Farm management factors associated with bulk tank total bacterial count in Irish dairy herds during 2006/07

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ABSTRACT

Research has shown that total bacterial count (TBC), which is the bacterial growth per ml of milk over a fixed period of time, can be decreased by good hygiene and farm management practices. The objective of the current study was to quantify the associations between herd management factors and bulk tank TBC in Irish spring calving, grass-based dairy herds. The relationship between bulk tank TBC and farm management and infrastructure was examined using data from 400 randomly selected Irish dairy farms where the basal diet was grazed grass. Herd management factors associated with bulk tank TBC were identified using linear models with herd annual total bacterial score (i.e., arithmetic mean of the natural logarithm of bulk tank TBC) included as the dependent variable. All herd management factors were individually analysed in a separate regression model, that included an adjustment for geographical location of the farm. A multiple stepwise regression model was subsequently developed. Median bulk tank TBC for the sample herds was 18,483 cells/ml ranging from 10,441 to 130,458 cells/ml. Results from the multivariate analysis indicated that the following management practices were associated with low TBC; use of heated water in the milking parlour; participation in a milk recording scheme; and tail clipping of cows at a frequency greater than once per year. Increased level of hygiene of the parlour and cubicles were also associated with lower TBC. Herd management factors associated with bulk tank TBC in Irish grazing herds were generally in agreement with most previous studies from confinement systems of milk production.

KEYWORDS: bulk tank, dairy cattle, infrastructure, management, total bacterial count

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INTRODUCTION

Total bacterial count (TBC) is the bacteria growth per ml of milk over a fixed period of time (Blowey and Edmondson 1995). High TBC milk should be avoided since some bacteria (*Staphylococcus aureus, Escherichia coli* and *Streptococcus agalactiae*) found in raw milk can cause diarrhoeal disease and food poisoning (Gilmour and Rowe 1990). After pasteurisation, the risk of illness to humans can occur by recontamination of milk through milk pipes and stored milk residues or by thermoduric bacteria (*Bacillus cereus*) which can survive pasteurisation (Gilmour and Rowe 1990). Bacteria can also have a negative effect on dairy products. For example, *Alteromonas putrefaciens* causes a surface taint in butter, and *E. coli* can spoil milk and dairy products by gas production during storage (Gilmour and Rowe 1990). Accordingly, milk quality is required to be within certain thresholds according to European law (EEC, 1992, Council Directive 92/46/EEC); total bacterial count must not exceed a geometric average of 100,000 per ml over two months, with at least two tests per month. Additionally, incentives (TBC less than 30,000) and penalties are applied by milk processors to help ensure high milk quality. Recent research indicates a general tendency for bulk tank TBC in Ireland to decrease between the years of 1994 to 2003, but this was followed by an increase between 2003 and 2004 (Berry *et al.* 2006).

Milk is synthesised in epithelial cells of the mammary gland and is virtually sterile when secreted into the alveoli of the udder (Tolle 1980). Thus, contamination of milk largely occurs subsequent to milk synthesis. According to Bramley and McKinnon (1990), the three main areas or sources of microbial contamination are from within the udder subsequent to synthesis, the exterior of the udder and the surface of milk handling and storage equipment. Bacteria can multiply through poor hygiene and

sanitation and subsequently be flushed into the bulk tank, increasing the TBC (Hayes *et al.* 2001). An increase in TBC can be related to mastitis organisms, environmental contaminants, dirty milking equipment or failure of refrigeration (Blowey and Edmondson 1995). Jayarao *et al.* (2004) documented that herd size and farm management practices influence bacterial counts in bulk tank milk. Furthermore, Hogan *et al.* (1990) reported that bedding material was a source of bacteria, and Natzke (1981) documented that an increased plate loop count was associated with poor maintenance of the milking machine. Also, Goldberg *et al.* (1992) reported that confined housing resulted in a higher bacteria level in milk, as measured by a standard plate count, than an intensively managed rotational grazing system.
The objective of the current study was to quantify the associations between herd management factors and bulk tank TBC in Irish spring calving, grass-based dairy herds.

MATERIALS AND METHODS

Data collection

Milk volume, somatic cell count (SCC) and TBC data were made available by a major Irish milk processor during 2004 to 2007. Milk on these farms was collected every one to four days, with TBC measured every second week and SCC measured weekly. Herd selection and data collection for this study have been described previously (Kelly *et al.* 2008). Briefly, annual herd milk supply in 2004 was divided into increments of 10,000 litres with herds supplying yields at either end of the supply distribution being merged due to small strata sizes. A total of 450 herds, of which 400 (89%) decided to take part in the study, were randomly chosen, with the percentage selected from each stratum being weighted by the frequency of herds within strata relative to the sample population.

Table 1: Association between milking process infrastructure components/ variables and bulk tank total bacterial score (TBS)

Variable	Level	%	TBS (TBC[1])	S. Error	P-value[2]
Number of milking cows	67-293	24	9.89 (20)	0.045	0.0642
	51-66	23	9.92 (20)	0.044	
	37-50	28	9.85 (19)	0.041	
	12-36	25	10.00 (22)	0.043	
Automatic cluster removers	Yes	5	9.76 (17)	0.093	0.0924
	No	95	9.92 (20)	0.022	
Heated water in parlour	Yes	40	9.82 (18)	0.035	0.0002
	No	60	9.99 (22)	0.028	
Frequency of liner change	≤ once a year	64	9.95 (21)	0.027	0.0178
	> once a year	36	9.84 (19)	0.036	
Filter used	Sock filter	71	9.90 (20)	0.026	0.4361
	Solid filter	10	9.89 (20)	0.069	
	No filter	19	9.97 (21)	0.049	

[1] Back transformed total bacterial count (TBC)10^3/ml.
[2] P-value is significant at less than 0.05

Table 2: Association between teat preparation and disinfection methods and bulk tank total bacterial score (TBS)

Variable	Level	%	TBS (TBC[1])	S. Error	P-value[2]
Teat preparation spring (Jan-Apr)	Wash only	22	9.88 (19)	0.047	0.8461
	Wash and dry with paper towel	5	9.89 (20)	0.095	
	Wash and dry with common cloth	3	9.88 (19)	0.119	
	Dry wipe	24	9.91 (20)	0.044	
	None	46	9.94 (21)	0.032	
Teat preparation summer (May-Sep)	Wash only	16	9.85 (19)	0.054	0.7019
	Wash and dry with paper towel	2	9.82 (18)	0.152	
	Wash & dry with common cloth	2	9.86 (19)	0.143	
	Dry wipe	26	9.93 (20)	0.043	
	None	54	9.93 (21)	0.029	
Teat preparation winter (Oct-Dec)	Wash only	22	9.92 (20)	0.046	0.5008
	Wash and dry with paper towel	7	9.84 (19)	0.084	
	Wash and dry with common cloth	4	9.76 (17)	0.105	
	Dry wipe	22	9.92 (20)	0.047	
	None	45	9.94 (21)	0.032	
Disinfecting after	Never	22	10.03 (23)	0.045	0.0124
	Intermittently	9	9.94 (21)	0.071	
	Every milking	69	9.87 (19)	0.026	

[1] Back transformed total bacterial count (TBC)10^3/ml.
[2] P-value is significant at less than 0.05

Two questionnaires were administrated during a face-to-face interview with each farmer, between April and July 2006 ('summer') and between December 2006 and March 2007 ('winter'). The summer questionnaire related mainly to the milking process and infrastructure, and the winter questionnaire to cow accommodation. The survey questions required objective measurements and factual responses from the farmer, as well as subjective measures. A scoring system for cow cleanliness based on Ruegg's score sheet (2004), where a random sample of ten cows on each farm was assigned a composite score of one (clean) to four (very dirty) based on the component score of the udder, tail and legs. An overall (herd) cow cleanliness score was calculated by adding the individual cow scores. Farms were divided into five regions based on geographical location. Any potential temporal-spatial bias was minimised by altering the order of farm visits within each region.
As described previously by Kelly *et al.* (2008), a milk sample was collected following agitation from the bulk tank of 300 farms during the summer visit. There were only 300 samples taken as the bulk tank milk had been collected by the processor before the arrival of the survey personal to the remaining farms. Each sample was collected in individual sterile sample bottles and stored frozen prior to processing. After thawing, 10 µl from each

Table 3: Association between summer management practices and bulk tank total bacterial score (TBS)

Variable	Level	%	TBS (TBC[1])	S. Error	P-value[2]
Milk recording practiced	Yes	49	9.80 (18)	0.030	<0.001
	No	51	10.03 (23)	0.030	
Gloves worn during milking	Yes	37	9.92 (20)	0.035	0.8614
	No	63	9.91 (20)	0.027	
Management of cow tails	Clip tails > once a year	48	9.84 (19)	0.031	0.0007
	Clip tails ≤once a year	39	10.02 (22)	0.034	
	Tails ringed/ cut	14	9.88 (19)	0.058	
Walk ways washed before milking	Yes	45	9.83 (19)	0.032	0.0002
	No	55	9.99 (22)	0.029	

[1] Back transformed total bacterial count (TBC)10^3/ml.
[2] P-value is significant at less than 0.05

sample was inoculated onto blood agar plates (base no. 2; MERCK product, Manufactured in Merck KGaA 64271 Darmstadt. Germany) and incubated at 37°C overnight (16-18 hours). Bacteria were visually identified from the plates by an experienced laboratory technician after incubation.

Statistical analysis

As TBC data were positively skewed, the variable total bacterial score (TBS) was calculated as the average of the natural logarithm of the bulk tank TBC for all milk collections in the 365 days prior to the first visit to a specific farm. Data regarding a wide range of independent variables were available from the two questionnaires, relating to the milking process infrastructure (14 variables), teat preparation and disinfection methods (seven variables), summer management practices (18 variables), winter management practices (nine variables), parlour and roadway hygiene (ten variables) and the hygiene of winter housing (17 variables) on each study farm. Data information from each questionnaire that was completed on-farm, was entered into Microsoft Excel, where the data was managed for ease of analysis. The milk processing data was also managed using Microsoft Excel. The two sets of data were combined using SAS Institute Inc. US. The association between TBS and each of these independent variables was assessed separately using linear fixed effects models developed with PROC GLM (SAS 2006); TBS was the dependent variable and geographic location was a confounding variable. Independent variables associated with TBS at P<0.30 were retained for further analysis. Multiple regression models were then developed with PROC GLM using stepwise regression. Separate multiple regression models were generated using independent variables from the summer questionnaire, from the winter questionnaire and from both questionnaires. Statistical significance for all final multiple regression models was defined as P<0.05.
The relationship between the bacterial plate counts and TBS was determined using PROC GLM (SAS 2006). The

Table 4: Association between winter management practices and bulk tank total bacterial score (TBS)

Variable	Level	%	TBS (TBC[1])	S. Error	P-value[2]
Cow housing	Cubicles	84	9.93 (21)	0.024	0.0611
	Loose	5	9.95 (21)	0.095	
	Paddock	2	10.30 (30)	0.149	
	Cubicles and loose	3	9.86 (19)	0.128	
	Stalls	6	10.08 (24)	0.086	
Cubicle bedding	Sawdust and other	11	9.92 (20)	0.066	0.0003
	Lime	17	10.01 (22)	0.051	
	Shredded paper	4	9.82 (18)	0.112	
	Straw	4	10.13 (25)	0.104	
	None	11	10.15 (26)	0.066	
	Mats	19	9.95 (21)	0.048	
	Mats and lime	34	9.82 (18)	0.037	
Cubicles cleaned	Twice a day	37	9.82 (18)	0.036	0.0038
	Once a day	46	10.00 (22)	0.032	
	Never	5	9.93 (21)	0.094	
	Every second day	7	9.98 (22)	0.085	
	Weekly	5	10.06 (23)	0.099	
Passage cleaning	Mechanical scrapers	55	9.92 (20)	0.029	0.0625
	Tractor	23	10.04 (24)	0.046	
	Hand scraper	6	10.01 (22)	0.094	
	Slats	11	9.85 (19)	0.068	
	Mixture	5	9.82 (18)	0.092	
Frequency of passage cleaning	Twice a day	16	9.95 (21)	0.059	0.2083
	Once a day	24	10.04 (23)	0.049	
	Never	1	10.25 (28)	0.245	
	Every one to two hrs	11	9.88 (20)	0.071	
	Every three to four hrs	32	9.89 (20)	0.042	
	Every five to seven hrs	12	9.90 (20)	0.067	
	Twice a week	4	10.01 (22)	0.123	
Calving area	Calving box	85	9.94 (21)	0.023	0.0103
	Cubicles house	4	9.68 (16)	0.112	
	Paddock	4	10.16 (26)	0.112	
	Stalls	3	10.17 (26)	0.121	
	Other	5	9.88 (19)	0.101	
Frequency of calving area cleaned	Daily	23	9.97 (21)	0.048	0.8697
	Twice a week	17	9.95 (21)	0.054	
	Weekly	11	9.94 (21)	0.065	
	Three times per calving season	15	9.90 (20)	0.058	
	Twice during calving season	24	9.92 (20)	0.046	
	End of calving season	10	10.00 (22)	0.071	

[1] Back transformed total bacterial count (TBC)10^3/ml.
[2] P-value is significant at less than 0.05

correlation between the somatic cell score (SCS is the average of the natural logarithm of the bulk tank somatic

Table 5: Association between parlour and roadway hygiene and bulk tank total bacterial score (TBS)

Variable	Level	%	TBS (TBC[1])	S. Error	P-value[2]
Cleanliness of the parlour	Clean	43	9.88 (19)	0.033	0.0047
	Slightly dirty	48	9.90 (20)	0.031	
	Dirty	9	10.14 (25)	0.074	
Cleanliness of milking unit claw piece	Clean	42	9.83 (19)	0.033	<0.001
	Slightly dirty	45	9.93 (21)	0.032	
	Dirty	13	10.13 (25)	0.059	
Condition of the milking unit liners	New	82	9.90 (20)	0.024	0.1551
	Slightly cracked	12	10.03 (23)	0.065	
	Cracked	7	9.93 (21)	0.086	
Collecting yard cleaning frequency	After every milking	17	9.90 (20)	0.053	0.1686
	Daily	37	9.85 (19)	0.035	
	Weekly	15	9.95 (21)	0.056	
	Every second day	13	10.02 (22)	0.061	
	Every third day or twice a week	6	9.91 (20)	0.087	
	Slates	6	9.93 (21)	0.087	
	As required or other	6	10.04 (23)	0.088	
Cleanliness of yard	Clean	26	9.87 (19)	0.045	0.1946
	Slightly dirty	43	9.88 (20)	0.035	
	Dirty	27	9.98 (22)	0.043	
	Very dirty	4	10.01 (22)	0.115	
Cleanliness of road	Clean	25	9.86 (19)	0.044	0.0389
	Slightly dirty	51	9.89 (20)	0.030	
	Dirty	17	9.97 (21)	0.053	
	Very dirty	7	10.12 (25)	0.087	
Condition of road way	Very good	17	9.84 (19)	0.052	0.0399
	Good	59	9.90 (20)	0.028	
	Poor	24	10.00 (22)	0.044	

[1] Back transformed total bacterial count (TBC)10^3/mL.
[2] P-value is significant at less than 0.05

cell count for all milk collections in the 365 days prior to the first visit to a specific farm) and TBS was calculated from the farms in the study, the SCS and TBS used was calculated from the average for each farm for the 365 days prior to the first farm visit.

RESULTS

Across the 400 study herds, the average number of cows and heifers was 55 (range 12 to 293) and 12 (0 to 67), respectively. There was a wide range in milk volume supplied to the processor in the 365 days prior to the farm visit varying from 17,087 to 1,324,474 litres. The average farm TBC for the 365 days prior to the visit to the study farms ranged from 10,441 to 130,458 cells/ml; the median TBC of all farms was 18,483 cells/ml. There was a correlation of 0.27 between SCS and TBS. *S. aureus* was present in 51% of the 300 bulk tank samples, varying from one CFU/10µl to 'numerous' (i.e., 40 to 100 CFU/10µl); 11% of all milk samples had more than 40 CFU/10µl. No other mastitis pathogens were isolated. There was no significant association between the level of *S. aureus* and TBS.

Tables 1 to **6** describe the associations between bulk tank TBS and milking process infrastructure, teat preparation, herd management, winter housing, parlour and roadway hygiene and the hygiene of winter housing, respectively, on 400 farms. Not all milking parlour infrastructure variables were associated with bulk tank TBS (**Table 1**). The presence of heated water in the parlour was also associated (P<0.001) with lower TBS. As the frequency of liner changing increased, the level of TBS decreased. Approximately half of farms surveyed in this study practised some form of teat preparation (**Table 2**), but there was no association between teat preparation and TBS. However, lower (P<0.05) TBS was observed on farms that disinfected teats after every milking. Participating in a milk recording programme, of which 49% of farmers did, was shown to have lower (P<0.001) bulk tank TBS than not participating.

Cleanliness of the farm, housing and milking parlour was strongly associated (P<0.05) with lower herd TBS (**Tables 4-6**). Bulk tank TBS was lower in herds with clean facilities and those herds that used shredded paper or lime and mats under the cows during housing (P<0.001).

Tables 7-9 summarise the summer, winter and combined management factors on the 400 farms that were significantly associated with bulk tank TBS, respectively, in the multiple regression models; the models had r-squared measurements of 0.191620, 0.197630 and 0.193459 respectively. These include the condition of the housing, washing of walkways in the parlour, bedding type, tail clipping, practicing milk recording, and whether or not heated water was available in the milking parlour. Residual diagnostics did not indicate any concern for departures from the statistical assumptions of constant variability and normality.

Additionally, when the combined management factor regression model was developed, the cumulative effect of best practices, such as participation in a milk recording scheme, heated water in the parlour, washing of the walkways before milking, the shed in good condition, tails ringed or clipped at a frequency of greater then once a year and clean cubicles, was calculated as 20,167 cells/ml, i.e., milk TBC was expected to be 20,167 cells/ml lower when these best practices were in place compared to the poorest alternative within each variable. However, this difference would only be seen if the practices were in place on a farm and they were causal.

Table 6: Association between degree of hygiene of cow accommodation and bulk tank total bacterial score (TBS)

Variable	Level	%	TBS (TBC[1])	S. Error	P-value[2]
Cleanliness of loafing area	Clean	43	9.87 (19)	0.033	0.0023
	Slightly dirty	43	9.97 (21)	0.033	
	Dirty	14	10.09 (24)	0.55	
Condition of cubicle shed	Very good	9	9.95 (21)	0.071	<0.001
	Good	85	9.91 (20)	0.023	
	Poor	6	10.33 (31)	0.088	
Cleanliness of cubicles	Clean	56	9.87 (19)	0.028	<0.001
	Slightly dirty	35	9.98 (22)	0.036	
	Dirty	9	10.21 (27)	0.072	
Cow cleanliness score (0 clean to 120 dirty)	<40	19	9.86 (19)	0.050	0.0603
	<60	65	9.95 (21)	0.027	
	>59	16	10.04 (23)	0.054	

[1] Back transformed total bacterial count (TBC)10^3/ml.
[2] P-value is significant at less than 0.05

Table 7: Summer herd management factors associated with bulk tank total bacterial score (TBS) on 400 Irish dairy farms, based on a multiple regression model

Question	Level	TBS (TBC[1])	S. Error	P-value[2]
Milk recording practiced	Yes	9.87 (19)	0.037	0.0066
	No	10.02 (23)	0.037	
Cleanliness of claw piece	Clean	9.86 (19)	0.035	0.0138
	Slightly dirty	9.92 (20)	0.035	
	Dirty	10.06 (23)	0.063	
Cow tail management	Clip tails > once a year	9.86 (19)	0.034	0.0043
	Clip tails ≤ once a year	10.02 (22)	0.039	
Walk ways washed before milking	Tails ringed/ cut	9.96 (21)	0.06	
	Yes	9.88 (20)	0.039	0.0067
	No	10.01 (22)	0.033	
Heated water in the pit	Yes	9.89 (20)	0.038	0.0090
	No	10.00 (22)	0.034	

[1] Back transformed total bacterial count (TBC)10^3/ml.
[2] P-value is significant at less than 0.05

DISCUSSION

Milk quality is important for both the economics and perception of milk production in Ireland and therefore, herd management factors associated with milk quality need to be accurately quantified. Hence, the objective of this study was to quantify the association between bulk tank TBS and herd management factors. It should be noted due to the design of the study, that the associations reported within do not imply cause and effect, and should not be interpreted as such. Purpose of the study was to identify factors that have greatest association with TBC, the detail of which could then be established in further experimental trails. The farms in the current study would be considered to be representative of the national population as they have similar SCC and TBC to those farms used by Berry *et al.* (2006) who used 40% of the national population of dairy farmers.

In the multi-regression models of summer and winter management factors, nine factors were identified as being significantly associated with TBS. Most of these variables have also been observed as significant in previous research (Olson and Mocquat 1980; Zehner *et al.* 1986; Magnusson *et al.* 2006).

The lower TBS observed in herds that practised milk recording was not unexpected, given the correlation (0.27) between TBS with SCS, and the fact that involvement in a milk recording scheme was associated with lower SCS (Kelly *et al.* 2008). Some studies have indicated deterioration in udder health (Dohoo and Leslie 1991) when SCC increased to greater than 200,000 cells/ml. Milk recording would allow the cows with high SCC to be identified and subsequently removed from the herd, resulting in a concomitant reduction in TBS.

Murphy *et al.* (2005) documented that the low microbial load in the milk of the cows getting no teat preparation in their trial, was a reflection of the importance of housing and milking parlour hygiene in decreasing TBC. Magnusson *et al.* (2006) reported that not all bacterial spores are removed even with the best cleaning method, therefore it is important to maintain good hygiene at all stages of milk production. Milk handling equipment can become contaminated due to poor hygiene and cleaning, the bacteria in turn can pass into the milk line, thus increasing TBC (Olson and Mocquat 1980). These observations are in agreement with the current study, where heated water in the parlour along with greater hygiene of the parlour, claw piece and cubicle house, as well as improved maintenance and condition of the cubicle house, were significantly associated with lower TBS.

Increased frequency of tail clipping had a significant association with lower TBS. Schreiner and Ruegg (2002) did not identify differences in milk quality that could be attributed to tail docking; however, their study compared cut tails to an unclipped tail, whereas the current study looked at the frequency of clipping and showed the difference between the frequencies.

Schreiner and Ruegg (2003) also reported that the primary sources of exposure of environmental mastitis pathogens to the cow were the presence of moisture, mud and manure in the environment of the cow. A higher frequency of cubicle cleaning and also specific bedding material types were associated with lower bulk tank TBS in the current study. The association between bacterial counts and bedding materials is well researched; Hogan *et al.* (1997) and Galton *et al.* (1982) showed that both used and unused organic bedding had bacteria present, while Zehner *et al.* (1986) reported that clean, damp bedding can support bacterial growth. Rendos *et al.* (1975) found that the populations of bacteria increased in the bedding material after use, while Zdanowicz *et al.* (2004) showed that bacterial counts in sawdust were correlated with bacterial counts on the teat ends. Hogan *et al.* (1989) also documented that bacterial populations

Table 8: Winter herd management factors associated with bulk tank total bacterial score (TBS) on 400 Irish dairy farms, based on a multiple regression model

Question	Level	TBS (TBC[1])	S. Error	P-value[2]
Condition of cubicle shed	Very good	10.13 (25)	0.087	0.0025
	Good	10.00 (22)	0.053	
	Poor	10.29 (29)	0.095	
Cleanliness of cubicles	Clean	10.05 (23)	0.062	0.0349
	Slightly dirty	10.15 (26)	0.064	
	Dirty	10.22 (28)	0.085	
Calving area	Calving box	10.11 (25)	0.044	0.0006
	Cubicles house	9.83 (19)	0.111	
	Paddock	10.22 (28)	0.117	
	Stalls	10.58 (39)	0.153	
	Other	9.96 (21)	0.100	
Cubicle bedding of cows	Sawdust and other	10.09 (24)	0.082	0.0049
	Lime	10.17 (26)	0.072	
	Shredded paper	9.94 (21)	0.120	
	Straw	10.31 (30)	0.109	
	None	10.30 (30)	0.082	
	Mats	10.13 (25)	0.072	
	Mats and lime	10.04 (23)	0.069	

[1] Back transformed total bacterial count (TBC)10^3/ml.
[2] P-value is significant at less than 0.05

Table 9: Overall herd management factors associated with bulk tank Total bacterial score (TBS) on 400 Irish dairy farms, based on a multiple regression model

Question	Level	TBS (TBC[1])	S. Error	P-value[2]
Milk recording practiced	Yes	9.95 (21)	0.047	0.0024
	No	10.09 (24)	0.047	
Heated water in the pit	Yes	9.96 (21)	0.049	0.0058
	No	10.08 (24)	0.045	
Walk ways washed before milking	Yes	9.96 (21)	0.048	0.0069
	No	10.08 (24)	0.045	
Condition of cubicle shed	Very good	10.01 (22)	0.074	0.0039
	Good	9.89 (20)	0.033	
	Poor	10.17 (26)	0.090	
Cow tail management	Clip tails > once a year	9.95 (21)	0.047	0.0335
	Clip tails ≤ once a year	10.07 (24)	0.045	
	Tails ringed/cut	10.04 (23)	0.066	
Cleanliness of cubicles	Clean	9.96 (21)	0.045	0.0432
	Slightly dirty	10.07 (24)	0.051	
	Dirty	10.03 (23)	0.075	

[1] Back transformed total bacterial count (TBC)10^3/ml.
[2] P-value is significant at less than 0.05

differed both over the season of the year and types of bedding material.

The presence of only one bacteria type in the milk samples of the current study could be due to the milk samples having been taken during the period when cows were grazing outdoors, thus reducing the likelihood of environmental bacteria presence. Also, the bulk tank samples were frozen which may have limited the presence of bacteria in the samples. Schukken *et al.* (1989) reported a reduction in the level of *E. coli* or *Actinomyces pyogenes* after freezing the milk samples; Luedecke *et al.* (1972) also documented that the presence of *S. agalactiae* decreased in milk samples after freezing at minus 20°C for 70 days.

CONCLUSIONS

This study described work practices and facilities on a representative sample of Irish dairy cattle farms. It also indicated the association of milk TBS with different management practices and farm infrastructure. Some of the management practices associated with low TBC included use of heated water, participation in a milk recording scheme, tail clipping of cows at a frequency greater than once per year. Additionally an increased level of hygiene of the parlour, cubicle houses and roadways was also associated with low TBC.

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