Short Communication: Effect of Alley Floor Cleanliness on Free-Stall and Udder Hygiene

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ABSTRACT

The objective was to evaluate the effect of alley floor cleanliness on the hygiene of the free-stalls and udder and teats of cows. Mechanical scrapers were used on rubber-slatted floors to improve the cleanliness of the alley floor. Two sections containing 21 cows each were evaluated once weekly for a period of 3 wk. One section had scrapers on the rubber-slatted floor in the alleys and the other section did not. The scrapers ran 12 and 7 times/d in the free-stall alley and feed alley, respectively. Manure accumulation in the alleys at approximately 2 h after the scrapers had run was less in the section with the scraper than in that without the scraper. Differences between sections with and without scrapers were found in the sites close to the wall in the feed alley, and immediately behind the free-stalls in the free-stall alley. In the section without scrapers, manure accumulation was greater in the free-stall alley than in the feed alley. Manure contamination of the area in the free-stalls where the udder normally comes in contact with the free-stall floor was significantly reduced from 29.1 to 17.9 ± 2.4 g of dry matter when the alley floor was kept clean by the use of scrapers. The hygiene scores of the dirtiness of udders were reduced from 25.8 ± 1.7 to 18.9 ± 1.6 , and those of the teats from 37.9 ± 2.3 to 24.2 ± 2.3 in the section with scrapers and cleaner alley floor compared with the section without scrapers. The scrapers greatly improved the hygiene on the rubber-slatted alley floor. The cleaner alley floor had a positive effect on the cleanliness of the free-stalls and the udder and teats of the cows.

Key words: floor, cleanliness, udder hygiene, scraper

The hygiene of the environment of cows and of the cows themselves influences milk quality and the risk of mastitis. A negative relationship between the cleanliness of the cows and the rate of subclinical mastitis was shown (Schreiner and Ruegg, 2003; Reneau et al.,

2005). Schreiner and Ruegg (2003) found an increased risk of IMI caused by major pathogens for cows having an udder characterized as dirty compared with those having an udder characterized as clean. Barn hygiene was correlated with SCC in the milk (Köster et al., 2006), and herds with low bulk tank SCC had cleaner housing and cleaner cows than did herds with higher bulk tank SCC (Barkema et al., 1998).

Bacterial counts in the bedding of the cows were correlated to bacterial counts found on their teat ends (Hogan et al., 1999; Zdanowicz et al., 2004), to the rates of clinical mastitis (Hogan et al., 1989), and to the amounts of bacteria and *Bacillus cereus* spores found in the bulk tank milk (Magnusson et al., 2007a). The factors of importance for bacterial growth in bedding material were the availability of nutrients, pH, and moisture content in the beds (Zdanowicz et al., 2004; Magnusson et al., 2007b). Therefore, it is important to keep the beds dry and clean. Additionally, large numbers of *Clostridium* spores can be found in the manure because of the feeding of inadequately fermented silage, and these spores can be found in the bulk tank milk (Stadhouders and Jørgensen, 1990). Manure contamination by cattle soiling in the free-stalls can be prevented by neck-rail placement (Tucker et al., 2005).

In the present study, the cleanliness of the slatted alley floor was improved by use of mechanical scrapers. The objectives were to evaluate the effect of alley floor cleanliness on 1) the cleanliness of the free-stalls, and 2) the cleanliness of the udder and teats of the cows.

The experiment was conducted at the Alnarp Dairy Research Station, the Swedish University of Agricultural Sciences. The herd of 170 Swedish Holstein cows housed in free-stalls had a milk production of approximately 9,000 kg of milk/yr per cow. Two groups with 21 cows each were studied. The cows were randomly allocated at calving into 2 equal groups by calving date within parity, with 7 primiparous and 14 multiparous cows in each group; cows were 74 to 144 DIM (average 136 d) at the start of the 3-wk period,

Each 21-cow group was housed in a section consisting of 21 free-stalls in 2 rows separated by a 2.20-m alley (the free-stall alley). One of the free-stall rows had a solid board partition in the front, separating the

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free-stalls from the feeding alley (width 3.02 m). There were 23 feeding places in each section and the cows were fed a TMR twice daily when they came back from milking. Additional concentrate was fed individually according to production in automatic feeding stations. The free-stalls had dimensions of 123 × 242 cm each and were equipped with free-stall partitions (Solid, DeLaval, Tumba, Sweden). The concrete floor of the free-stall was covered by a 30-mm-thick polymeric mat (DeLaval Cow Mat CM30L, DeLaval). Approximately 5 kg of wood shavings per stall was provided twice weekly. The free-stalls were cleared of wet bedding and manure twice daily. The curb height (i.e., the level differences between the alley and free-stall floors) was 190 mm. Both groups had an alley floor with slatted rubber mats (Kura-S, Gummiwerk Kraiburg Elastik GmbH, Tittmoning, Germany) on top of concrete slats. The rubber mats had perforated slots (270 × 40 mm) with a void ratio (the ratio between the slot area and the total floor area) of approximately 20%. The housing section of one group of cows had fully automatic hydraulic manure scrapers with rubber blades (DeLaval Delta Master, DM II, DeLaval) installed on top of the slatted floor. The alley between the free-stall rows was scraped 12 times/d and the feeding alley 7 times/d. The housing section for the other group of cows was not provided with scrapers. The total alley area in both sections was 4.6 m² per cow. The cows were milked in the parlor twice daily.

The study was conducted over a 3-wk period. The cleanliness of the alleys, free-stalls, and udder and teats were evaluated once weekly. On each of the 3 individual samplings days, 5 samples from the food alley and 5 samples from the alley between the free-stalls were collected from both sections ($n = 60$). Samplings were equally distributed over the 2 alleys at 5 different sites. Samples were collected around 1100 h, about 2 h after the scrapers had run. Using a standardized frame of 500 × 1,000 mm, all manure within the frame was collected at each sampling point on the floors and the manure was weighed (g).

Bedding samples were collected on 3 sampling days from 9 randomly selected free-stalls in each section ($n = 54$). Sampling was carried out in the morning before the stalls were cleaned 4 d after the fresh bedding had been added to the stalls. A frame of 600 × 600 mm was placed 200 mm from the rear curb of the free-stalls, and all the used bedding material and manure from this area was collected. The site and size of the frame was assumed to reflect the area where the udder normally came in contact with the free-stall floor. When the selected free-stall was contaminated with an entire patch of manure, sampling was made in the neighboring free-stall.

The samples of used bedding were dried at 100°C for approximately 24 h to determine the DM. Duplicates of 2 g for each dried and milled (1-mm sieve) sample were heat-treated at 650°C for 30 min to determine the ash content. Ash content of wood shaving was close to zero (0.03% of DM) and pure manure was 11.2% of DM. The calculation of the amount of manure in the samples was simplified by setting the ash content of the wood shavings to zero.

The dirtiness of the udder and teats of all cows was observed before udder cleaning in preparation for the morning milking on the same days as the bedding samples were collected; that is, 4 d after the fresh bedding had been added to the free-stalls. Twenty-one cows in the group with scrapers and 20 cows in the group without scrapers were hygiene scored; 1 cow became dry during the study and was not scored. The dirtiness of the udder and teats was estimated visually and was linearly scored on a continuous line between 0 and 100 by marking on a 100-mm line, where 0 = completely clean and 100 = completely covered with dirt. Two separate scores were given: 1) the lower part of the udder and 2) the teats and teat tips were scored together. The method was developed from Christiansson et al. (1999), who used 5 categories of dirtiness.

Statistical calculations were performed using MINITAB version 14 for Windows (Minitab Inc., 2003). Manure accumulation on the alley floor, extent of free-stall contamination, and udder and teat cleanliness were analyzed by ANOVA. Manure accumulation on the alley floor was normalized by logarithmic transformation. In the model, treatment (with and without scrapers), day, site (5 different sites), treatment by day interaction, and treatment by site interaction were included as fixed effects. Differences between the sites or alleys within treatments and between the treatments within sites were tested by Tukey's test. However, for a better presentation, the least squares means and the SE values were retransformed. Free-stall contamination was analyzed by a model including treatment, day, and treatment by day interaction as fixed effects. The hygiene scores of the udder and teats were analyzed by a model including treatment, day, and treatment by day interaction as fixed effects, and cow within treatment as a random effect.

The use of scrapers greatly affected the amount of manure present in the dairy house sections (Figure 1). An interaction between use or nonuse of scraper and site was found ($P = 0.004$). The section with scrapers had less accumulated manure on the alley floor in the sites behind the free-stalls ($P = 0.001$) and close to the wall in the feeding alley ($P < 0.001$) than did the section without scrapers. Within the section with scrapers, there were no significant differences between the

Table 1. The effect of cleaner alley floors on free-stall hygiene¹

Item	With scraper	Without scraper	SE	P-value
Sample (g)	94.3	157.2	15.4	0.006
DM in samples (%)	50.9	40.7	2.8	0.014
Manure, DM (g)	17.9	29.1	2.4	0.002

¹Least squares means and SE for weight of bedding samples, DM in samples, and calculated amount of manure in the samples from section with and without scrapers on the slatted alley floors (n = 27).

accumulated amounts of manure in the feed alley and the free-stall alley, or between the different sites in the alleys. For the section without scrapers, there was 3.4 times more accumulated manure in the free-stall alley than in the feed alley ($P = 0.005$). In the free-stall alley, there was more manure behind the free-stalls than in the middle of the alley ($P = 0.004$). In the feed alley there was more manure close to the wall than behind the feeding gates ($P < 0.001$) and in the middle of the alley ($P < 0.001$), respectively.

The amounts of used bedding and manure collected from the sampling area in the free-stalls varied from 20 to 508 g. Samples from free-stalls in the section without scrapers was heavier and had less DM content than in sections with scrapers and cleaner alley floor (Table 1). There was 39% less manure in the samples from free-stalls in the section with scrapers and cleaner alley floor (17.9 ± 2.4 g of DM) than in the section without scrapers (29.1 ± 2.4 g of DM; $P = 0.002$).

Figure 1. Manure accumulation on the alley floors in sections with and without scrapers. Least squares means ($\pm$ SE) of manure accumulation in different sites of the alleys in the section without scrapers (gray bars) and with scrapers (white bars) on the slatted floor. ***Means between sections with and without scrapers differed at $P < 0.001$. Each mean is based on 5 samples, except for "behind stalls" (n = 10).

The cleaner alley floor achieved by the use of scrapers significantly improved the udder and teat cleanliness as the hygiene score for the dirtiness of udder was reduced by 27% from 25.8 ± 1.7 to 18.9 ± 1.6 ($P < 0.001$) and that for the teats by 37% from 37.9 ± 2.3 to 24.2 ± 2.3 ($P < 0.001$) compared with not using scrapers on the slatted floor.

The cows in the groups were kept in identical housing environments except for scrapers. The cows were matched with respect to the number of primiparous and multiparous cows, and lactation stage. They were fed the same ration and were given the same management. The cleanliness of the alley floor was a result of the use or nonuse of scrapers on the slatted floor of the respective housing sections. The cleanliness of the alley floor did affect the amount of manure in free-stalls and the cleanliness of udder and teats. The methods used to evaluate the hygiene gave consistent results from manure on alley floor to hygiene scoring of udders and teats.

Decreasing the void ratio will diminish the drainage capacity (Magnusson et al., 2008), and with a void ratio $< 20\%$, the alley floor cleanliness without scrapers would be even worse. Rubber-slatted floor was used in this study, but a scraper would have similar effects on concrete-slatted floors, and the effect of a cleaner alley floor on the cleanliness of the free-stalls and of the udders and teats would probably be the same for any type of alley flooring. The scraper cycled 12 times daily in the free-stall alley and at a reduced frequency (7 times/d) in the feeding alley because of less manure and in order not to disturb the cows when they were fed. The accumulation of manure on the alley floor was studied approximately 2 h after the scrapers had cycled. Scrapers cycling less often would probably result in greater manure accumulation.

Manure accumulation on the alley floor was evaluated at 1100 h. The choice of time of day could have influenced the results because the activities of the cows over the day vary with their feeding and milking routines. The results were in accordance with those of Boxberger and Pfadler (1980), who found 3.2 times more manure on the slatted floor in the alley between the free stalls ($1,667$ g/m²) than in the feed alley (517 g/m²).

In the section without scrapers, there was a large accumulation of manure on the slatted alley floor close to the wall and behind the free-stalls. The manure has to be removed manually or automatically to prevent too much accumulation at these sites and to prevent contamination of the free-stall flooring. The cleanliness of the slatted floors is dependent on the cow traffic (Boxberger and Pfadler, 1982). More frequent cow traffic and more frequent manure trampling might explain the smaller amount of manure in the feeding alley. By using scrapers on slatted floors, the floor hygiene on slatted floors would not depend on the cow traffic and larger alley areas could be used.

Köster et al. (2006) did not find that the hygiene in the alley was significantly related to SCC, but that the hygiene in the free-stalls was. The hygiene in the free stalls depended on several factors, such as the free-stall size and design, amount and type of bedding, frequency of adding bedding, proportion of cows and free-stalls, and of the manure brought into the free-stall by the feet of the cows. In the present study, the measured amount of manure in the free-stalls reflected the amount of manure brought into the stalls by the claws, and the difference in amounts of manure in the free-stalls did affect the cleanliness of the udders and teats. The bedding samples from the free-stalls were collected 4 d after fresh bedding was added and a small amount of bedding was left in the free-stalls. Using a greater amount of bedding or more frequent addition of bedding would probably embed the manure and improve the cleanliness of the udders and teats.

In conclusion, improved cleanliness of alley flooring in a dairy house, in this instance with the use of scrapers on top of rubber-slatted floor, reduced the amount of manure in the free-stalls and improved the cleanliness of the udders and the teats.

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