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Comparison of bulk-tank standard plate count and somatic cell count for Wisconsin dairy farms in three size categories

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ABSTRACT

The objective of this study was to evaluate possible claims by advocates of small-scale dairy farming that milk from smaller Wisconsin farms is of higher quality than milk from larger Wisconsin farms. Reported bulk tank standard plate count (SPC) and somatic cell count (SCC) test results for Wisconsin dairy farms were obtained for February to December, 2008. Farms were sorted into 3 size categories using available size-tracking criteria: small (≤118 cows; 12,866 farms), large (119–713 cattle; 1,565 farms), and confined animal feeding operations (≥714 cattle; 160 farms). Group means were calculated (group = farm size category) for the farms' minimum, median, mean, 90th percentile, and maximum SPC and SCC. Statistical analysis showed that group means for median, mean, 90th percentile, and maximum SPC and SCC were almost always significantly higher for the small farm category than for the large farm and confined animal feeding operations farm categories. With SPC and SCC as quality criteria and the 3 farm size categories of ≤118, 119 to 713, and ≥714 cattle, the claim of Wisconsin smaller farms producing higher quality milk than Wisconsin larger farms cannot be supported.
Key words: standard plate count, somatic cell count, farm size

INTRODUCTION

In Wisconsin, dairy processing plants must test bulk tank milk from each dairy producer supplying them, and report at least one SPC and one SCC result each month to the state regulatory authorities (Wisconsin Department of Agriculture, Trade and Consumer Protection, 2008). The bulk-tank SPC for grade A milk cannot exceed 100,000 cfu/mL. Wisconsin grade B milk cannot have bulk tank SPC greater than 300,000 cfu/mL (Wisconsin Department of Agriculture, Trade and Consumer Protection, 2008). Higher SPC values trigger a range of regulatory responses, including permit suspension, and are likely caused by lapses in sanitation or inadequate refrigeration. The maximum SCC level allowed for grade A or grade B bulk tank milk is 750,000 somatic cells/mL; SCC values above the maximum also lead to a variety of regulatory actions that may include permit suspension. The SCC of bulk tank milk is often used as a measure of mammary disease or mastitis in a dairy herd, and has been proposed for use in statistical process control as an indicator of ongoing herd health (Lukas, et al., 2005). A study of Wisconsin dairy herds enrolled in a milk quality improvement program found that bulk-tank SCC was positively associated with bulk tank SPC, estimated rate of clinical mastitis, prevalence of subclinical mastitis, number of cows culled for mastitis, and estimated financial losses attributable to mastitis (Rodrigues et al., 2005). Another study of Wisconsin herds found that the rate at which milk contained antibiotic residues increased as the SCC class (ranging from ≤250,000 to >700,000 cells/mL) increased (Ruegg and Tabone, 2000). The SCC of a farm's bulk tank milk may also be related to overall farm hygiene and upkeep. A recent study of on-site dairy farm inspection and laboratory milk testing results in Wisconsin showed that the rate at which monthly bulk-tank milk samples failed to meet the grade A SCC limit was linked to an increased likelihood of failing an on-site dairy farm inspection (Ingham et al., 2010). On-site dairy farm inspections include evaluation of the cows, milk house, and barn for cleanliness, and observation of the condition and the sanitary upkeep of the milking equipment (Wisconsin Department of Agriculture, Trade and Consumer Protection, 2008). Collectively, the SPC and SCC for bulk tank milk are widely viewed as an indicator of dairy farm sanitation and animal-handling practices, and can be used by processors and consumers as indicators of milk quality.

Some consumers believe that small-scale dairy farms produce milk that is of higher quality than the milk produced by large-scale farms. Although the term quality is subjective and multi-faceted, bulk tank SPC and

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SCC can be used as 2 measures of quality. Advocates for small-scale dairy operators may believe that these farmers have a greater stake in successful farm operation than do operators of large-scale farms and will, thus, take greater care to hygienically collect milk and refrigerate it. Small-scale dairying supporters may also assert that dairy cows are less likely to be intensively milked on small-scale farms, will be less likely to contract mastitis, and thus, will produce milk with a lower SCC.

Opponents of these views may state that large-scale dairy operations are more likely to expend the resources necessary to purchase the most effective sanitation and refrigeration equipment, which, when used correctly, will lead to lower SPC. Opponents may also state that the negative consequences of mastitis in a large herd provide a financial incentive to rapidly remove infected cows from the herd and treat them before their milk is collected in the bulk tank. The possibility also exists that larger herd sizes allow the milk from a small proportion of mastitic cows to be diluted such that the bulk tank SCC remains low.

The present study was conducted to investigate existing SPC and SCC data and determine whether the average minimum, median, mean, 90th percentile and maximum levels of SPC and SCC differ between Wisconsin farm size categories.

MATERIALS AND METHODS

Source of Data

Wisconsin food safety regulatory authorities do not collect information on the milk output from each dairy producer. However, dairy farm inspectors do note on their reports when a producer's output is more than 2,944.5 kg/d (6,500 lb/d). The average daily milk production on Wisconsin dairy farms is 25.0 kg (55.2 lb)/cow, so 2,944.5 kg/d represents the output from about 118 average cows—somewhat higher than the most recently reported average dairy farm size in Wisconsin (95.5 cows; USDA, 2010). In the present study, farms with production below the 2,944.5 kg/d level were categorized as small. A database of all dairy producer license numbers, along with monthly SPC and SCC results for each license-holder during February to December, 2008, was obtained from the Wisconsin Department of Agriculture, Trade and Consumer Protection (Madison). Wisconsin dairy farms with at least 714 cows must be issued a Confined Animal Feeding Operation (**CAFO**) permit by the state natural resources regulatory agency. In this study, dairy producers with ≥714 cattle were placed in the CAFO category. A list of CAFO dairy operations was obtained from a Wisconsin Department of Natural Resources Web site (http://dnr.wi.gov/runoff/agriculture/cafo/permits/cafo-all.asp). Dairy producers with an output of more than 2,944.5 kg/d, but who did not hold a CAFO permit were categorized as large. Monthly SPC and SCC results for each farm in the small, large, or CAFO size categories were extracted from the all-farms database described earlier. In total, 12,866 small farms, 1,565 large farms, and 160 CAFO farms were evaluated. The SPC and SCC results were obtained from analyses done in licensed laboratories using methods approved by the US Food and Drug Administration (US FDA, 2011).

Statistical Evaluation of Data

The minimum, median, mean, 90th percentile, and maximum values were calculated for the ≤11 SPC and for the ≤11 SCC results obtained for each farm. Group means were calculated, with group mean defined as the average minimum, median, mean, 90th percentile, or maximum for SPC or SCC for a given farm size category.

To detect statistically significant differences between farm size categories, the SPC and SCC values were log transformed, because the original data value distributions were strongly skewed with unequal variances across groups. Even after log transformation, the SPC and SCC values were still quite non-normally distributed and had unequal variances across groups. Therefore, each variable listed in Table 1 was analyzed using the nonparametric Kruskal-Wallis rank sum test, to detect overall differences among groups. Pairwise comparisons between groups were then conducted by using the Wilcoxon rank sum test with a Bonferroni correction, which consisted of comparing P-values to the corrected standard of 0.05/3 or 0.017. Results obtained using one-way ANOVA and Tukey pairwise comparisons on the log-transformed values were qualitatively similar to those obtained using the Kruskal-Wallis rank sum test and Wilcoxon and Bonferroni analyses.

RESULTS AND DISCUSSION

SPC Group Means

The group means for mean and median SPC, as well as for mean and median SCC, were well below the grade A maximum values (Table 1). The group means for mean SPC were about 58,700, 36,300, and 35,000 cfu/mL, respectively, for the small, large, and CAFO farm size categories. The group means for median SPC were 31,300, 26,000 and 25,400 cfu/mL, respectively, for the