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Manageable risk factors associated with bacterial and coliform counts in unpasteurized bulk milk in Flemish dairy herds

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ABSTRACT

Associations between herd management practices and both bacterial counts (BC) and coliform counts (CC) from 254 and 242 dairy herds in Flanders (Belgium), respectively, were studied. Data were analyzed using multivariable, multilevel linear regression analysis, allowing variance components analyses. Both BC and CC fluctuated throughout the year, although the milk quality parameters followed an opposite pattern. Bacterial count values decreased with each increase of the cleaning frequency of the cubicles (once per week, once per day, twice per day, or more than twice per day) between January and March. Herds with a conventional milking parlor had substantially lower BC than herds where the cows were milked using an automatic milking system. Lower BC were observed when the milking parlor was equipped with an automatic cluster removal system, when premilking teat disinfection was applied, when the dry cows were supplemented with a mix of minerals and vitamins, and when the teats were prepared either first wet and dried or via an automatic milking system. Milking cows with a high-pipeline milking parlor setup or with an automatic milking system was associated with substantially higher CC values. Herds where prepartum heifers were often treated with antimicrobials before calving had a lower CC than farms where heifers were either not or only rarely treated. Most variation in BC and CC resided at the herd level rather than at the observation level, indicating that management is important in the control of both BC and CC. Still, only a small proportion of the total variance was explained by factors capturing information related to the milking, herd health, and dry cow management, which suggests that the bacteriological milk quality and, in particular, CC is primarily driven by other factors than the ones included in this study.

Key words: bacterial count, bulk milk, coliform count, dairy herd, management practice

INTRODUCTION

High bacterial levels in milk, whether originating from the cow or the environment, substantially affect the quality, safety, and consumer acceptance of milk and dairy-derived products. Some bacteria found in unpasteurized milk such as *Staphylococcus aureus*, *Escherichia coli*, *Listeria monocytogenes*, *Campylobacter jejuni*, *Mycobacterium tuberculosis*, and *Salmonella* spp. pose a potential risk for human health (Gilmour and Rowe, 1990; Murphy and Boor, 2000). Bacteria that are not known to be pathogenic can cause flavor changes, rancidity, and thus reduced shelf life (Boor, 2001; Barbano et al., 2006). Bacterial quality of milk can be determined using several parameters including bacterial counts (**BC**), preliminary incubation counts, laboratory pasteurization counts, and coliform counts (**CC**; Murphy, 1997). Among these, BC is the most commonly used one in regulatory programs (Murphy and Boor, 2000) and estimate the number of colony-forming units or individual BC (**IBC**) present in unpasteurized bulk tank milk.

In Flanders (Belgium), the official mandatory milk-quality regulations follow European legislation and require a geometric mean BC over the last 2 mo (based on 2 recordings per month) $<100 \times 10^3$ IBC/mL of milk. In contrast, testing of CC is nonobligatory for milk quality in Flanders, yet implemented as part of an incentive program. Similar to other countries, such as Ireland (Berry et al., 2006) and different regions in the United States (Jayarao et al., 2004), the majority of milk processors in Flanders pay incentives of up to €0.75/100 L of milk to farmers that meet higher quality requirements, including geometric mean bacterial counts $<50 \times 10^3$ IBC/mL and geometric mean CC <50 cfu/mL over the last 2 mo (4 recordings) in combination with a geometric mean SCC $<350 \times 10^3$ cells/mL, in the absence of antibiotic residues in any milk delivery, all to ensure the image of milk as a high-quality and safe product. Although bulk tank BC and CC in Flanders decreased by 19.2% between 2005 and 2008, an increase of almost 10% was observed between 2008 and 2009 (K. Lommelen, Milk Control Centre, Lier,

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Belgium, personal communication), warranting the need to understand the reasons behind this tendency.

Most studies have identified factors holding information on milking and equipment hygiene, sanitizing procedures (Elmoslemany et al., 2009a,b; Pantoja et al., 2011), and milk storage conditions (Murphy and Boor, 2000), explaining variability in BC and CC. Apart from 2 studies, of which one was conducted in Chile (van Schaik et al., 2005) and the other in Canada (Elmoslemany et al., 2010), factors related to either herd health management, transition and feeding management, or housing, which are known to affect udder health, have not been studied as potential risk factors. Still, mastitis-causing streptococci such as *Streptococcus uberis* and *Streptococcus agalactiae* can be important contributors to bacterial levels of unpasteurized bulk tank milk (Zadoks et al., 2004). Given this information, one could anticipate that the latter management practices are also relevant for milk quality and BC in particular, and could explain the increase in BC and CC in Flanders, coincident with the increase in the average bulk milk SCC (**BMSCC**) during the same period.

The main objective of this study was to evaluate to what extent differences in management practices different from those related to milking and equipment hygiene are associated with BC and CC in unpasteurized bulk milk on Flemish dairy herds. A secondary objective was to assess whether the variation in BC and CC resided mostly at the herd or at the observation level.

MATERIALS AND METHODS

Herd Demographic Data

In 2009, Flanders had 6,971 dairy herds, with an average herd size and milk production of 40.9 cows and 8,059 milk kg/cow per year. The average milk quota size was 310,708 kg. Herds included in this study were, on average, larger (65.8 cows/herd) in both size and milk production (8,503 kg of milk/cow per year). The average of the geometric mean of BC and CC in Flanders was 11.3×10^3 IBC/mL and 10 cfu/mL, respectively. In 2009, 97% of the herds met the requirements for BC according to the European legislation (geometric mean BC $<100 \times 10^3$ IBC/mL), whereas approximately 85% of the herds met the specific requirements for higher-quality milk for CC (geometric mean CC <50 cfu/mL). The average of the geometric mean BMSCC was 230,000 cells/mL. The milk quality of the herds included in this study was comparable.

Herd Selection and Data Collection

A written web-based questionnaire was conducted between January 2010 and July 2010. The questionnaire was pretested and fine-tuned in close cooperation with 4 dairy farmers before the start of the study.

In total, 254 farmers completed the online questionnaire that consisted of 39 questions concerning general management (n = 8), herd health management (n = 5), milking management (n = 11), calving (n = 3) and dry cow management (n = 6), and nutrition (n = 6) in place on farm during 2009 (Table 1).

From all farms that completed the online questionnaire, the bulk tank milk BC and CC records measured at 2-wk intervals from January 2009 to December 2010 were retrieved from the Milk Control Centre Flanders that executes the (regulatory) farm screening program in Flanders, Belgium. Bacterial counts and CC were examined on unpasteurized bulk milk samples collected in 30-mL sterile screw-cap tubes by trained milk haulers. The samples were kept cooled (±4°C) until arrival at the laboratory.

Total BC and CC

All microbiological analyses were performed within 24 h after pick up at the farm. The milk samples were

Table 1. Overview of all herd management practices collected via a web-based questionnaire on 254 dairy herds in Belgium

Management type	Description
General management	Type of livestock farming, expected time the farm will still exist, herd size, number of lactating cows, milk quota size, duration of access to pasture during summer, barn type, cleaning frequency of the housing
Herd health management	Registration of animal diseases, herd health monitoring by veterinarian, monthly incidence of clinical mastitis, antimicrobial treatment during lactation of subclinical mastitis, treatment of prepartum heifers with antimicrobials
Milking management	Milking machine type, milking parlor type, cows kept in headlock after milking, use of automatic cluster removal, providing a preparation lag time of 60 s, teat-preparation method, application of premilking teat disinfection, application of postmilking teat disinfection, machine unit liner, rinsing of machine unit liners, replacement of machine unit liners
Calving management	Calving on pasture, presence of calving pen, use of calving pen for sick cows
Nutrition management	Concentrate provided during milking, concentrate provided on top of forage, concentrate provided via TMR, concentrate provided via automatic feeder, forage provided, type of forage feeding system
Dry cow management	Drying-off procedure, use of long-acting antimicrobials, adapted diet provided, mineral/vitamin mix provided, use of external teat sealer, use of internal teat sealer