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Correlation between standard plate count and somatic cell count milk quality results for Wisconsin dairy producers

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ABSTRACT

The objective of this study was to determine if a correlation exists between standard plate count (SPC) and somatic cell count (SCC) monthly reported results for Wisconsin dairy producers. Such a correlation may indicate that Wisconsin producers effectively controlling sanitation and milk temperature (reflected in low SPC) also have implemented good herd health management practices (reflected in low SCC). The SPC and SCC results for all grade A and B dairy producers who submitted results to the Wisconsin Department of Agriculture, Trade, and Consumer Protection, in each month of 2012 were analyzed. Grade A producer SPC results were less dispersed than grade B producer SPC results. Regression analysis showed a highly significant correlation between SPC and SCC, but the R^2 value was very small (0.02–0.03), suggesting that many other factors, besides SCC, influence SPC. Average SCC (across 12 mo) for grade A and B producers decreased with an increase in the number of monthly SPC results (out of 12) that were ≤25,000 cfu/mL. A chi-squared test of independence showed that the proportion of monthly SCC results >250,000 cells/mL varied significantly depending on whether the corresponding SPC result was ≤25,000 or >25,000 cfu/mL. This significant difference occurred in all months of 2012 for grade A and B producers. The results suggest that a generally consistent level of skill exists across dairy production practices affecting SPC and SCC.
Key words: milk, standard plate count, somatic cell count, milk quality

INTRODUCTION

In the United States, SPC and SCC are 2 bulk tank milk tests recommended by the Pasteurized Milk Ordinance (US Department of Health and Human Services, 2011) and mandated by statutes or regulations in each state, including Wisconsin (Wisconsin Administrative Code, 2013), for determining unpasteurized milk quality. The 2 tests measure very different things and each can be affected by multiple facets of dairy farm management. In the current study, we tested the hypothesis that a strong correlation exists between SPC and SCC results for Wisconsin dairy producers, perhaps indicating that these dairy producers have a generally consistent level of skill across the spectrum of practices affecting SPC and SCC.

The Pasteurized Milk Ordinance sets the SPC limit for grade A milk at 100,000 cfu/mL and the SCC limit at 750,000 cells/mL. Wisconsin regulations have the same limits. Grade A milk can be used in interstate commerce for the production of milk and specified milk products. All states, including Wisconsin, are allowed to set their own microbiological standards for non-grade A (grade B) milk that is converted to cheese or other grade B products. In Wisconsin, the microbiological standards for grade B fluid milk are specified in regulations (Wisconsin Administrative Code, 2013) enforced by the Wisconsin Department of Agriculture, Trade, and Consumer Protection (**WDATCP**). The current Wisconsin grade B milk limits for SPC and SCC are 300,000 cfu/mL and 750,000 cells/mL, respectively.

During every month that a licensed Wisconsin dairy plant operator receives grade A or B milk shipments from a dairy producer, the dairy plant operator must report to WDATCP the results of at least 1 SPC or plate loop count test and 1 SCC test performed on milk obtained from the producer (Wisconsin Administrative Code, 2013). The federal government, by the action of Federal Milk Marketing Orders, authorizes the use of penalties and premiums based on microbiological milk quality in Wisconsin and some other states. Dairy processors may also promote improved milk quality by the use of SPC- or SCC-linked premium systems (Smith, 1996).

Microbiological raw milk quality, as measured by SPC and SCC, has a direct effect on the quality of several final milk products (Barbano, et al., 2006). Standard plate count measures the total number of mesophilic aerobic and facultatively anaerobic bacte-

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ria capable of growth on a nonselective bacteriological medium. A high SPC result can be caused by excessive milk contamination or inadequate milk refrigeration that allows bacterial growth, both of which adversely affect milk quality and safety. Many types of bacteria found in unpasteurized milk produce proteases and lipases that catalyze the hydrolysis of proteins and lipids, respectively, and thereby produce a variety of compounds, which can have detrimental effects on the flavor of milk and milk products. Some bacterial proteases and lipases are heat-stable, meaning that they can cause quality problems even after pasteurization has killed the bacteria that produced these enzymes. For example when the numbers of some bacteria, especially psychrotrophs, exceed 10^6 cfu/mL, heat-stable extracellular lipases are produced in quantities sufficient to cause off-flavors, which become increasingly noticeable during the shelf-life of pasteurized milk. Similarly, some spore-forming bacteria, such as *Bacillus* spp., produce heat-stable phospholipases that can cause a postpasteurization defect known as “bitty cream” (Marth and Steele, 2001).

Reducing the extent of bacterial contamination and growth is also important in ensuring that milk and milk products are safe to consume. Pathogenic bacteria, such as *Escherichia coli* O157:H7, *Salmonella* spp., and *Listeria monocytogenes*, are reportedly found in a small, but important, percentage of bulk tank milk samples (Oliver et al., 2005). Pasteurization is intended to destroy foreseeable levels of these bacteria but it does not destroy heat-stable enterotoxin(s), which may be produced by *Staphylococcus aureus* if the milk storage temperature is suitable (10–48°C; International Commission on Microbiological Specifications for Foods, 1996). Adequate refrigeration is important for safety because it precludes production of staphylococcal enterotoxin(s); it also increases the likelihood that vegetative pathogens do not grow to population levels that cannot be eliminated by proper pasteurization. The production of low-SPC milk clearly is desirable for reasons of milk safety and quality.

The SCC test is an indicator of whether milk has been collected from mastitic cows and is often viewed as an indicator of general milking herd health. Mastitis, frequently cited as one of the most costly dairy cattle diseases (Sharma et al., 2011; NMC, 2013), is an infection in which microorganisms can damage the cow’s mammary epithelial cells, thereby causing decreased milk production and leakage of blood components into the milk. In severe cases, alveolar atrophy can occur. Milk loss resulting from this atrophy is permanent.

Mastitis can be either clinical or subclinical. Symptoms of clinical mastitis are clearly visible. Some common causes of clinical mastitis are *Streptococcus dysgalactiae*, *Streptococcus uberis*, and coliform bacteria, including *E. coli*, *Klebsiella* spp., and *Pseudomonas* spp. (Anderson et al., 2001a,b,c). Subclinically infected quarters appear normal. Microorganisms associated with subclinical mastitis include *Staph. aureus* and *Streptococcus agalactiae* (Anderson et al., 2001a,b,c). Milk from mastitic cattle can contain high levels of the causative bacteria. Marth and Steele (2001) described infected cows shedding *Strep. uberis* and *E. coli* in milk at levels of up to 10^7 and 10^8 cfu/mL, respectively.

As the number of microorganisms associated with the mastitic infection increases, a larger number of somatic cells, especially leukocytes, accumulate at the site of infection. Leukocytes engulf and enzymatically destroy invading microorganisms. Whereas the SCC for milk from a healthy udder can reportedly vary from 50,000 to 200,000 cells/mL (Schepers et al., 1997; NMC, 2013), cases of clinical mastitis can result in SCC counts of 1,000,000 cells/mL or more (University of Guelph, 2013).

Defects associated with milk from mastitic cows include reduced fat content, increased chloride ion concentration, a significant decrease in lactose, and a greater likelihood of lipolysis and other reactions that result in undesirable flavor. Cheese-making can be negatively affected by high-SCC milk, with reported defects including reduced curd firmness, lower cheese-making yield resulting from increased casein and fat loss in whey, and sensory defects (Barbano et al., 2006). The employment of practices resulting in low-SCC milk will benefit the dairy producer and the dairy processor.

Microorganisms associated with decreased microbiological milk quality, as evidenced in high SPC or SCC, are prevalent in the environment of even the best managed dairy farm and can contaminate milk via the udder, the environment external to the milking equipment (manure, feed, soil, and so on; Marth and Steele, 2001), the milking equipment (Murphy and Boor, 2000), or milking personnel. The strategies used by a dairy producer to minimize contamination from these sources are diverse. For example, udder-related contamination may be reduced by premilking teat disinfection, discarding milk from infected quarters, administering medication to a mastitic cow and discarding that cow’s milk, or culling the cow from the herd. Equipment-related contamination may be decreased by cleaning and sanitizing the equipment between milkings, or upgrading to equipment of better sanitary design.

The hypothesis tested in the present study is that a strong correlation exists between SPC and SCC results for Wisconsin dairy producers, which may indicate that skilled dairy producers in Wisconsin tend to use SPC- and SCC-reducing management strategies equally effectively. Recent work by Guo (2011) indicated that no