Incidence and Causes of Sub-Clinical Mastitis in Dairy Cows on Smallholder and Large Scale Farms in Tropical Areas of Tanzania

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ABSTRACT : A study on the prevalence and causes of sub-clinical mastitis was conducted on ten smallholder and large-scale dairy farms in Morogoro urban and peri-urban areas. A total of 65 lactating cows were screened using the California Mastitis Test (CMT). Confirmatory tests used included; the direct microscopic somatic cell count (DMSCC), culture, bacteriological and biochemical tests. Structured questionnaires were used to collect information on management aspects. Results showed 62% and 4% cows as sub- clinical and clinical mastitis cases respectively. Levels of infection were higher on smallholder farms (75%) than on large-scale farms (25%). All tested cows had high cell counts (>500,000) per ml of milk. Incidences of mastitis were significantly ($p<0.05$) related to milking practices. The dominant bacterial isolates in the same order were *Staphylococcus aureus, Streptococcus spp*, and *Escherichia coli.* Other organisms isolated included *Pseudomonas spp* and *Klebsiella spp*. It was concluded that the high rates of sub-clinical mastitis in the research area were mainly due to poor management and unhygienic milking practices. *(Asian-Aust. J. Anim. Sci. 2001. Vol. 14, No. 3 : 372-377)*

Key Words : Dairy Cows, Bacterial Infections, Management, Bacterial Isolates

INTRODUCTION

Mastitis is recognised as one of the most costly diseases in dairy cattle (Kinabo, 1983). Worldwide, about 50% of dairy cows have some form of mastitis (McDonald, 1979). Studies conducted in the Lake zone of Tanzania, (Msanga et al., 1984) showed that the average annual incidence of sub-clinical mastitis was between 40% and 71.6%. Sub-clinical mastitis adversely affects quantity and quality of milk, and can bring great losses to farmers through high culling rates (especially for clinical mastitis), veterinary expenses and losses in milk production. Type, strain, number and virulence of bacteria influence the incidence of mastitis in the cow (Blood and Radostis, 1985). The commonest bacterial causes of sub-clinical mastitis are *Staphylococcus aureus*, *Streptococcus spp.* and *Escherichia coli* (Msanga et al., 1984).

Management is an important factor in the spread and control of mastitis. For example, type of milking, be it by machine or by hand can influence the incidence of sub-clinical mastitis (Rodriguez, 1997). Either technique requires hygienic conditions to avoid the spreading of mastitis to cows. Other important management factors include housing (Goodger et al., 1988, Wilson et al., 1997) and nutrition, especially vitamin A, which is necessary for the integrity of the epithelium lining the mammary gland (Nangwala and Kurwijila, 1995). Animal factors including stage of lactation, breed, teats shape and size and immunity level also influences the incidence of mastitis (Topley, 1982; Whitlemore, 1980; Dodd, 1984; Blood and Radostis, 1985).

Several studies in E. Africa have shown that both clinical and sub-clinical mastitis affect dairy cattle both on large and small-scale farms (Kinabo and Assey, 1983; Mahlau and Hyera, 1984; Machangu and Muyungi, 1988; Shekimweri et al., 1998). However, little work has been done to elucidate the extent of the problem in urban and peri-urban dairy production under variable management conditions.

This study was therefore carried out to determine the influence of management on the incidence of sub-clinical mastitis and to identify the main causative organisms of sub-clinical mastitis both on large-scale farms and smallholder farms in Morogoro urban and peri-urban areas.

MATERIALS AND METHODS

Animals and their management

Ten dairy farms (five large scale/medium and five smallholder) were selected from a sampling frame of 30 farms in Morogoro urban and peri-urban areas, Tanzania using a systematic sampling procedure (Mettrick, 1993). From these farms, a total of 64

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lactating cows (in equal numbers) were selected at random. All the cows selected were in the third to fifth lactations and were producing an average of 13 litres per day per cow. Cows selected were in their 3rd to 4th month of lactation. For sampling, all cows on smallholder dairy farms were zero grazed while those on large/medium scale dairy farms were freely grazed either in established pasture or in communal grazinglands. Lactating cows under both systems of management were supplemented with concentrates at the time of milking. Except for one farm where machine milking was practised, all cows were hand milked. All farms practised pre-milking sanitization with warm water only. None of the farms practised either post-milking teat sanitization or dry cow therapy at drying off.

Survey study

The one point survey method was used to collect information on general management from the ten dairy farms (Horton, 1982). The study was carried out only in the wet season between the months of January and April 1998. Information was collected on aspects such as milking practices, feeding practices, housing and general hygiene. Milking practices included the methods used (hand or machine milking, milking personnel and their employment record and skills, and assessment of udder empting (by teat stripping). The formal survey data were supplemented with information obtained through personal observations and discussions with farmers and/or their workers.

Sampling procedure

Simultaneous to the survey study, milk samples were collected once from each of the randomly select ed cows in each test farm according to two breeds (Friesian and Ayrshire). Samples were collected under strict hygienic conditions as described by Shekimweri et al. (1998). Milk samples were taken after discarding the first three strokes of milking to avoid contamination by extraneous bacteria. Approximately 10ml of milk was collected from each quarter into sterile universal bottles and subjected to the California Mastitis Test (CMT) as described by Schalm et al. (1971). The CMT was done during the afternoon milking to enable correct appreciation of the reactions under natural light conditions. Arbitrary scores were assigned to the various degrees of coagulation as follows:

Degree of coagulation:	-	+	2+	3+
Assigned score	0	1	2	3

Milk leucocyte counts were done on all CMT tested samples using the Direct Microscopic Somatic Cell Count (DMSCC), except that the stain used was the modified Newman Lampart stain. The stain was prepared by mixing 54 ml of 95% ethanol and 40 ml of trichloroethane as described by the International Dairy Federation (IDF/FIL. 1979). Clinical mastitis was determined by palpation and visual observation of first squirts of milk.

Isolation and characterisation of the bacterial strains

A loopfull from a sub-sample of 0.5 ml of each CMT positive milk sample was passed onto blood agar plate using a sterile wire loop. Similarly, a sample was also streaked onto MacConkey agar (prepared according to the manufacturer's instructions (Oxoid Ltd, Basingstoke Hampshire, England) and Edward's medium (Machangu, 1988) to selectively favour the growth of *Enterobacteriaceae spp.* and *Streptococcus spp.* respectively. All plates were incubated at 37℃ for 18-24 hours. Growth on the primary culture media was tentatively identified by colony morphology and haemolytic characteristics. Coagulase and sugar fermentation tests were carried out to confirm the genera Staphylococcus and Streptococcus respectively. IMVIC tests to confirm the genera, *Klebsiella*, *Pseudomonas spp* and *coli* were carried out according to IDF/FIL (1981).

Statistical analysis

The survey data was analysed using SPSS statistical package. The DMSCC data were subjected to analysis of variance (ANOVA) using the general linear model (GLM) (SAS 1988). The following model was applied:

$$Y_{ujk} = \mu + F_i + M_j + e_{ijk}$$

Where:

Y_{ujk}=observation from ith farm practising jth management practice (small scale-zero grazing vs large scale free grazing

μ =General mean

Fi=Effect due to ith farm

M_j=Effect due to jth milking practice

e_{ijk}=Random error (residual effect particular to kth observation from the breed in the ith farm

RESULTS

Management

The survey results revealed that smallholder and large-scale dairy farmers kept between 5 to 20 and 41 to 80 cows respectively. The breeds kept in order of importance were Friesian (80%), Ayrshire (15%), and Jersey (5%). Out of the 10 farms surveyed 7 had free stall housing with flat rough floors and 3 had individual or tie stall housing with sloping floors. Housing on large/medium scale farms was for security purposes at night against cattle theft and was therefore, mainly of the free stall housing type. General cleanliness, drainage and manure disposal was poorer in farms with free stalls compared to farms with individual or tie stall housing system. The latter housing system was mostly found in urban farms. All farms had separate milking areas with 90% of them practising hand milking. However, milking practices were generally poor both in smallholder and large-scale farms (table 1). For example only 10% of the farmers used single towels to dry teats before milking. Detergents, disinfectants and teat dips were not on any of the surveyed farms. Incomplete milking also was found to be prevalent on more than 70% of the surveyed farms.

Incidence of mastitis

The sub-clinical mastitis screening results are presented in table 2. Out of 64 cows tested 41 (64%) had sub-clinical mastitis, 7 cows (11%) had clinical mastitis and 16 (25%) were free from mastitis. Fore and hindquarters (46%) and (45.4%) respectively of all the tested cows had positive CMT scores (i.e +1 and above). The incidence of sub-clinical mastitis was lower in zero grazed cattle than in free-range grazed cattle with infection rates of 37.5% and 90.6% respectively (table 2).

Other factors being equal, results (table 2) showed that Friesian cattle had relatively higher incidences (69.7%) of sub-clinical mastitis than Ayrshire (58.1%).

Causative agents

Apparently all the diagnosed sub-clinical mastitis cases were of bacterial origin. *Staphylococcus aureus* was the most frequently isolated bacteria being isolated from milk samples collected from 90% of the surveyed farms (table 3). The second and third most common bacteria were *Escherichia coli* and *Streptococcus agalactiae*, which occurred on 80% and 70% respectively on surveyed farms. Other isolated mastitis causing bacteria were, *Streptococcus dysglactiae*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae* and *Streptococcus uberis*.

Effect of breed and management on somatic cell counts

The least square means of somatic cell count of mastitis causing micro-organisms amongst the farms and between breeds are shown in table 4. Generally there were significant differences ($p<0.05$) between and within breeds in all the farms. From the least square means for somatic cell counts shown in table 4, Ayrshire cows had higher somatic cell count than Friesian cows.

DISCUSSION

Lohay (1988) defined smallholder and large-scale farmers in Tanzania as those that keep 5 to 20 cows and 21 to 70 cows respectively. The surveyed farms therefore, fell in both categories as shown in the results section. The high infection rates reported above were not surprising since none of the farms surveyed were applying recommended milking and hygiene procedures. Poor hygiene and milking practices are reported to accelerate the transmission of the disease from cow to cow (Pankey et al., 1984) and might account for the high infection rate among the tested

Table 1. Milking management practices on surveyed farms in Morogoro urban and peri-urban areas

Factor	Response	Small-scale farms	Large-scale farms	Frequency distribution	Percentage
Use of towels	Used	0	1	1	10
	Not used	5	4	9	90
Milking method	Hand milking	5	4	9	90
	Machine milking	0	1	1	10
Milkers	Hired labour	5	5	10	100
	Family labour	3	0	3	30
Milking status	Complete	1	2	3	30
	Incomplete	4	3	7	70
Use of teat dip	In use	0	0	0	0
	Not used	5	5	10	100
Use of disinfectant	Used	0	0	0	0
	Not used	5	5	10	100
Chemotherapy measures	Used	5	5	10	100
	Not used	0	0	0	0
Prophylatic measures	Used	0	0	0	0
	Not used	5	5	10	100
Detergent use	Used	0	0	0	0
	Not used	5	5	10	100

Table 2. Location, breeds, type of management and feeding regime in relation to incidence of sub-clinical mastitis on surveyed farms in Morogoro urban and peri-urban areas

Factor	Response	Frequency distribution	% of farms	No. of cows screened	Infected cows	Clinical cases	Sub-clinical cases
Location	Urban	4	40	32	16	4	12
	Peri-urban	6	60	32	32	3	29
Breed	Friesian cross	8	80	33	29	6	23
	Ayrshire cross	1	10	31	19	1	18
Management system	Zero-grazing	5	50	25	16	4	12
	Free range	5	50	39	32	3	29

cows. In addition incomplete emptying of milk from a cow's udder, which was common on 70% of the surveyed farms, could have led into trauma of the udder, and thus bacterial infection leading to mastitis. Shekimweri et al. (1998) working in the same area, reported 60% sub-clinical mastitis infection rate among smallholder herds and an infection rate of 21% on large-scale commercial farms. The later authors reported an infection rate of 2.4% clinical mastitis regardless of the management system. However, Mahlau and Hyera (1984) reported average infection rates of 40% to 71.4% for sub-clinical mastitis in smallholder and large-scale commercial farms respectively in Tanzania. In Kenya, Hamir et al. (1978) reported incidences of 2.3 to 3.0% for clinical mastitis and 48% of sub-clinical mastitis. On quarter basis, Shekimweri et al. (1998) reported an average infection rate of 32.8% sub-clinical mastitis for all quarters. Somatic cell counts in all farms exceeded accepted threshold level for clinical mastitis, i.e. above 500×10^3 per ml (Golda et al., 1984). Poor milking management, housing and unhygienic conditions are among the factors that might have accounted for the greater percentage of the observed somatic cell count.

Infection rates were lower on farms in the urban areas than in peri-urban areas probably because farmers in the former generally practiced better management techniques and had better housing systems than most farmers in the latter (table 1). Wilson et al. (1997), observed that unhygienic housing systems accelerate the transmission of mastitis, especially where milking practices are also poor. The results confirm the commonly held view that management on smallholder dairy farms is generally more efficient than on large-scale farms in most urban and peri-urban areas of Tanzania a fact which is more financial than technical (Shem et al., 1998).

Although bacterial counts were higher for the Ayrshire breed, the low correlation value obtained between breed and bacterial counts suggests that the differences could be attributed more to management than to breed effects. The later conclusion is in agreement with the work of Goodger et al. (1988), Rodgrigues (1997) and Wilson et al. (1997). However, Rodriquez (1997), observed that Friesian breeds were more susceptible to streptococcal and staphylococcal mastitis than other breeds.

Staphylococcus aureus and *Streptococcus spp.* were

Table 3. Prevalence of bacterial isolates from CMT positive (quarter) milk samples of cows from the surveyed farms in Morogoro urban and peri-urban areas

Factor	Response	No. of farms surveyed	Frequency distribution of isolation cases	Percentage of surveyed farms	Rank
Causative agent	*Staphylococcus aureus*	10	9	90	1
	Streptococcus agalactiae	10	7	70	3
	Streptococcus dysglactiae	10	1	10	6
	Streptococcus uberis	10	4	40	4
	Escherichia coli	10	8	80	2
	Klesiella pneumoniae	10	2	20	5
	Pseudomonas aeroginosa	10	2	20	5

isolated from sub-clinical cases on the majority of the surveyed farms probably because they are commonly found on the skin, cuts, tick bite and on floors and walls in cattle barns, where hygienic conditions are poor (Fox and Hankok, 1988, Shekimweri et al., 1998). *Staphylococcus aureus* and *Streptococcus spp* has been reported by many workers to be the major cause of mastitis (Hamir et al., 1978; Mahlau and Hyera, 1984; Kinabo and Assey, 1983, Mbise et al., 1984; Shekimweri et al., 1998). The results on the rate of infection between the two grazing systems in the study area, are in agreement with those of Goodger et al. (1988), who reported that free range cows were bound to be less affected by mastitis due to ample area per cow compared to zero grazed cows.

To reduce the economic losses incurred by most farmers due to mastitis, sub-clinical cases must be prevented through routine prophylactic measures. Routine dry cow therapy and pre- and post-milking udder disinfection significantly reduces overall incidence of mastitis (Shekimweri et al., 1998). Mastitis may nevertheless persist due to variations in the pathology, which can also be a function of bacterial or bovine genetics (Dodd and Griffin, 1975).

CONCLUSION

The results of this study confirm the view that management on smallholder dairy farms is more efficient than on large-scale farms under the Tanzanian dairy farming conditions. It is also concluded that mastitis infection rate is more of a management effect than of breed effect and that the higher rates of sub-clinical mastitis infection in the research area was mainly due to poor and unhygienic milking practices. More research is needed especially on better management techniques suitable for smallholder and large-scale dairy farming conditions not only in the urban areas but also in the rural areas of Tanzania and elsewhere in the tropics.

Table 4. Least squire means ($\pm$SE) for somatic cell count observed in two dairy breeds from the different farms surveyed

Farm number	Breed	
	Friesian	Ayrshire
1 (large-scale)	2647490 ± 468189^{b}	NA
2 (large-scale)	1946157 ± 378169^{b}	4378170 ± 810927^{a}
3 (large-scale)	2005323 ± 573412^{b}	NA
4 (smallholder)	2336342 ± 405463^{b}	1395335 ± 57412^{c}
5 (smallholder)	2260556 ± 578054^{b}	3363024 ± 573412^{a}
6 (smallholder)	1349684 ± 952405^{c}	3714455 ± 629794^{a}
7 (smallholder)	2042290 ± 531512^{b}	1214227 ± 810927^{c}
8 (smallholder)	NA	1613773 ± 835634^{c}
9 (large-scale)	3555000 ± 810927^{a}	2441941 ± 573412^{b}
10 (smallholder)	3229399 ± 465289^{a}	4440020 ± 758927^{a}

[a,b,c] Least Squire Means in the same column with different superscripts are significantly different ($p<0.05$).
NA: Not available.

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