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RESEARCH ARTICLE

The Management Practices and Microbiological Quality of a Dairy Farm with Low Bulk Tank Milk Somatic Cell Count

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A B S T R A C T

In this study, we present the management practices and microbiological quality of a dairy farm with low bulk tank milk somatic cell count (BTMSCC). In the mentioned farm, BTMSCC was generally <150,000 cells/mL. BTMSCC per day and bulk tank milk (BTM) microbiological analysis per week were carried out during one year. Weekly animal and udder health controls and management evaluations were performed; the somatic cell counts (SCCs) of the milk samples collected in only 21 weeks of the year were over 150,000 cells/mL but this value was never over 320,000 cells/mL in the herd. When the management practices of the weeks with high BTMSCC were evaluated, negative conditions including changes of paddocks of the animals and estrus synchronization were detected. In the samples taken from the milk collection tank for a total of 22 weeks, microbiological isolation occurred; the most common bacterium was *Escherichia coli*. Udder hygiene, barn hygiene, the cleanliness of the beddings, the care of the employees toward their work and personal hygiene, and disinfection of the milking machines and their maintenance were all very good for the whole year. During the weekly routine controls, clinical mastitis and teat stenosis were detected twice and once, respectively; however, in those 3 weeks, BTMSCC increased in only the week that the teat stenosis was observed. We observed that, even in farms with intense precautions, BTMSCC may increase and microbiological growth may occur in BTM. To ensure that these situations do not become permanent, these precautions should be applied continuously.

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INTRODUCTION

The factors that increase the risk of mastitis in dairy cattle may include the rapid spread of infectious mastitis among cows and the under-education of the breeders about mastitis (Dimitar and Metodija, 2012; Reyher *et al.*, 2013; Bastan *et al.*, 2015). However, in recent studies, it was suggested that inadequate or bad management practices are important predisposing factors for mastitis. Companies with high animal numbers and heavy workloads may neglect some management practices important for herd health and management, increasing the incidence of mastitis. The most important neglected applications include barn hygiene, milking hygiene, and fertilizer management. Conditions such as bad barn hygiene, inadequate animal care and nutrition, contaminated milking equipment, unhygienic milking sheds, and false milking cause permanent mastitis in dairy herds. Because the effects of these factors interfere with each other, it is difficult to determine the exact cause of mastitis in dairy herds.

Somatic cell count (SCC) in 1 mL of milk is one of the main indicators of milk quality. In addition, personal and milk bulk tank SCC follow-ups are among the important parameters used to diagnose subclinical mastitis (Smith, 1996; Malek dos Reis *et al.*, 2013); however, many factors affect SCC other than mastitis. Therefore, SCC data evaluation should be made carefully and supported with other diagnostic techniques. High bulk tank milk somatic cell count (BTMSCC) values are considered an important problem worldwide. The average BTMSCC vary between different countries, even within a country by year. This value decreased from 750,000 to 200,000 cells/mL in the USA after implementing effective mastitis control programs (Barkema, 2013). The other milk quality criterion is the microbiological isolation rate from the bulk tank. In modern farms, the quality of milk is checked routinely via samples taken from the milk bulk tanks. In weekly or monthly analyses, the numbers of *Streptococcus* spp., *Staphylococcus* spp., and coliforms and the number of total bacteria are calculated (Gillespie *et al.*, 2012; Vanderhaeghen *et al.*, 2014). In this study, we present the management practices and microbiological quality of the milk in a dairy farm with low BTMSCC.

MATERIALS AND METHODS

In this study, the daily SCC and weekly microbiological isolation rate results of a dairy farm's bulk tank milk (BTM) in the Elazig province of the East Anatolia Region of Turkey (38°35`51.55`N, 39°16` 53,28"E) (Fig. 1) were used. In the farm, there were 200 Simmental cows, between 2 and 7 years old. The study was conducted from June 2014 to June 2015. An electronic herd control system was used in the farm (DeLaval, Turkey). The cows were housed in semi-open and free-range barns for the whole year. Automatic machines with 24 openings were used in the milking sheds of the farm (DeLaval, Turkey). Forestripping was performed before each milking. The average lactation milk capacity of the included cows was 5.500 L and they were milked twice a day. Post-milking dipping was performed as a part of milking hygiene. The iodine antiseptic in the teat dipping container was changed every day and the containers were washed. Dry period treatment was not performed. Rubber beds were used in the barns. The fertilizer was cleaned with automatic scrapers 4 times a day. The veterinary staff employed at the farm followed the health states of the cows daily and cows were vaccinated according to the vaccine calendar. In addition, the authors of the article did weekly routine controls during the research. The diseases conditions of the animals (foot diseases, infectious diseases, metabolic diseases, retained placentas, abortus, etc.) were monitored using farm records. In all milked cows, the conditions related to udder health, such as clinical mastitis, pathological udder edema, hyperkeratosis, teat stenosis, and skin lesions, were additionally recorded. All these conditions were scored as present (+) or absent (-). We also observed the animals' wellbeing, foot hygiene, udder hygiene, barn hygiene, the cleanliness of the beds, the density of flies and insects, the care of the employees toward their work and personal hygiene, the control of the entrances and exits of people and vehicles, and the disinfection of the milk machines and their maintenance. These observations were scored as bad (-), good (+), or very good (++). The same person performed this scoring during the study. If any bacteria were isolated in the microbiological tests, the milking system was completely washed with electrolyzed water.

Microbiological tests were performed at the Laboratory of the Department of Microbiology, Veterinary Faculty, Firat University. Samples were collected from the bulk milk tanks in sterile 10-mL test tubes once a week. The collected samples were transferred to the laboratory under cold conditions (+4ºC) in 30-40 minutes. The microbiological analyses were performed with cultivation in 5% blood agar and MacConkey agar and incubated under aerobic, anaerobic and microaerophilic atmosphere at 38ºC. The identification of the isolates of the bacteria was performed according to the classical techniques (Britten, 2012; Deb *et al.*, 2013).

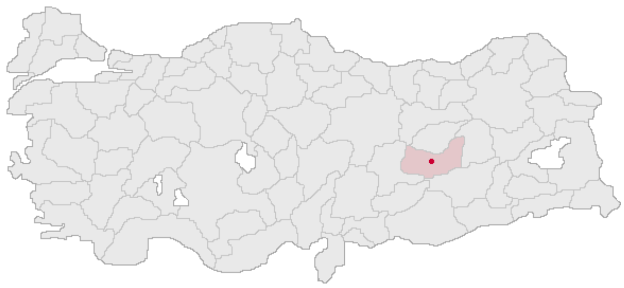

Fig. 1: The location of the farm in the Elazig province, Turkey where the study was conducted (38°35`51.55`N, 39°16`53, 28"E).

For SCC, samples were collected in 5-mL plastic tubes from the bulk milk tank at morning milking every day. A DeLaval Cell Counter® (DeLaval International, Sweden) cell count machine was used for SCCs (Pyörala, 2003; Dufour *et al.*, 2011; More *et al.*, 2013).

Using the data collected in this study, the weekly, monthly, and seasonal BTMSCC descriptive statistics were calculated. Afterward, one-way analysis of variance was used for inter-seasonal comparisons of SCC values. SPSS 11.5 program was used for calculations and analyses.

RESULTS

Generally, the farm’s BTMSCC values were less than 150,000 cells/mL. The weekly, monthly, and seasonal BTMSCC distributions are shown in Fig. 2 & 3 and Table 1, respectively. No statistically significant differences were found in the BTMSCC values between seasons ($P>0.05$); however, the highest BTMSCC value was detected in March 2015 (229,000±24,770 cells/mL $P<0.05$) and the lowest value was detected in July 2014 (105,000±10,359 cells/mL $P<0.05$). According to this, the SCCs of the milk samples collected in 21 weeks in the year were over 150,000 cells/mL. In the weeks where the SCCs were high, there were changes in the animals' paddocks and estrus synchronization facilities, increases in births, vaccinations against mastitis, anti-parasitic applications, and milking machine failures. However, in 9 weeks of the year, in routine follow-up, despite the lack of any abnormal conditions for the herd, the SCCs were over 150,000 cells/mL. Even so, the BTMSCC was never over 320,000 cells/mL in this herd.

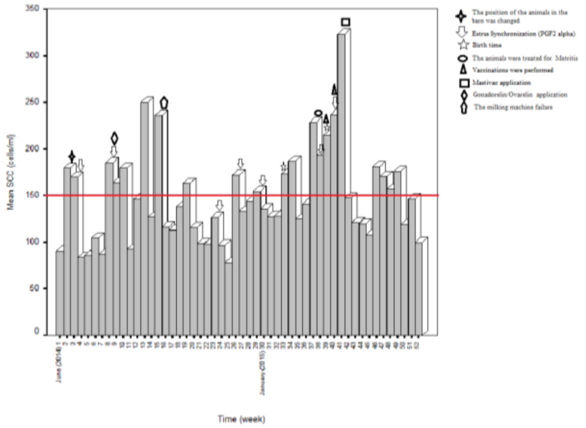

Fig. 2: BTMSCC distribution by week (* cells/mL x 1000)

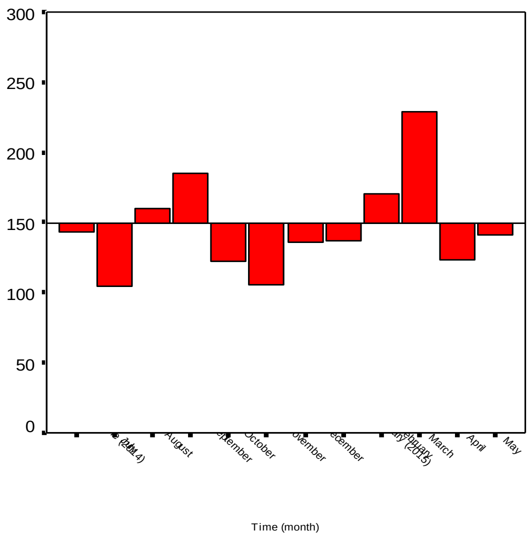

Fig. 3: BTMSCC distribution by month (* cells/mL x 1000)

Table 1: BTMSCC distribution by season (* cells/mL x 1000)

Seasons	BTMSCC
Summer	132±9.869
Fall	138±11.948
Winter	148±9.129
Spring	159±11.289
P	-

Table 2: The bacteria isolated from the samples taken from the bulk milk tanks, by week.

Bacteria	Week
Escherichia coli	9
Escherichia coli + *Candida*	6
Escherichia coli + *Staphylococcus spp.*	2
Escherichia coli + *Streptococcus spp.*	1
Escherichia coli + *Pseudomonas spp.*	1
Candida	3
Total	22

The bacteria isolated from the bulk milk tanks and their weekly distributions are presented in Tables 2 and 3, respectively. Isolation was observed in 22 weeks of the year in the milk samples, and the most commonly identified bacterium was *Escherichia coli*.

The evaluation of the animals' wellbeing in the farm was made according to the area distribution per animal in the paddocks, animal number in the paddocks, situation of the animals (if they could move freely or not), air conditioning and lighting state of the paddocks, accessibility to clean water and food, and state of the pads (Yener *et al.*, 2013). According to these criteria, the animal wellbeing was very good (++) in the farm. Foot hygiene was good in 2 weeks (+), but very good (++) in the remaining weeks. Udder hygiene, barn hygiene, the cleanliness of the beds, the care of the employees to their work and personal hygiene, and the disinfection of the milking machines and their maintenance were very good (++) for the whole year. There were problems observed with the density of flies and insects and the control of vehicle and person entrances and exits at the farm; especially in the summer season, the density of flies and insects increased despite all the preventive applications.

Weekly routine controls showed clinical mastitis in 2 weeks (7th and 20th weeks) and teat stenosis in 1 week (8th week) in the cows. In these 3 weeks, BTMSCC increased only in the week in which teat stenosis was detected. The conditions related to udder health, such as pathological udder edema, hyperkeratosis, and skin lesions, were not observed during the whole year.

Infectious diseases, metabolic diseases, and retained placentas were not detected during the weekly routine controls for the whole year; however, foot diseases in 1 week (9th week) and abortus cases in 2 weeks (4th and 5th weeks) were observed. Within these 3 weeks, however, BTMSCC increases were observed only in the week that the foot diseases were observed.

The antibiotic application for treatment or prevention of metritis was only performed at the 37thintrauterine week during the study.

DISCUSSION

Our results confirmed that low BTMSCC in dairy farms is closely related with good farm management practices. There is no linear relationship between BTMSCC and the prevalence of cows with high SCC (Lievaart *et al.*, 2007) because there are many factors that affect SCC. For example, SCC may differ according to the bacteria that cause mastitis; *Streptococcus agalactiae* or *Streptococcus uberis* cause less SCC than *Staphylococcus aureus*. Still, BTMSCC may give an approximate rate of cows with high SCC in the farm (Pinzón-Sánchez and Ruegg, 2011; Barkema, 2013; Bortolami *et al.*, 2015).

Table 3: The weeks where bacterial growth was detected from the bulk milk tanks.

Week	1	2	3	4	5	6	7	8	9	10	11	12	13
Growth	-	-	-	-	+	+	+	+	+	+	+	+	+
Week	14	15	16	17	18	19	20	21	22	23	24	25	26
Growth	-	+	-	-	-	-	+	-	-	+	-	-	+
Week	27	28	29	30	31	32	33	34	35	36	37	38	39
Growth	+	-	-	-	-	-	+	-	+	+	+	-	-
Week	40	41	42	43	44	45	46	47	48	49	50	51	52
Growth	+	-	+	-	+	-	-	-	+	-	-	-	-

Microbiological tests of BTM samples allow early diagnosis of contagious pathogens that cause mastitis, such as *Staphylococcus aureus*, *Streptococcus agalactiae*, or *Mycoplasma* spp (De Vliegher *et al.*, 2012; Fry *et al.*, 2014; Oliveira *et al.*, 2015; Tomazi *et al.*, 2015). In a study performed in Italy (Zucali *et al*., 2011), the standard plate count, coliform count, and SCC of the samples taken from the BTM were higher in the hot seasons than the cold seasons. In the same study, it was found that the cleanliness of the cows affected the standard plate count, coliform count, and *Escherichia coli* presence in the BTM. Bacterial BTM counts were also significantly affected when companies gave less care toward milking hygiene and disrupted forestripping, pre-dipping, and post-dipping applications. Reyher *et al.* (2012) showed that *Corynebacterium bovis* and coagulase-negative staphylococci prevalence were high in farms where post-milking teat disinfection was not performed. In our study, the most frequently isolated bacterium from BTM was *Escherichia coli*. In addition, *Escherichia coli*, *Staphylococcus* spp., *Streptococcus* spp., *Pseudomonas* spp., and *Candida* grew. Despite this kind of isolation in the milk samples, the absence of clinical mastitis in the cows and the disappearance of isolation within a period of time were accepted, as this situation is a marker of BTM contamination or other kinds of contamination. If there was any isolation from the samples taken from the BTM, the milking system and the tank were completely washed with electrolyzed water.

In a study conducted by Sterrett and Bewley (2013), it was reported that the most common applications in farms with low BTMSCC were drying teats (100.0%, n=47) before attaching milkers (95.8%, n=46), pre-dipping (91.7%, n=44), dry treating all quarters of all cows (85.4%, n=41), incorporating the Dairy Herd Improvement Association guidelines as a SCC management tool (83.3%, n=40), using individual towels to dry teats (77.1%, n=37), receiving bulk-tank SCC (77.1%, n=37), and trimming hooves at least annually (75.0%, n=36). Still, in the same study, it was recommended that, in farms with low BTMSCC, cow and barn cleanliness, clean and dry beds, forestripping applications, and following the milking rules should be considered. In a study conducted by Sadeghi-Sefidmazgi and Rayatdoost-Baghal (2014), in farms with low SCC in dry climate regions, sawdust combined with sand bedding, using automatic cup removers, disinfection of the teats by dipping into disinfectant, using washable towels for teat cleaning, free-stall barns, wet disposable tissue for udder washing, wearing gloves during milking, and the use of humidifiers and shade and management practices should be applied. In our study, animal wellbeing was very good (++) in all weeks. The foot hygiene was good (+) in only 2 weeks but very good (++) in the remaining weeks. Conditions such as udder hygiene, barn hygiene, the cleanliness of the beddings, the care of the employees to their work and their personal hygiene, and the disinfection of the milking machines and their maintenance were all very good (++) for the whole year. Some problems were observed in the density of flies and insects and the control of the entrance and exit of people and vehicles at the farm; especially in the summer season, the density of flies and insects increased despite all the preventive applications.

Both clinical and subclinical mastitis and generalized diseases observed in the animals have observably increased BTMSCC (Dimitar and Metodija, 2012; Barkema, 2013; Bastan *et al.*, 2015). In the present study, the routine weekly controls revealed clinical mastitis in 2 weeks (7th and 20th weeks), teat stenosis in 1 week (8th week), foot diseases in 1 week (9th week), and abortus cases in 2 weeks (4th and 5th weeks). Laboratory analyses were performed after these situations, especially after abortus cases, and no disease was detected. These abortus cases were classified as idiopathic. In addition, it was observed that the animals with clinical mastitis were removed from the herd without antibiotic treatment and intensive disinfection was performed afterwards.

Conclusions: BTMSCC may increase and micro-biological growth may occur in BTM, even in farms with proper precautions like the one we studied, possibly due to changing the locations of the animals within a farm, estrus synchronization applications, and mastitis vaccine applications. Intense precautions should be applied continuously to ensure that increases in BTMSCC and microbiological growth are not permanent.

Authors contribution: AR, IS conceived and designed the experiments; NS, BK, AK, EK performed the experiments; IS analyzed the data and AR, IS wrote the manuscript. All authors critically revised the manuscript for important contents and approved the final version.

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