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Do farm audits improve milk quality?

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ABSTRACT

Milk quality is assessed using bulk milk analysis and by farm audits in the Netherlands. However, the extent of the effect that dairy farm audits have on milk quality is unknown. Data from over 13,000 audits performed on 12,855 dairy farms from February 2006 to April 2008 were merged with laboratory test results of 325,150 bulk milk samples collected 6 mo before and after the audit. A linear mixed model with the method of restricted maximum likelihood was conducted to study whether the total bacterial counts (TBC) of bulk milk were lower during the periods before and after the dairy farm audit. Results showed that TBC values were 2 to 6% lower (i.e., 0.010 to 0.026 log cfu/mL) for a period from 1.5 to at least 6 mo after an audit. Additionally, several variables were significantly associated with bulk milk TBC values: seasonality, total number of attention points (given if some checklist points were not appropriate), audit type, audit result, and the categories milking equipment maintenance, and utility room-tank maintenance. The TBC values increased with a higher level of attention points. Furthermore, the farms rejected based on the audit results had the highest average TBC values and the approved farms had the lowest values. If dairy farms had an overall negative audit assessment and consequently needed a re-audit in the following year, the TBC values of bulk milk were more likely to be higher. Auditing may provide dairy farmers the opportunity to receive advice about factors that influence bulk milk TBC values, for a period of at least 6 mo following the audit.
Key words: bulk milk, certification scheme, second-party audit, hygiene

INTRODUCTION

Over the past few years, the quality and safety of dairy products have become an increasing issue of concern for both consumers and producers. This is due, in part, to incidents such as dioxin contamination of animal feed in Belgium (Boor, 2001; Noordhuizen and Metz, 2005) and Germany (Velthuis and Van Asseldonk, 2011), melamine-contaminated powdered infant formula in China (Haenlein, 2002; WHO, 2008), and outbreaks of *Escherichia coli* O104:H4 infection in 16 countries in Europe and North America (EFSA, 2010). Today, the food industry is under the watchful eye of many; consumers are concerned and demanding information about the quality and safety of products and on how they are produced (Hutchison et al., 2005; Gonzalo et al., 2006). Losses can be considerable for food business operators if the quality and safety of the product is insufficient or if the product is recalled (Velthuis et al., 2009; Velthuis and Van Asseldonk, 2011). This is one reason for the food processing industry to set high standards for quality and safety criteria. Microbiological contamination of milk is an important issue because pathogens can affect food safety, and spoilage microorganisms can limit shelf life and affect quality or yield of milk products.

The demand for safe dairy products emphasizes the importance of an integrated approach of ensuring food safety throughout the entire dairy production chain—"from grass to glass"—including the importance of the farm level in supplying safe and good quality raw milk (EC, 2000). The role of each participant in the chain is crucial to guarantee the overall food safety level of the consumer product, and each participant relies on food safety assurance from the previous participant in the chain. For example, when regulatory standards for total bacterial count (**TBC**) in raw milk are met at the farm level, the product quality later in the chain will be better guaranteed.

In the Netherlands, each bulk milk delivery is routinely sampled, monitored, and analyzed for composition and quality in an independent monitoring laboratory under the supervision of Netherlands Controlling Authority for Milk and Milk Products (COKZ, Leusden, the Netherlands). Payment contracts include milk content or levels of fat, protein, lactose, urea, SCC, TBC, antimicrobial drug residues, butyric acid-forming spores, freezing point depression, free fatty acids, and milk sediment. The testing frequency differs for differ-

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ent milk quality parameters: every delivery (antimicrobial drug residues), twice per month (SCC, TBC), once per month (butyric acid-forming spores, milk sediment), or twice per year (freezing point depression, free fatty acids). Farmers whose milk does not meet all these requirements are paid a lower price for their milk or can be rejected by the dairy processor, according to company or government regulations. On the other hand, farmers with a continuous supply of high quality milk are paid a bonus.

Some widely used tools for improving the quality and safety of bulk milk are quality assurance and certification programs for dairy farms to reach the desired farm performance level. These levels are set by the dairy processing industries that communicate this to the stakeholders (Meuwissen et al., 2003; Velthuis and Van Asseldonk, 2011). These programs include farm audits that assess different criteria such as the use of veterinary drugs, animal health, equipment, facilities, personnel and farm hygiene, disinfection procedures, residues, and feed and water management. A typical farm audit requires several hours of labor (including preparation, visit, and reporting phase) and costs several hundred euros.

Bulk milk monitoring and certification schemes aim to improve the quality of bulk milk. As farm audits entail costs, it is important to know if they actually help improve quality and safety parameters in bulk milk and if this effect is temporary or permanent. The commercial or economic advantages of auditing have not been measured (Dillon and Griffith, 2001) and studies into the effectiveness of auditing in food production are scarce; Albersmeier et al. (2009) compared the outcomes of various certification schemes in pork production and Sampers et al. (2010) related quality assurance measures to the presence of selected bacteria in poultry production. However, to date, the relationship between audits and their effect on specific microbial parameters has yet to be quantified. Therefore, the goal of this research is to study whether the TBC values of bulk milk change during the period before and after the dairy farm audit.

MATERIALS AND METHODS

The data were provided by Qlip NV (Leusden, the Netherlands), which is an independent Dutch organization responsible for the certification and auditing of dairy farms and testing deliveries of bulk milk to the processors. One data set contained bulk milk test results of milk deliveries to processors and another contained the results of all dairy farm audits (first audits, standard audits, and re-audits) performed from February 2006 to April 2008.

Farm Audit Data

Table 1 presents the descriptive statistics of the compound data set that consisted of 13,007 audits conducted on 12,855 farms from February 2006 to April 2008 and corresponding to 325,150 TBC values from 6 mo before an audit until 6 mo after. The complete farm audit data set is described in Velthuis and Van Asseldonk (2011). A farm audit record included 271 binary checklist items distributed among 52 categories that indicated a possible deviation (value 1) from the desired farm situation as defined by the Dutch dairy industry (base value 0). Only 8 checklist items were used in the model, 4 under the category of milking equipment maintenance, and 4 under the category of utility room-tank maintenance (Table 1). Additionally, other variables are included such as the dairy processing plant (n = 23), the number of attention points received, the auditor (n = 16; anonymous), the day number of the year (to test seasonality), year (n = 3; 2006, 2007, and 2008), audit type (n = 3; standard, repeated, and first audit), and audit result (n = 3; approved, rejected, and blocked). A standard audit is conducted every 2 yr, but is randomly planned, irrespective of any previous audit results. The repeated audit is performed when the result of the previous audit was not favorable (i.e., rejected), and a first audit is performed when the farm enters the program and is audited for the first time. A rejected farm was reported to have important deviations or received a high number of attention points, whereas approved farms were not. Furthermore, a farm is blocked if a decision has not yet been made various reasons and the final decision (i.e., approved or rejected) is pending for various additional information or actions.

Bulk Milk Laboratory Result Data

The TBC bulk milk was chosen because it is used in the dairy industry worldwide as the main indicator of raw milk quality. The TBC is used to assess the efficiency of cleaning and sanitation practices and general hygienic conditions during milk production (Gonzalo et al., 2006; Elmoslemany et al., 2009) and as a basis for payment schemes (Hutchison et al., 2005). For the production of high-quality milk, bacterial counts should be as low as possible. In Europe, the TBC for raw cow milk intended for heat-treated drinking milk at delivery should not exceed 100,000 cfu/mL (EEC, 1992).

In the Netherlands, TBC is analyzed twice a month in the milk monitoring laboratory by automatic enumeration with Bactoscan FC 150 (Foss A/S, Hillerød, Denmark) using flow cytometry, and each result is recorded as first or second fortnight. A suspension of cells