Canadian National Dairy Study: Herd-level milk quality

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ABSTRACT

The objective of this study was to estimate Canadian national milk quality parameters and estimate the bulk tank milk (BTM) prevalence of 4 mastitis pathogens, *Staphylococcus aureus*, *Streptococcus agalactiae*, *Mycoplasma bovis*, and *Prototheca* spp., on Canadian dairy farms. A questionnaire was sent to all Canadian dairy producers. Of the 1,062 producers who completed the questionnaire, 374 producers from across the country were visited and milking hygiene was assessed. Farm-level milk quality data for all Canadian dairy producers was collected from the provincial marketing boards and combined with the questionnaire and farm visit data. In addition, a BTM sample was collected either during the farm visit or by the marketing board in November of 2015 and was tested for 4 major mastitis pathogens using the PathoProof Mastitis Major 4 PCR Assay (Thermo Fisher Scientific Inc., Waltham, MA). Apparent herd-level prevalence was 46% for *S. aureus*, 6% for *Prototheca* spp., 0% for *M. bovis*, and 0% for *Strep. agalactiae*. Due to the low prevalence of *M. bovis* and *Strep. agalactiae* and a lack of significant factors associated with farms testing positive for *Prototheca* spp., an association analysis could only be carried out for *Staph. aureus*-positive farms. Factors associated with *Staph. aureus*-positive farms were not fore-stripping cows before milking (odds ratio = 1.87), milking with a pipeline system (odds ratio = 2.21), and stall bases made of a rubberized surface (mats and mattresses), whereas protective factors were using blanket dry cow therapy (odds ratio = 0.49) and applying a tag or visible mark on cows known to have chronic mastitis infections (odds ratio = 0.45). The Canadian national production-weighted geometric mean somatic cell count was determined to be 208,000 cells/mL. This is the first national dairy study conducted in Canada. Participating farms had higher milk yield; were more likely to have a loose housing system, parlor, or automated milking system; and had lower weighted mean BTM somatic cell count than the national level. Sampling larger farms with better milk quality means the apparent prevalence of the 4 mastitis pathogens likely underestimates the true levels.
Key words: Canada, *Staphylococcus aureus*, somatic cell count, mastitis, milk quality

INTRODUCTION

Analyzing bulk tank milk is a convenient and inexpensive method of monitoring milk quality and the presence of some pathogens in dairy cattle herds. Measuring bulk tank milk (**BTM**) SCC and the ability to detect the presence of bacterial pathogens (through culture or PCR-based methods) can identify herds with a high prevalence of cows with mastitis that may be caused by equipment issues, hygiene, or both. Repeated monitoring of bulk tank samples over time can also be used to evaluate the effect of implemented management and policy changes (Cook, 2007). Usefulness of BTM SCC also increases when benchmarks are available (i.e., national provincial and herd size-specific values) as it provides further motivation for change (Ritter et al., 2017).

However, establishing an accurate national benchmark for BTM SCC is contingent on the availability of the data. In most Canadian provinces, although BTM SCC is determined on a representative sample of BTM that is picked up from each herd by the provincial marketing boards, these data are confidential and reside with the boards. Only some boards report a monthly provincial average SCC, and when they do, some report a production-weighted arithmetic mean (**aSCC**) whereas others report an unweighted aSCC. Therefore, it is not possible to calculate an accurate national average based on this lack of uniform data. In addition, the recent trend in the dairy industry is to calculate geometric mean BTM SCC for each herd (**BTM**

gSCC) as this is less influenced by incidental spikes in SCC than arithmetic means (Schook and Ruek, 1999). Epidemiological attempts at estimating the Canadian BTM gSCC have been limited regionally (Reyher et al., 2011) or based on SCC data obtained confidentially from milk recording agencies (Olde Riekerink et al., 2010; Reyher et al., 2011). Given that only 67 to 75% (Olde Riekerink et al., 2010) of dairy farms in Canada are a DHI participant, these estimates may be biased. Calculating a true national BTM gSCC would require obtaining a complete data set of SCC from all producers which is logistically challenging and has not been available to date.

Obtaining national benchmark data on the prevalence of mastitis pathogens (*Staphylococcus aureus*, *Prototheca* spp., *Streptococcus agalactiae*, and *Mycoplasma bovis*) has also been challenging. Previous studies have either been limited by their regional nature (Olde Riekerink et al., 2006; Francoz et al., 2012), used convenience sampling (Olde Riekerink et al., 2008), or lacked representation of producers not participating in DHI (Reyher et al., 2011). The concern with these studies is that the methods used to sample herds might be subject to selection bias causing the reported values to be underestimated (Reyher et al., 2011). It has been difficult to compare these values to other countries such as the ones conducted by the National Animal Health Monitoring System (**NAHMS**) where national dairy studies, such as NAHMS, are conducted regularly. It therefore became a priority for the Canadian dairy industry to conduct a comprehensive national dairy study that randomly sampled a subset of producers from all regions of the country and did not rely only on accumulating production data from milk recording agencies to provide national benchmarking data. The objectives of this study were therefore to (1) estimate the national BTM gSCC, (2) determine the bulk tank prevalence of *Staph. aureus*, *Strep. agalactiae*, *M. bovis*, and *Prototheca* spp., and (3) identify factors associated with farms testing positive for these mastitis pathogens.

MATERIALS AND METHODS

Questionnaire Design

A cross-sectional study of the Canadian dairy cattle industry was conducted in 2 parts: phase I, a comprehensive questionnaire administered between March 1 and April 30, 2015, followed by phase II, a farm visit to a sub-sample of questionnaire respondents that occurred between May 10 and August 30 of the same year.

Prior to undertaking the study, a collaborative research team was assembled with representatives from the 5 veterinary colleges in Canada. The main areas of focus for the questionnaire were obtained from a Priority Assessment of Canadian dairy industry stakeholders conducted in 2014 (Bauman et al., 2016). Questions were formulated to address the top 5 management and disease priorities for each stakeholder group from the assessment and were then modified upon comparison with questions from the most recent NAHMS dairy study and consultation with Canadian dairy researchers with overlapping interests and concurrent research projects funded under the Dairy Farmers of Canada Cluster 2 initiative. The initial questionnaire was 49 pages and consisted of 242 questions. Questions were initially written in English and translated to French by a bilingual representative of a provincial dairy organization. To ensure the questionnaire was relevant, nonrepetitive, concise, and easy to understand, the questionnaire was provided to a 16-person advisory group developed for this project. The group consisted of 2 dairy producers, 1 government representative, and 1 veterinarian from each of the following regions: Western provinces [British Columbia (**BC**), Alberta (**AB**), Saskatchewan (**SK**), and Manitoba (**MB**)], Ontario (**ON**), Québec (**QC**), and the Eastern provinces [Prince Edward Island (**PE**), Nova Scotia (**NS**), New Brunswick (**NB**), and Newfoundland (**NL**)].

The advisory group provided feedback with regards to questions to keep, remove, and modify to improve clarity. The feedback assisted in the final formulation of a questionnaire consisting of 189 questions on 42 pages. The questionnaire format breakdown was as follows: 76 (40%) multiple-choice questions with single-answer option (14 had an open-ended text entry option), 40 (21%) multiple-choice questions with multiple-answer option (27 had an open-ended text entry option), 26 (14%) matrix tables, 6 (3%) slider scales (participant provides their response to a question on a sliding scale), 25 (13%) open-ended text entry, 3 (2%) drop-down menus, and 13 (7%) constant sum questions (entries must total up). At the end, participants were asked if they would participate in a farm visit if they were selected. The final version of the questionnaire was pre-tested by 5 bilingual dairy stakeholders to confirm the context of the questions was consistent in both languages. The English version of the questionnaire is available in Supplemental File S1 (https://doi.org/10.3168/jds.2017-13336).

Ethics approval for human participants was received from each participating school: University of Calgary (REB#14–2481), University of Guelph (REB#14DC025), Université de Montréal (15–007-CE-RES-D), and the University of Prince Edward Island (REB#6006095). The questionnaire was formatted for online use with the Qualtrics platform (https://www