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Short communication: Microbial quality of raw milk following commercial long-distance hauling

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ABSTRACT

Hauling is a critical part of the commercial milk supply chain, yet very few studies have aimed to understand its effect on raw milk quality. This study focused on the effect of extended-duration tanker use during hauling on raw milk quality at a commercial facility. Standard tanker use [cleaned-in-place (CIP) once per 24 h] served as a control and an incremental between-load water rinse with sanitizer treatment (RS) was evaluated to mitigate any effect from extended duration hauling. During this study, 1 commercial truck with 2 trailers was monitored for 10 d. The truck collected milk at a large dairy farm, transported the milk to a manufacturing facility, and then returned to the same farm for a second load. Each round-trip journey took between 10 and 12 h, allowing for 2 loads per 24-h use period. Following the second delivery, the truck was cleaned by CIP treatment starting a new treatment day. Producer samples were collected from the raw milk bulk tank on the farm before loading milk into the tanker. The same milk was sampled directly out of the tanker truck before unloading at the manufacturer. Effect on individual bacteria count, thermophilic spore count, and preliminary incubation count was quantified through common industry tests. Surface sponge swabs were also used to monitor tanker sanitation and the efficacy of cleaning treatments. Results did not identify a negative effect on raw milk quality due to extended duration hauling. Whereas the addition of RS did not provide any measurable quality benefits for the microbial milk quality, swab results demonstrated that the RS treatment was able to reduce surface bacteria in the tanker, although not to the same level as the full CIP treatment. Based on this study, current CIP practices for long distance milk hauling appear to be effective in mitigating any measurable effect on raw milk quality.
Key words: hauling, milk tanker, bacteria, cleaning

Short Communication

Within the United States, all Grade A dairy products are regulated by the Pasteurized Milk Ordinance (**PMO**). As stated in the PMO, milk tanker trucks can be used repeatedly for a full 24 h between clean-in-place (**CIP**) treatments (Food and Drug Administration, 2013). Although individual truck utilization varies, routes can involve extended-duration hauls where each load of milk is hauled for long durations and only a few loads can occur per each 24-h period. Extended-duration hauls may also include situations where a truck remains soiled and empty for extended periods between loads. Residual milk remaining in the truck may lead to microbial growth, as well as the formation of biofilms that could negatively affect the microbiological quality of subsequent load quality (Teh et al., 2014), making extended-duration hauling an industry practice that poses potential risk to raw milk quality.

The objective of this study was to understand the effect of extended-duration hauling practices on raw milk microbiological quality within an industrial setting. The study was outlined to measure (1) the effect of hauling loads of milk for long distances during standard intervals between CIP treatments and (2) the effect of an incremental between-load water rinse with sanitizer treatment to remove milk residue.

This study was performed within the standard operations of a commercial dairy manufacturing plant. Samples were analyzed using microbiological methods commonly used by dairy manufacturers to ensure that the study was representative of industry practices. The study was conducted during summer to ensure maximum heat exposure. Average temperature was 23°C with a highest day temperature of 36°C and a lowest night temperature of 12°C.

Milk was hauled within 1 double trailer tanker truck with a flexible transfer hose to connect the 2 compartments. Each milk trailer consists of 2 cylinders fabricated from stainless steel metal sheets welded around a 38.1-mm polystyrene core, which acts both as support and as an insulator between the internal and external diameter of the tank. The trailers are not refrigerated, but instead rely on insulation alone to preserve milk

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Table 1. Outline of milk and swab sample location, collection frequency, and analysis method

Sample location	Frequency	Analysis[1]
Producer milk	Duplicate samples were collected from every bulk tank that was loaded into tanker (n = 40)	IBC, TSC, PI
Tanker milk	Duplicate samples were collected from the front and back trailer of every tanker load that was delivered to plant (n = 80)	IBC, TSC, PI
Tanker surface swab	Swabs were taken from the front and back trailer ceiling[2] following every load delivered to the plant. When a cleaning treatment occurred a second set of swabs were taken before a truck continued on route (n = 74).	APC
Rinse water	Samples were taken throughout the study from the clean-in-place tank or outlet pipe (n = 6)	APC

[1]IBC = individual bacteria count (Bactoscan FC, Foss, Hillerød, Denmark); TSC = thermophilic spore count; PI = preliminary incubation count: TEMPO (bioMérieux, Marcy l'Etoile, France); APC = aerobic plate count (Petrifilm, 3M, St. Paul, MN).

[2]Location of swab sample rotated with every load and before and after cleaning treatment.

temperature. These trailers were transported by a truck that carried the transfer pump and hose, which loaded the milk from the farm bulk tank into the trailer compartment. Prior to the study, all equipment had passed regulatory inspection.

To reduce variability in producer milk quality, one route was repeated for the duration of this study. This route consisted of milk from 1 farm, which was collected twice daily. Prior to the first load, the truck underwent a CIP treatment at the manufacturing plant. Following CIP, the tanker would travel to the farm, which was located approximately 5 h away. All milk was loaded from a single bulk tank, filling both trailer compartments of the truck. Once loaded, the truck would return to deliver the milk to the same manufacturing plant. Following delivery of the first load, the truck would either return to the same farm without any cleaning treatment [standard use (**SU**)] or a water rinse followed by a sanitizing spray (**RS**) would occur before the second farm pick up. Milk picked up in the second load was from the same herd, but from a subsequent milking. Regardless of treatment, following the delivery of the second load the truck would undergo a CIP treatment and a new treatment day would begin. All cleaning treatments, including CIP, were conducted in the receiving bay of the plant immediately after unloading milk and before continuing on to the next load.

This study investigated the addition of a between-load water rinse (RS), which was incremental to the standard operating procedure of a 24-h CIP (SU). The truck underwent each treatment for multiple days, creating 7 replicated days for the RS treatment followed by 3 replicated days of the SU treatment over the 10-d study.

Incremental treatments were partial stages of the full CIP cycle that used existing chemicals, receiving bays, and equipment. The RS treatment consisted of 2 to 3 min of ambient water rinse followed by a sanitizing spray containing a blend of peroxyacetic acid and hydrogen peroxide (Oxonia Active, Ecolab US, St. Paul, MN). Water samples were taken from the CIP system throughout the study to ensure no contamination of the tanker occurred due to the RS treatment.

Samples were collected daily (Table 1) at both the farm and plant. Milk was sampled from the raw milk bulk tank on the dairy farm and the same milk was sampled directly out of the tanker truck before unloading at the manufacturer. Prior to the study, training of both the receivers and haulers was conducted to ensure that sampling and cleaning procedures were consistent throughout the study. Samples were shipped by courier to the corporate laboratory once every 24 h and were tested upon arrival. All samples were kept below 7°C during storage and transport and were tested within 36 h of sampling.

Haulers followed PMO regulations when collecting producer samples from the farm bulk tank (Food and Drug Administration, 2013). Receivers took tanker samples using a sanitized stainless steel dipper from the top hatch of the front and back tanker trailer. A different dipper was used for each compartment of the truck to avoid cross contamination.

Sponge-stick swabs moistened with Letheen broth (3M US, St. Paul, MN) were used after unloading milk to measure residual bacteria left on the internal surface of tank. For every load, a 900-cm^2 area (30 × 30 cm) was swabbed per the manufacturer's instructions. Following CIP or RS treatment, a second swab was taken to measure the efficacy of the clean. Receivers were trained to rotate the area of the ceiling swabbed with each incoming load and before and after cleaning treatments.

Milk samples were evaluated using the same microbiological techniques as was described in detail within Darchuk et al. (2015). Briefly, all milk samples were analyzed for individual bacteria count (**IBC**), thermophilic spore count (**TSC**), and preliminary incubation (**PI**) most probable number. Individual bacteria counts of all milk samples were conducted using a Bactoscan FC (Foss, Hillerød, Denmark). Thermophilic spores