and the conditions of milk production on the farm.

Samples must be taken under aseptic conditions and held between 0.0ºC – 4.5ºC (32ºF – 40ºF), without freezing, until used. Samples are required to be collected in clean, dry, sterile containers, using a sterile or sanitized sampling device (i.e., sterile straw or sanitized dipper). Single-service plastic sample vials are acceptable and most commonly used. Care must be taken not to contaminate the inside of the sample container, the collection device or the sample itself. Each sample container must be clearly identified with a waterproof label or marker.

Dippers carried in a sanitizer solution are typically used for collecting samples. The sanitizer solution must be of the proper strength, and the container must be taken into the milkhouse. When taking a sample, the dipper must be drained completely of sanitizer, then dipped in the milk and drained at least two times before taking the sample for testing. This will avoid water and sanitizer contamination of the sample. Sample vials generally have fill lines and should be filled 2/3's to 3/4 capacity. When sampling is complete, the dipper must be rinsed thoroughly before being returned to the sanitizer solution. Similar procedures are used when milk is received at the processing plant.

Once the sample is collected at the farm, it must be immediately placed in an ice and water mixture in an insulated case for transportation (i.e., stored in the truck's back compartment). During collection and transportation, samples must be suspended with the ice water level only slightly higher than the level of milk in the sample containers to prevent contamination of the sample. Racks or floaters should be used to hold sample vials in the ice water. Refrigeration packs in water may also be used provided they maintain the samples at 0.0ºC – 4.5ºC (32ºF – 40ºF). An extra sample must be collected at the first stop of each load, identified, and used as a temperature control. Each rack of samples must be identified, and the date and time of collection recorded. Temperature at the time of shipment and receipt (i.e., check temperature control) must be shown. On arrival to the lab, all samples must be stored under refrigeration, maintained at 0.0ºC – 4.5ºC (32ºF – 40ºF). Tank truck samples collected at receiving are generally tested immediately (i.e., drug residues) or placed in a laboratory refrigerator.[1]

Laboratory Testing Procedures

Following are overviews of a number of laboratory tests that are used to evaluate the quality of raw milk. These procedures require access to a well-equipped laboratory and trained, competent laboratory technicians. While it is required that some of the listed testing procedures (Standard Plate Counts (SPC), Direct Microscopic Somatic Cell Counts (DMSCC), and drug residue testing) be performed on a regular basis (i.e., PMO and State regulations), it is recommended that more extensive and more frequent quality monitoring be done. If testing is reduced or eliminated, there is the potential for quality to decline. The general quality tests available include the microbiological tests, somatic cell counts, and tests for adulteration or contamination.

Microbiological Tests

Bacteria and other microorganisms in milk are of primary concern as they are most often responsible for the deterioration of milk and dairy product quality. Also of concern is the potential presence of pathogens in the raw milk supply. When the numbers of microorganisms in raw milk are found to be high, they are generally an indication of poor production practices and/or milk handling procedures. Because raw milk can be stored for several days before processing, it is critical that levels of contamination be kept at a minimum, as spoilage bacteria have the potential to grow during storage prior to pasteurization. Heat resistant enzymes, produced by certain microorganisms during growth in raw milk, may continue to be active even after the milk is heat processed and the organisms are destroyed.

Microbial contamination of raw milk can occur by a variety of microorganisms; from a variety of sources, including inadequate cleaning, sanitizing and maintenance of milk handling equipment; poor pre-milking hygiene procedures; insufficient refrigeration; and in some cases mastitis. Because of this, determining the cause of bacterial defects is not always clear and straightforward. While high bacteria counts can result from one source, they often are the result of a combination of factors (i.e., dirty equipment and marginal cooling).[2]

The standard procedure for enumerating bacteria in milk is called the Standard Plate Count (SPC), which along with modifications of the procedure, is the only PMO required bacteria

[1] For more detailed information on proper milk collection and sampling procedures and requirements, refer to DPC050, *Farm Bulk Milk Collection Procedures*, DPC007, *Guidelines for Sampling Fluid Milk* or Appendix B of the PMO.

[2] For more detailed information on investigating high bacteria counts, refer to DPC024, *Guidelines for Troubleshooting On-Farm Bacteria Counts in Raw Milk*.

test for raw milk. In addition to the SPC, a number of other testing procedures may be used to evaluate the microbiological quality of raw milk, providing additional insight to farm practices. Alternative tests commonly used include the Preliminary Incubation Count (PIC), the Laboratory Pasteurization Count (LPC), the Coliform Bacteria Count and specific culturing methods. These tests generally select for bacteria that occur as contaminants that are not considered to be the natural flora in the animal's milk. Generally, elevated counts using any of these procedures would suggest that production practices and hygiene procedures on the farm are in need of improvement. A rapid method using the microscope (Direct Microscopic Count) is also routinely used, especially for screening incoming milk loads. An overview of these procedures follows.

Standard Plate Count (SPC)

The Standard Plate Count (SPC) is a determination of the number of "colony forming units" (cfu) in one milliliter (ml) of milk, which will form visible colonies when incubated for 48 hours at 32°C (90°F). Raw milk is generally diluted 1:100 and 1:1000 before mixing the sample in a "plate" (i.e., petri dish) with a nutrient agar that promotes bacterial growth, where individual bacteria or bacterial clumps suspended in the agar multiply to form visible colony forming units (cfu's). The cfu's are then visually counted on the plate. Diluting the sample allows for easier, more accurate counting. The Petrifilm Aerobic Count (PAC), a dehydrated plating system, is equivalent to the SPC procedure, again incubating for 48 hours at 32°C (90°F). While the SPC procedure requires two dilutions, there are two other acceptable alternative methods. The Plate Loop Count (PLC) as used with SPC or PAC is an acceptable alternative method, delivering a calibrated 0.001 ml or a 1:1000 dilution to be mixed with the SPC agar or deposited on a PAC plate using the same time and temperature of incubation. The other is the Spiral Plater that automatically dilutes the sample on the surface of an agar plate as it "spirals" from the center to exterior. In addition to the alternative plate count procedures used, the Bactoscan® (Foss Instruments) is an automated bacteria counting system that is approved for raw milk, providing counts in approximately 9 minutes using a flow cytometry technology similar to what is used for automated Somatic Cell Counts. A larger percentage of bacteria counts for producer samples are currently performed on Bactoscan® instruments.

Specific requirements are set forth in Sections 6 and 7 of the PMO regarding sampling and testing of raw milk for regulatory compliance. Most states require at least one such sample and analysis each month. Some cooperative, dealer and state quality control programs provide for twice a month or more frequent testing. The regulatory limit for SPC for producer raw milk is 100,000 cfu/ml while for commingled raw milk (i.e., tank-trucks) it is 300,000 cfu/ml. Recommended industry standards are generally 50,000/ml or lower.

The SPC gives an overall indication of the total bacteria present in a milk sample. When sanitation is good and cooling is adequate, bacteria counts of fresh producer samples are often less than 5,000/ml, and generally represent the natural flora of the animal's milk and minor levels of contamination. Under ideal conditions, counts can be less than 1,000/ml. Many dairy companies offer quality premiums for SPC's of less than 10,000/ml, which should be easily achievable for most farms. Counts in excess of 10,000 cfu/ml indicate that improvements in production and/or milk-handling practices are warranted.

In some cases, low SPC values do not correlate well with the actual sanitation conditions on farms. Prompt cooling of milk and other procedures may yield low counts, disguising unclean milking equipment or poor production practices. Several additional tests that give

insight to production conditions have been recommended and are routinely used in the dairy industry. These include the Preliminary Incubation Count (PIC), the Laboratory Pasteurization Count (LPC), and the Coliform Bacteria Count. More selective culturing procedures have also been found to be a useful tool, especially when mastitis is suspected as a source of high bacteria counts. For more detailed procedures see, FDA/NCIMS 2400a Series Forms.

Preliminary Incubation Counts (PIC)

The Preliminary Incubation count (PIC) is performed by "incubating" a milk sample at 12.8°C (55°F) for 18 hours, followed by the SPC procedure. This incubation temperature selects for bacterial contaminants in a sample that are capable of growth at cool temperatures, and is based on the theory that the natural flora of the animal's milk and most mastitis bacteria generally will not grow significantly at the PI temperature in 18 hours. The PIC should always be compared to a fresh SPC, and PIC results should be less than 3-4x the SPC. Desirable results are 25,000/ml or less. There is no legal limit, although values of 25,000 to 50,000/ml are often used as targets when the test is used in quality/testing programs. When the PIC is high compared to the fresh SPC, poor production practices, such as inadequate cleaning; omitted sanitization; poor udder washing procedures; or marginal cooling are indicated.

The bacteria that are most often associated with high PIC's are generally "psychrotrophic" in nature, that is, they are capable of growing at refrigeration temperatures (7.2°C/45°F or less). Psychrotrophic Bacteria Counts can be determined directly by plating samples by the same methodology as for the SPC but with incubation of the plates at 7°C for 10 days. A rapid, modified psychrotrophic count may also be made by following the same plating technique, but with the incubation at 21º C (70°F) for 25 hours (48 hours with Petrifilm). The most common psychrotrophic bacteria are capable of growing and increasing in numbers during prolonged refrigerated storage of raw milk, especially if temperatures are marginal. Generally, these bacteria do not survive pasteurization, but they may produce heat stable enzymes that may degrade dairy product quality.

Thermoduric Bacteria or Laboratory Pasteurization Count (LPC)

The Laboratory Pasteurization Count (LPC) is performed by heating the milk sample to 62.8°C (145°F) for 30 minutes (simulates batch pasteurization) followed by the SPC procedure. Samples are usually diluted 1:10 or 1:100 prior to plating. This procedure counts those bacteria that survive pasteurization. Although the SPC limit for pasteurized milk is 20,000/ml, there are no legal standards for thermoduric bacteria in raw milk. Levels in raw milk following laboratory pasteurization and in pasteurized milk should be less than 250-300/ml. The natural flora of the animal's milk and most mastitis bacteria generally do not survive pasteurization. Excessive LPC values have been associated with dirty equipment (especially areas that are persistently neglected in cleaning or often left insufficiently cleaned), old rubber parts, and poor pre-milking hygiene procedures. Generally, thermoduric bacteria do not grow or grow very slowly at proper refrigeration temperatures of 4.5º C (40°F) or less, although they may limit the extension of pasteurized milk shelf-life, especially if the milk is held at marginal refrigeration (i.e., 7.2°C or 45°F).

Coliform Bacteria Count

The Coliform Bacteria Count is performed by plating the sample on Violet Red Bile Agar (VRBA), which is a microbial growth medium that selects for coliform bacteria (i.e., it contains inhibitors that prevent most other bacteria from growing). Incubation is at 32º C (90°F) for 24 hours. Coliforms are associated with fecal and/or environmental contamination. Counts in raw milk produced under good production methods should be less than 50-100/ml, while counts of less than 25 should be easily obtainable. There are no legal limits for coliform bacteria counts for raw milk as defined under the PMO, although some states may have standards, especially if the milk is allowed to be sold for raw consumption (i.e., < 10/ml). Coliform organisms may comprise the dominant flora on the SPC, causing it to exceed 100,000/ml. This test may be used as an indication of production methods, since excessive levels have been associated with poor pre-milking hygiene, dropped milking units, dirty equipment, and, in some cases, with coliform mastitis.

Coliform counts are commonly used to check for contamination following thermal processing of pasteurized milk and dairy products. This group of bacteria does not survive pasteurization. While the legal limit in pasteurized milk is <10/ml, their presence at any level indicates post-pasteurization contamination. In pasteurized milk samples, coliform counts should be made using 1 ml of undiluted sample, plated with VRBA. After the plate solidifies, it should be overlaid with a second layer of VRBA to inhibit surface colony formation. The Petrifilm coliform count is an accepted alternative method.[3]

Blood Agar & Culturing Procedures

Blood agar (5% bovine blood, 0.1g/100 ml. of esculin, added to a soy-based agar) and other differential and/or selective media have long been used in identifying disease-causing organisms in milk. Blood agar and other medias have also been shown to be useful in identifying the causes of high bacteria counts. Unlike the SPC procedure, blood agar not only gives a relative count of how many organisms are present (quantitative results may vary), but can be used to characterize certain organisms based on blood hemolytic reactions, esculin hydrolysis and colony morphology. Knowing the type of organisms present is useful in identifying the source of problems on the farm (e.g., the source of Streptococcus agalactia, an organism associated with contagious mastitis that gives characteristic growth on blood agar, would most likely be an infected animal).

The test is performed by smearing or spreading a measured amount of milk sample over the surface of a blood agar plate, leaving a thin film, followed by incubation at 37°C (98.6°F) for 48 hours before being read. Using this agar as a characterization tool requires experience and a trained eye and it is strongly suggested to use a qualified laboratory.[4]

Titratable Acidity (TA) as an Indication of Bacterial Growth

The titratable acidity (TA) test has been used as an indirect method of indicating bacterial growth or possibly acid contamination. Lactic acid and other acid levels generally are increased in milk as the result of excessive growth of acid producing bacteria, especially

[3] For more detailed procedures see, FDA/NCIMS 2400a Series Forms.

[4] For information on organism identification, see the Laboratory and Field Handbook on Bovine Mastitis produced by the National Mastitis Council (NMC). Also refer to, DPC024, *Guidelines for Troubleshooting On-Farm Bacteria Counts in Raw Milk*.

when milk is improperly cooled. The TA of milk is determined using 0.1 N sodium hydroxide and is expressed as the amount of lactic acid in milk. Normal titratable acidities range from 0.13% to 0.17%. This acidity comes from the normal constituents of the milk and is directly related to the solids content of the milk. Milk that is high in solids will have a high titratable acidity, and may exceed the normal range.

Before rejecting milk based on the TA test, it is important that laboratories establish the normal acidity for each of their milk supplies. If the acidity is above what is considered normal, a direct microscopic count should be performed along with flavor and odor checks to determine the status of the milk. Generally, milk with a titratable acidity of 0.20% or less is acceptable, unless other test results indicate otherwise. Also, it should be noted that it is possible for milk to have odor, flavor and bacterial problems yet have the TA within the normal range.

Direct Microscope Methods

The Direct Microscopic Clump Count (DMCC) and the Direct Microscopic Somatic Cell Count (DMSCC) are determined by counting bacterial or somatic cells (following procedures set forth in Standard Methods for the Examination of Dairy Products) in a representative portion of 0.01 ml of milk smeared over 1 square centimeter, using a microscope of 1000x magnification. The milk smears are stained with a special milk stain, Levowitz-Weber mod. Newman-Lampert (LW/NL –Tetrachlorethane or LW/NL – Xylene) Stain or the Canadian modification (LW/NL – F) to facilitate counting of bacteria and somatic cells. Estimated counts are determined by using a "microscopic factor" based on the field of view of the microscope.

Direct Microscopic Clump Count (DMCC)

Although the sensitivity of the DMCC test is limited, it can be performed in less than 15 minutes. This test is routinely used to screen incoming milk supplies at dairy plants and can easily mark loads that are approaching the legal commingled limit of 300,000/ml. The test has also been used to rapidly identify individual producers with high counts and can sometimes lend insight into potential causes of bacterial problems based on bacterial shapes and configurations (i.e., pairs or chains of cocci may indicate cooling or sanitation problems). A DMCC should be performed regularly on samples from all loads of raw milk when received.[5]

Direct Microscopic Somatic Cell Count (DMSCC) and Abnormal Milk

Milk normally contains leucocytes (white blood cells) and other body tissue cells, collectively known as somatic cells. Somatic cells counts (SCC) may increase naturally during late lactation or due to aging, but most significant increases are the result of some form of udder infection (mastitis) or injury where somatic cells infiltrate the milk in the udder as part of the animal's immune response. Milk is considered "abnormal" when the number of somatic cells is excessive. While the legal limit under the PMO is 750,000 SCC/ml, counts in excess of 200,000 - 300,000/ml are considered to be above the level expected in a healthy herd. High numbers of somatic cells in bulk milk suggest mastitis

[5] For more information on bacteria in raw milk, refer to DPC024, *Troubleshooting On-Farm Bacteria Counts in Raw Milk.*

problems in a herd and may result in products of lower quality and yield. Premiums are often paid for milk with counts less than 200,000/ml.

Official determinations of SCC and abnormal milk are based on the DMSCC procedure or on results from one of several approved automated procedures. DMSCC is the reference method used to calibrate electronic cell counters. The National Mastitis Council (NMC) recognizes several rapid "screening" tests as valid procedures to estimate SCC in raw milk, though these are not considered “official regulatory tests.”

Because goats have a different physiology than cows, a special stain (Pyronin Y-Methyl Green) and DMSCC procedure is required to be used to determine the number of cells in milk from dairy goats when automated screening tests exceed the 1,500,000 SCC /ml limit. Sheep have a physiology similar to goats. The same SCC limit as used for cows does apply to sheep, although the Pyronin -Y- Methyl Green stain and DMSCC procedure is required for milk from dairy sheep when automated screening tests exceed 750,000.[6]

Other Measures of Adulteration or Contamination

Drug Residues, Antibiotics and Growth Inhibitors

Dairy animals are occasionally treated with antibiotics and other drugs to help cure or prevent certain diseases, including mastitis. If drugs are not administered properly or if the milk from treated animals is not withheld from the bulk tank for sufficient time, the potential for contaminating the milk supply exists. Drug residues, antibiotics and other microbial growth inhibitors found in milk samples have been defined as adulterants and thus are subject to penalty under existing law. Violators may be required to pay for milk loss, and may be subject to potential loss of market for stated periods, fines, or both. Milk found to be contaminated with drug residues cannot be marketed or purchased and must be disposed of in a manner acceptable to the regulatory agency.

Detection of antibiotics or other growth inhibitors in raw milk and other dairy products is made possible by validated growth inhibitor assays or by several rapid receptor based screening “kits” or procedures. Acceptable methods have been validated and approved by FDA and are listed in the most recent update of an FDA memorandum (M-a-85). Several available methods have been used successfully on the farm to prescreen treated animals or suspected contaminated tanks and are recommended. Under Appendix N of the PMO, it is required that all tank trucks be tested for Beta lactam drug residues before unloading/processing at receiving stations/plants and that if a load is confirmed positive, producer trace back testing must be performed. Individual producer samples are also routinely tested under Section 6 guidelines of the PMO.

Abnormal milk and residues of antibiotics and pesticides are illegal in milk from either goats or cows. Of immediate concern is the fact that few of the antibiotics approved for use in milking cows have been tested and approved for treating goats.

[6] For more detailed procedures for testing DMSCC see, FDA/NCIMS 2400d Form.
For help in correcting abnormal milk situations, refer to DPC018, *Fieldperson’s Guide to High Somatic Cell Counts*, DPC072, *Farmers Guide to Somatic Cell Counts in Goats*, and DPC071, *Farmers Guide to Somatic Cell Counts in Sheep*.

There are now rapid antibiotic tests available that have been tested using goat milk. Contact your local regulatory agency or milk handler for a current list of the approved tests.[7]

Added Water and Milk Freezing Point

Water added to milk, either at the farm, in transit or at the plant is considered adulteration. Added water dilutes the solids and the value of the milk and in some cases may contribute to microbial contamination. This might occur due to poorly drained milk handling equipment (i.e., pipes, tanks, trucks etc.) or in some cases by intentional addition. Added water can be detected by determining the milk freezing point (FP), which is considered relatively constant. The FP is generally determined by commercial milk "cryoscope" instruments that are found in most dairy laboratories. Because of the soluble components, such as lactose and salts, normal milk freezes slightly below the freezing point of pure water. Samples from loads, representing a number of herds, should give values between -0.540°H and -0.550°H (°H= Hortvet – a scale modified from Celsius used almost exclusively for milk FP - conversion factors may be found in Standard Methods for the Examination of Dairy Products.) Small amounts of added water dilute the soluble solids in milk causing the freezing point to move upward toward that of water. Determination of freezing points to detect added water should be made on all loads of milk received at a processing plant or receiving station.

Although most farm milks will have freezing points of less than –0.540°H, factors related to specific herds (i.e., nutrition) may result in higher than normal FP's. Natural low-solids milk may have higher freezing points, but in most cases will not cause a sample to be much above the normal range. Generally, FP readings above the average for a geographical area suggest that the milk contains some added water. Milk samples having a freezing point above -0.530°H to -0.525°H may be considered to be adulterated and thus subject to regulatory action. Where added water is suspected, a milking time inspection and sample retest are recommended. Start with an empty, well-drained system and test samples at the end of each milking. This is to ensure that the high FP determination was not the norm for the tested farm.[8] [9]

Sediment

Sediment levels in milk provide visual evidence of milk production practices and or the cleanliness of animals and surroundings and reflects that milk is becoming adulterated with these contaminants. Excessive levels result from dirty animals, poor pre-milking hygiene procedures and/or milking claw slippage. Sediment is determined by filtering a portion of milk by suction through a fine fiber filter. This simple inexpensive method of screening can be a valuable tool to the dairyman. The sediment collected on the filter is compared to visual standards with results reported in milligrams (mg) per gallon. This test is required for manufactured milk and by some states for fluid milk. Levels should be less than 1.0 mg

[7] DPC022, *Control of Antibiotics and Growth Inhibitors in Milk and Milk Products*, has been prepared to outline procedures for the detection of antibiotics and growth inhibitors in milk and other dairy products. Other useful references include Appendix N of the PMO and pertinent memorandums and updates issued by the FDA (available at http://www.fda.gov/Food/GuidanceRegulation/GuidanceDocumentsRegulatoryInformation/Milk/default.htm.

[8] For more detailed procedures see, FDA/NCIMS 2400n Series Forms.

[9] For more information on freezing point standards for small ruminant milk contact your local regulatory agency. Further discussion of added water and acceptable freezing points may be found in DPC017, *Prevention of & Testing for Added Water in Milk.*

per gallon of milk, although levels less than 1.50 mg may be accepted. Any milk sold to the consumer as raw should yield <0.5 mg per gallon sediment count.[10]

Pesticides and Chemical Contaminants

It is required that raw and pasteurized milk be free (i.e., below detection or established "safe" levels) of adulterants, including pesticides and other chemical contaminants. Adulteration of this nature has been rare and testing is done infrequently with the exception of routine pesticide testing done by state and federal laboratories. Most dairy labs are not equipped to run these types of tests. Testing for chemical contaminants in milk may be increased if warranted (i.e., contaminated feed discovered) or if contamination is suspected. In these situations, it is recommended that producers notify the regulatory authority as soon as possible, as consequences can be wide spread. Procedures outlined in the latest edition of Official Methods of Analysis of the Association of Official Analytical Chemists (AOAC International) should be followed.

REFERENCES

- Grade "A" Pasteurized Milk Ordinance, US Department of Health & Human Services, Public Health Service, Food & Drug Administration.
- Laboratory and Field Handbook on Bovine Mastitis, 1999. National Mastitis Council, Madison WI.
- Standard Methods for the Examination of Dairy Products, 17th Edition, 2004. American Public Health Association Publications, Washington D.C.
- Trouble-shooting sources and causes of high bacteria counts in raw milk, 2000. S. C. Murphy & K. J. Boor. Dairy Food & Environmental Sanitation 20:606-611.
- Official Methods of Analysis of the Association of Official Analytical Chemists, AOAC, International, Gaithersburg, MD, www.aoac.org.

APPENDIX

None.

[10] A complete discussion of testing procedures and a list of recommended practices can be found in DPC011, *Sediment Testing and Producing Clean Milk*.

CURRENT ACKNOWLEDGEMENTS

**This guideline was developed by contributors who are of experienced individuals in a related field(s). The acknowledged persons are included with their professional affiliations and may be contacted via a DPC Officer(s) and/or Task Force Director(s) for questions or concerns.*

Officers

Name	Position
Chris Hylkema	President
Keith Hay	Vice President
Mary Wilcox	Executive Vice President

Task Force Director

Jessica Smith, Laboratory and Quality Control Procedures Task Force

Lead Author(s)

Jessica Smith, USDA-FMMA

Contributor(s)

- Carli Peskar *(USDA-FMMA)*
- Mary Wilcox *(DPC-EVP)*

HISTORICAL ACKNOWLEDGEMENTS

Version(s)

March 2014

- Wendy Landry *(HP Hood)*
- Scott MacKenzie *(Nova Scotia Dept. of Ag.)*
- Pat Healy *(USDA-FMMA)*

April 2003

- Rebecca Piston *(Garelick Farms)*
- Robert Kiser *(University of Kentucky)*
- Fran Matusiak *(Meadowbrook Dairy)*
- Steven Murphy *(Cornell University)*
- Ruth Riner *(Upstate Farms)*
- Dan Scruton *(Vermont Dept. of Ag.)*
- Sally Stephenson *(MMPA)*
- Kelly Wedding *(USDA-FMMA)*

September 1991

- Rebecca Piston *(Cabot Farmer's Coop Creamery)*
- Jeffrey Bloom *(Environmental Systems Service)*
- Laurie Justis *(Vermont Dept. of Ag., Food & Markets)*
- Sidney E. Barnard *(The Pennsylvania State University)*
- Patrick J. Cleary *(St. Albans Coop Creamery)*
- Dr. J. Russell Bishop *(Virginia Tech.)*
- Susan Duncan *(Virginia Tech.)*

July 1984

- Sidney E. Barnard *(The Pennsylvania State University)*
- Albert F. Zimmermann *(QC, Inc.)*
- Dr. Henry V. Atherton *(University of Vermont)*
- Dr. Charles Livak *(QC, Inc.)*

August 1976

- Dr. Charles Livak *(Penn Dairies, Chairman)*