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Correlation between mastitis occurrence and the count of microorganisms in bulk raw milk of bovine dairy herds in four selective culture media

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Milk is the normal secretion of the mammary gland, practically free of colostrum and obtained by the complete milking of one or more healthy animals. Mastitis is an inflammatory process of the mammary gland and it may cause alterations in the milk. The present work aimed to verify whether it is possible, by means of the counts of microorganism in the bulk raw milk in four selective culture media, to establish a correlation with the occurrence of mastitis and therefore, to monitor this disease in bovine dairy herds. The following selective culture media were used: KF *Streptococcus* Agar, Edwards Agar, Baird-Parker Agar, Blood Agar plus potassium tellurite. Spearman's correlation coefficient was calculated in order to compare the occurrence of mastitis (percentage) in each herd with respective selective culture media counts of microorganisms in bulk raw milk. Thirty-six possibilities were analysed (Tamis and CMT-positive rates were compared with the log-transformed count in four selective culture media) and there was a negative correlation between Tamis 3 and the Baird-Parker Agar plate count. The total results of microbiological tests showed that there were three correlations of the counts in selective culture media. Fifty-two possibilities were analysed and there was a negative correlation between no-bacterial-growth mastitis rates and $\log_{10}$ of KF *Streptoccocus* Agar plate count and there were two positive correlations between coagulase-positive staphylococci and $\log_{10}$ of Baird-Parker Agar plate count and Blood Agar plus potassium tellurite plate count.

Keywords: Mastitis, bulk raw milk, selective culture media.

Milk synthesis involves the supplying of suitable precursors to the mammary gland, their transformation into milk, and its expulsion from the gland (Cullor & Tyler, 1996). Milk is the normal secretion of the mammary gland, practically free of colostrum obtained by the complete milking of one or more healthy animals, well fed and rested, under appropriate hygiene conditions, that has not been heated to more than 40 °C or undergone any treatment that has an equivalent effect (Brazil, 2002; EU, 2004; US Food and Drugs Administration, 2003). Lactating animals that show evidence of the secretion of milk with abnormalities in one or more quarters, based upon bacteriological, chemical or physical examination, shall be milked last or with separate equipment and the milk shall be discarded (US Food and Drugs Administration, 2007).

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Mastitis is an inflammatory process of the mammary gland that causes changes in milk composition, secretion of epithelial cells and a reduction in the functional capacity of the mammary gland. The loss of mammary tissue function can be permanent, depending on the severity of the lesions resulting from the inflammatory process, reducing partially or totally the productive capacity of the affected mammary quarter (Cullor & Tyler, 1996; Merck, 2008).

Huijps, Lam & Hogeveen (2008) show that the financial losses caused by mastitis are higher than perceived by milk producers. The authors claim that annual financial losses caused by mastitis were around €78/cow, on average, on Dutch dairy farms. Bennett, Christiansen & Clifton-Handley (1999) studied five endemic diseases in bovine dairy herds and observed that mastitis is the disease that presents the highest financial losses, even higher than the costs of treatment and preventive measures.

Several papers show that the increase in the number of somatic cells in the milk causes alterations in physical-chemical composition, microbiological and sensorial characteristics of dairy products. There is also a reduced yield of dairy products from milk with high somatic cell counts (SCC) (Daniel, Biggs & Barnum, 1966; Audist et al. 1996; Fitz-Gerald, Deeth & Kitchen, 1981; Kitchen, 1981; Hortet & Seegers, 1998; Fernandes, Oliveira & Lima, 2007; Mazal et al. 2007; Vianna et al. 2008).

Ruegg & Tabone (2000) observed that dairy cow herds with high SCC posed a higher risk of presenting antibiotic residues in the milk. The authors point out the importance of a control programme so that this risk can be reduced, since it is considered a Critical Control Point in the Hazard Analysis Critical Control Point (HACCP). Sumner (1999) pointed out that milk is a good medium for microbial growth and that the dairy cows can transmit pathogenic microorganisms to human beings, a health risk that must be controlled.

Mastitis rates in dairy cow herds influence the microbiological quality of the bulk raw milk and SCC influences the bulk tank milk (Jayarao & Wolfgang, 2003; Jayarao et al. 2004; Rysanek & Babak, 2005; Park et al. 2007).

The aim of the present work was to assess whether it is possible, by means of the counts of microorganisms in the bulk raw milk using four selective culture media, to establish a correlation with the occurrence of mastitis; and therefore to monitor this disease in dairy bovine herds through the bulk tank milk.

Materials and Methods

Thirty-six farms provided the samples included in this study. All lactating cows were sampled to determine the presence of mastitis. The farms were located in fourteen cities of São Paulo State, Brazil. Samples were collected from April 2004 to September 2005. Among the 36 farms that took part in the study, 10 (27·78%) had an intensive system of production and 26 (72·22%) had a semi-intensive production system; 15 (41·67%) of herds were pure Holstein-Friesian herds, 1 (2·78%) was a Jersey herd and 20 (55·55%) were herds with a mixed origin; daily production was 40–1500 l; 15 farms (41·67%) produced up to 250 l/d, 15 (41·67%) produced between 251–1000 l/d and 6 (16·66%) produced 1001–1500 l/d; 16 properties (44·44%) were considered as producers of type B milk, which presupposes a limit of total bacteria count (TBC) of $5{\cdot}0 \times 10^5$ cfu/ml and 20 (66·66%) were considered as producers of refrigerated bulk raw milk with a maximum TBC of $1{\cdot}0 \times 10^6$ cfu/ml (Brazil, 2002).

Tests to detect mastitis

Each mammary quarter in the dairy production system was analysed only once for the presence of mastitis by using the Tamis Test (Blood & Radostits, 1991) and California Mastitis Test (CMT) (Schalm & Noorlander, 1957). Positive results to Tamis test or CMT required one sample of nearly 5 ml collected aseptically in a sterile tube for the microbiological test. Samples were stored in isothermal boxes with ice and sent to the Laboratory of Infectious Diseases at the Department of Preventive Veterinary and Animal Health, Faculty of Veterinary Medicine, University of São Paulo.

Animals that were under antibiotic treatment at the time of collection were withdrawn from the sampling. All animals presenting a positive result for the Tamis Test also presented positive results for CMT. Animals that presented any positive reactions to CMT test were considered as positive mastitis cases, either clinical or subclinical, and constituted the total mastitis group. Animals that were positive according to Tamis test were considered as positive cases for the group of clinical mastitis. All positive samples in the Tamis test were subdivided into Tamis 1, Tamis 2 and Tamis 3 according to the intensity of clots in the milk. All positive samples in the CMT test were subdivided into CMT trace, CMT 1, CMT 2 and CMT 3 according to the score of visible reaction.

In the laboratory, the samples were kept frozen until analysis, which was performed within 30 d. Samples were then thawed at room temperature, homogenized in a vortex shaker and sowed with a platinum handle (0·01 ml) in Blood Agar Base (Oxoid Ltd., Basingstoke, UK) with the addition of defibrinated sheep blood (5%) previously incubated for 18 h at 37 ± 1 °C (overnight) in order to verify the sterile conditions of the culture medium. Three readings were performed after 24, 48 and 72 h to verify the growth of microorganisms (presence or absence of colony). Samples that did not present (negative) the growing of at least a colony of microorganisms were re-analysed, repeating the procedure described above. Isolated microorganisms (bacteria and fungi) were identified and classified according to Murray et al. (1999), National Mastitis Council (1987) and Quinn et al. (2005).

Bulk raw milk to plate count agar in selective culture media

For the analysis of raw-milk plate count agar in selective culture media, a single sample of about 200 ml of bulk raw milk was collected into a sterile glass container on the same day as the analysis of mammary quarters of the herd for mastitis, and this sample was sent to the laboratory in an isothermal box with ice. Samples of bulk raw milk were collected from the surface of the storage tank after agitation, by raising the cover and taking out the required quantity, using sterile equipment. Samples were then stored under refrigeration for a maximum of 18 h before being subjected to microbiological analysis aimed at verifying the number of microorganisms present in the bulk raw milk. Milk from mammary quarters of animals treated with antibiotics was discarded and the milk from these animals was not added to the bulk raw milk sample

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because Brazilian law does not permit milk containing antibiotic residues be added to milk for human consumption.

The sample was subjected to serial decimal dilutions up to 10^{-6} in Peptone Water (0·1%; Difco, Becton Dickinson, Sparks MD, USA) and sowing in specific media was as described by the American Public Health Association (2001) and by US Food and Drugs Administration (2001).

KF Streptococcus Agar: We used the technique of sowing in depth with plates in duplicate for the dilution in medium KF *Streptococcus* Agar (Difco) added to a solution of 2,3,5-triphenyltetrazolium chloride (TTC) (Vetec Fine Chemistry Ltd, Taboão da Serra, São Paulo, Brazil) to 1% in the proportion of 1 : 100 to the culture medium. Plates were incubated inverted in a bacteriological incubator at 37±1 °C for 42–48 h (American Public Health Association, 2001; US Food and Drugs Administration, 2001).

Edwards Agar: We used the technique of sowing on the surface with plates in duplicate for dilution in Edwards Medium (Modified; Oxoid Ltd.) with the addition of defibrinated sheep blood (5%) and previously incubated for 18 h at 37±1 °C (overnight). Plates were incubated inverted in a bacteriological incubator at 37±1 °C for 42–48 h (American Public Health Association, 2001; US Food and Drugs Administration, 2001).

Baird-Parker Agar: We used the technique of sowing on the surface with plates in duplicate for dilution in Baird-Parker Agar (Merck KgaA, Darmstadt, Germany) added to a solution of egg yolk with potassium tellurite (Laborclin Ltd., Pinhais, Paraná, Brazil) in the proportion of 5 : 100 to the culture medium. Plates were incubated inverted in a bacteriological incubator at 37±1 °C for 42–48 h (American Public Health Association, 2001; US Food and Drugs Administration, 2001).

Blood Agar plus potassium tellurite: We used the technique of sowing on the surface with plates in duplicate for the dilution in Blood Agar Base (Oxoid Ltd.) with the addition of defibrinated sheep blood (5%) and a solution of potassium tellurite (Inlab Ltd., Diadema, São Paulo, Brazil) to 3·5% in the proportion of 1 : 100, and previously incubated for a period of 18 h at 37±1 °C (overnight). Plates were incubated inverted in a bacteriological incubator at 37±1 °C for 42–48 h (American Public Health Association, 2001; US Food and Drugs Administration, 2001).

Statistical analysis

To calculate the correlation between the occurrence of mastitis and the counts in bulk raw milk, we performed a $\log_{10}$-transformation of the counts in selective culture media.

Spearman's correlation coefficient was calculated to compare the frequency of mastitis (percentage) in each dairy herd with the respective counts of microorganisms in selective culture media, using the SPSS® 9.0 Statistics Software.

Results

Both the mastitis occurrence and the counts in selective culture media varied considerably among the 36 herds studied. The main cases of infectious mastitis were caused by *Corynebacterium* spp. (11·24%), *Staphylococcus* spp. (9·20%), *Streptococcus* spp. (5·34%) and by associations among these groups of microorganisms (4·76%). Few cases of mastitis caused by yeast and other microorganisms were identified (0·45%). The bacterial species most frequently identified biochemically was coagulase-negative staphylococci (9·52%) and the least frequent was *Streptococcus uberis* (1·57%). Data on mastitis occurrence in dairy herds are presented in Table 1. Table 2 presents lowest and highest values, averages and median values of aspects related to mastitis cases in the herds.

Counts using selective culture media for samples of bulk raw milk are described in Table 3. The lowest and the highest counts were $2{\cdot}3 \times 10^1$ cfu/ml and $2{\cdot}9 \times 10^7$ cfu/ml, respectively. Both the lowest and the highest values were observed in Edwards Agar selective media.

Comparing the tests indicative of mastitis (Tamis and CMT) with the plate counts using selective culture media revealed only one negative correlation between Tamis 3 and $\log_{10}$ of Baird-Parker Agar counts (Table 4).

A significant negative correlation was observed between the occurrence of no-bacterial-growth mastitis and the $\log_{10}$ of counts in KF *Streptococcus* Agar. A significant positive correlation was observed between the occurrence of mastitis due to coagulase-positive staphylococci and $\log_{10}$ of Baird-Parker Agar plate counts and Blood Agar plus potassium tellurite plate counts. All other correlations did not present significant results. Results of the analysis of correlation between the mastitis occurrence in dairy herds and the $\log_{10}$ of counts in selective media are presented in Table 5.

Discussion

As reported by others, *Staphylococcus* spp., *Streptococcus* spp. and *Corynebacterium* spp. were the microorganisms responsible for the largest number of cases of intramammary infectious. Mastitis rates (39·12%) found in the present work were similar or higher than found by others (Nader Filho, Shocken-Iturrino & Rossi Júnior, 1983, 1984; Costa et al. 1986; Cullor & Tyler, 1996; Langoni et al. 1998; Tenhagen et al. 2006; Ferguson et al. 2007; Piepers et al. 2007).

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Table 1. Distribution of cases of mastitis occurrence and their respective percentages (in relation to the mammary quarters) found in the 36 analysed properties

Dairy herd data	Total number	Percentage
Number of animals	1180	
Number of mamary quarters†	4662	98·77
Tamis Test total	125	2·68
Tamis 1	59	1·27
Tamis 2	24	0·51
Tamis 3	42	0·90
California Mastitis Test (CMT) total	1824	39·12
CMT traces	558	11·97
CMT 1	490	10·51
CMT 2	513	11·00
CMT 3	263	5·64
No infection mastitis	379	8·13
Mastitis infection	1445	31·00
Genus of microorganisms isolated		
Staphylococcus spp.	429	9·20
Streptococcus spp.	249	5·34
Corynebacterium spp.	524	11·24
Staphylococcus spp. + *Streptococcus* spp.	58	1·24
Staphylococcus spp. + *Corynebacterium* spp.	94	2·02
Streptococcus spp. + *Corynebacterium* spp.	63	1·35
Staphylococcus spp. + *Streptococcus* spp. + *Corynebacterium* spp.	7	0·15
Yeasts	2	0·04
Other microorganisms and combinations‡	19	0·41
Species of micoorganisms isolated		
Coagulase-positive staphylococci	146	3·13
Coagulase-negative staphylococci	444	9·52
Streptococcus agalactiae	212	4·55
Streptococcus dysgalactiae	96	2·06
Streptococcus uberis	73	1·57
Corynebacterium ulcerans	409	8·77
Corynebacterium bovis	280	6·01

† 58 of the total mamary quarters (1·23 %) with lost milk production due to severe mastitis cases
‡ Combinations may include *Staphylococcus* sp., *Streptococcus* sp. or *Corynebaterium* sp.

According to the increase of no-bacterial-growth mastitis rates, there is a decrease in the counts of microorganisms of bulk raw milk in one selective medium (KF *Streptocooccus* Agar) and vice-versa. Souto et al. (2008) also observed a negative correlation among cases of no-bacterial-growth mastitis rates with mesophilic and psychotropic aerobic plate counts.

The positive correlation between the coagulase-positive staphylococci mastitis rates and the counts of microorganisms in bulk raw milk in Baird-Parker Agar and Blood Agar plus potassium tellurite shows that, by means of an analysis of the bulk raw milk, this selective culture medium can be an indicator of mastitis cases due to coagulase-positive staphylococci in dairy cow herds. Zecconi & Hahn (1999) report that *Staph. aureus* is the pathogen most frequently isolated from mastitis cases. They say that in order reduce the contamination risk of the raw milk by *Staph. aureus*, it is necessary to implement control measures to reduce the number of cows presenting intramammary infections caused by this microorganism. The authors also say that bacteriological methods applied to pathogen diagnosis must be periodically updated and revised. Phuektes et al. (2003) report that the presence of *Streptococcus agalactiae* was associated with high TBC; however, they did not observe this association for the isolation of *Staph. aureus, Str. dysgalactiae* and *Str. uberis*. Souto et al. (2008) found a positive correlation between *Staphylococcus* spp. mastitis rates with thermophilic and yeasts and mould aerobic plate counts. Park et al. (2007) found a correlation between SCC and the identification of several microorganisms that cause mastitis in milk samples. Jayarao et al. (2004) observed that the increase of the bulk tank SCC was significantly associated with the isolation of *Staph. aureus* and *Str. agalactiae*.

Ruegg (2003) describes the relationship between CMT and SCC. CMT score approximates to corresponding SCC values: negative, 0–200 000 cells/m; CMT traces, 150 000–500 000 cells/ml; CMT 1, 400 000–1 500 000 cells/ml;

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Table 2. Lowest and highest values, averages and median of aspects related to mastitis in dairy herds (number of mammary quarters)

Dairy herd data	Minimum	Maximum	Average	Median
Number of animals	9	92	32·78	27
Number of mammary quarters†	36	364	129·50	107·5
Tamis Test total	0	19	3·47	1
Tamis 1	0	14	1·64	1
Tamis 2	0	6	0·67	0
Tamis 3	0	11	1·17	0
California Mastitis Test (CMT) total	7	148	50·67	46
CMT traces	1	79	15·50	12
CMT 1	0	41	13·61	12
CMT 2	0	47	14·25	9
CMT 3	0	56	7·31	0
No infection mastitis	0	42	10·53	6
Mastitis infection	6	126	40·14	34·5
Genus of microorganisms isolated				
Staphylococcus spp.	1	37	11·92	9
Streptococcus spp.	0	34	6·92	5
Corynebacterium spp.	0	64	14·56	9
Staphylococcus spp. + *Streptococcus* spp.	0	12	1·61	1
Staphylococcus spp. + *Corynebacterium* spp.	0	12	2·61	2
Streptococcus spp. + *Corynebacterium* spp.	0	8	1·75	1
Staphylococcus spp. + *Streptococcus* spp. + *Corynebacterium* spp.	0	2	0·19	0
Yeasts	0	1	0·06	0
Other microorganisms‡	0	7	0·53	0
Species of microorganims isolated				
Coagulase-positive staphylococci	0	22	4·06	2
Coagulase-negative staphylococci	1	56	12·34	8,5
Streptococcus agalactiae	0	46	5·89	2
Streptococcus dysgalactiae	0	14	2·67	1
Streptococcus uberis	0	12	2·03	1
Corynebacterium ulcerans	0	64	11·36	8
Corynebacterium bovis	0	30	7·78	5

† 58 of the total mamary quarters (1·23 %) with lost milk production due to severe mastitis cases
‡ Combinations may include *Staphylococcus* sp., *Streptococcus* sp. or *Corynebaterium* sp.

Table 3. Lowest, highest, average and median values of different counts of microorganisms in selective culture media in bulk raw milk

Microorganism counts of raw milk in all dairy herds	Minimum	Maximum	Average	Median
KF Streptococcus Agar†	$2{\cdot}6 \times 10^{1}$	$2{\cdot}3 \times 10^{7}$	$1{\cdot}3 \times 10^{6}$	$4{\cdot}1 \times 10^{4}$
Edwards Agar†	$2{\cdot}5 \times 10^{1}$	$2{\cdot}9 \times 10^{7}$	$1{\cdot}8 \times 10^{6}$	$4{\cdot}2 \times 10^{4}$
Baird-Parker Agar†	$1{\cdot}4 \times 10^{3}$	$2{\cdot}0 \times 10^{7}$	$1{\cdot}3 \times 10^{6}$	$2{\cdot}8 \times 10^{4}$
Blood Agar + Potassium Tellurite†	$1{\cdot}4 \times 10^{2}$	$1{\cdot}7 \times 10^{7}$	$8{\cdot}5 \times 10^{5}$	$1{\cdot}4 \times 10^{4}$

† Plate count, cfu/ml

CMT 2, 800 000–5 000 000 cells/ml; and CMT3, above 5 000 000 cells/ml. In the present study we did not observe a relationship between CMT-positive rates and counts using selective media (Table 4). CMT scores and corresponding SCC values in raw milk showed no significant correlation between bacterial counts with SCC in bulk raw milk in the conditions of this research.

We observed a negative correlation between Tamis 3 mastitis rates and Baird-Parker Agar, showing that the lower clinical mastitis rates, degree 3 (the most severe) showed the highest count of microorganisms in Baird-Parker Agar (Table 4). Schukken et al. (1989) observed an association between cases of clinical mastitis and low SCC. On the other hand, Haas et al. (2004) found a correlation between cases of clinical mastitis and high SCC.

Coagulase-positive staphylococci showed a positive correlation with two counts in selective culture media, showing that Baird-Parker Agar and Blood Agar plus potassion tellurite can be effective culture media to demonstrate the degree of mastitis for coagulase-positive

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Table 4. Values of Spearman's correlation test among the different $\log_{10}$ counts of microorganisms in selective culture media in bulk raw milk and the mastitis occurrence (Tamis and CMT) in dairy herds

Correlation test (Spearman)	KF Streptococcus Agar†	Edwards Agar†	Baird-Parker Agar†	Blood Agar + potassium tellurite†
Tamis-positive total	−0·024	0·048	−0·050	0·039
Tamis 1	0·081	0·069	0·036	0·061
Tamis 2	−0·147	−0·167	−0·197	−0·138
Tamis 3	−0·326	−0·150	−0·372*	−0·279
CMT-positive total	−0·020	0·210	0·158	0·102
CMT traces	0·103	0·192	0·257	0·177
CMT 1	0·036	0·093	0·012	0·238
CMT 2	−0·123	0·100	−0·165	−0·187
CMT 3	−0·191	−0·239	−0·234	−0·288

† Plate count, cfu/ml
* $P<0·05$

Table 5. Values of Spearman's correlation test among the different $\log_{10}$ counts of microorganisms in selective culture media in bulk raw milk and the microbiological test for mastitis occurrence in dairy herds

Correlation Test (Spearman)	KF *Streptococcus* Agar†	Edwards Agar†	Baird-Parker Agar†	Blood Agar + potassium tellurite†
No bacterial growth	−0·339*	0·100	−0·261	−0·281
Infectious mastitis	0·135	0·292	0·281	0,222
Staphylococcus spp.	0·148	0·299	0·315	0·316
Coagulase-positive staphylococci	0·166	0·272	0·338*	0·341*
Coagulase-negative staphylococci	0·001	0·097	0·074	0·038
Streptococcus spp.	0·111	0·151	0·028	0·099
Streptococcus agalactiae	0·040	0·140	0·026	−0·078
Streptococcus dysgalactiae	0·097	0·097	0·012	0·226
Streptococcus uberis	0·021	−0·190	−0·159	−0·077
Corynebacterium spp.	−0·004	0·058	−0·010	0·015
Corynebacterium ulcerans	0·088	0·101	0·142	0·047
Corynebacterium bovis	−0·250	−0·212	−0·277	−0·171
Other microrganisms	0·181	0·178	0·140	0·183

† Plate count, cfu/ml
* $P<0·05$

staphylococci. However, when we tested the four selective culture media for the main mastitis pathogens, our study showed a low number of correlations between the occurrence of mastitis in dairy herds and the count of microorganisms in the bulk raw milk (Tables 4 and 5). Sumner (1999) identified six risk groups in hygienically produced milk: microbiological contamination, bacterial growth, mastitis milk, antibiotic and drug residues, cleaning residues and environmental contamination. In the present research, however, we did not study all the risk groups indicated by Sumner. Other variables such as microbiological contamination during the milk production process, increased storage temperature, lack of hygiene and environmental contamination seem to be more important to the bacteriological quality of bulk raw milk than the mastitis rates.

The wide variation in mastitis occurrence in the dairy herds (Table 2) and also in the counts in selective culture media (Table 3) may have interfered with the correlation results between the cases of mastitis and the counts of microorganisms in the bulk raw milk (Tables 4 and 5). Maybe it is easier to establish correlations between mastitis rates and bulk tank milk counts when there is more hygienic control in dairy herds in which the bacterial counts are low ($1·0 \times 10^5$ cfu/ml, for example). A greater number of samples and better standardization of herd production conditions than in the present work may present more correlations between mastitis rates and counts in selective media.

Several reports show a loss of milk nutrients, increased enzymic activity and decreased yield of dairy products associated with the high SCC (Haenlein, Shultz & Zikakis, 1973; Randolph & Erwin, 1974; Fitz-Gerald, Death & Kitchen, 1981; Murphy et al. 1989; Rogers & Mitchell, 1994; Auldist et al. 1996; Cooney et al. 2000; Somers et al. 2003).

Some studies show sensorial alterations and decrease of milk and dairy products shelf-life caused by the increased SCC (Ma et al. 2000; Santos et al. 2003). Østerås (2005) states that the first financial losses caused by mastitis are

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related to the following: drugs, veterinarian, milk production losses, discarded milk, changes in milk price, culling, mastitis cases in other cows and the risk of other diseases.

Despite the low number of correlations between the occurrence of mastitis and the counts of bacteria in the bulk raw milk, the disease must be controlled because it causes alterations in milk composition and incurs financial losses.

Conclusion

Under the conditions of this experiment, mastitis occurrence showed few correlations with counts of microorganisms in bulk raw milk in four selective culture media. Two counts of microorganisms were negatively correlated with cases of Tamis 3 and no-bacterial-growth mastitis and two counts of microorganisms were positively correlated with the occurrence of coagulase-positive staphylococci. Two selective culture media used for *Staphylococcus* sp. count (Baird-Parker Agar and Blood Agar plus potassium tellurite) were effective in identifying mastitis rates with coagulase-positive staphylococci in dairy herds.

The selective culture media that were used were not very effective in monitoring mastitis rates in dairy herds according to the model proposed in this study.

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