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Factors influencing production of hygienic raw milk by small scale dairy producers in selected areas of the Jaffna district, Sri Lanka

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Abstract The objective of the study was to investigate the influence of dairy cow management techniques and milking methods on hygienic quality of raw milk. Total Bacterial Count (TBC) and Total Coliform Colonies (TCC) were studied to determine the effects. Investigations were carried out in fifty dairy farms from August 2007 to December 2007. The mean TBC and TCC for the herds with comparatively good and poor management practices were 0.9×10^5 cfu/ml and 0.2×10^3/ml and 99×10^5 cfu/ml and $>180\times10^3$/ml, respectively. The overall mean TBC (22×10^5 cfu/ml) and TCC (47×10^3/ml) obtained in this study exceeded the internationally recommended levels for TBC (10^5 cfu/ml) and TCC (<1,000/ml). The overall results obtained suggested that the raw milk tested was of poor hygienic quality with the presence of a great variability among milk samples.

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Introduction

The vast majority of the dairy farmers in the Jaffna district are small scale producers with a weak and vulnerable position due to their low level production and the need to dispose milk daily. Recent increase in demand for fresh milk consumption due to government sponsored dairy drive will provide new opportunities for domestic dairy production. But the hygienic standard of the milk and milk products on the local market is usually poor with regard to contamination with potentially pathogenic *Staphylococcus aureus*, *E. coli*, *Bacillus cereus* and spoilage bacteria *Enterobacteria*, *Enterococcus*, yeasts and mould. Bacteria in milk originate from three sources: the environment, intra mammary infection and normal udder flora (Van Schaika et al. 2005). The risk of bacterial contamination have been reported to originate at farm level then increases with bulking and number of agents handling milk before it reaches the consumer (Omore et al. 2004). Whether, milk is intended for the liquid market or for further processing, its storage ability

and quality for further processing is reduced when contaminated.

In Sri Lanka milk grading system based on the microbial quality is rarely practiced. Hence, the present study focused on the factors influencing the hygienic quality of the raw milk, particularly microbial count, on farms in the Jaffna district of Sri Lanka.

Materials and methods

Data collection

The study was carried out between August and October 2007 among the member dairy farmers of the Jaffna District Development Cooperative Society (JDDC) who sell milk to the centers of the JDDC. Out of the 19 JDDC centers 30% were randomly selected for the present study. From each center 17% of the farmers were selected randomly using Table of Random Numbers. The total number of farmers studied was 50. A structured questionnaire was used to obtain information from the selected farmers through personal interview. The data collected included background information of the farmers, milk production potential, management and other practices adopted before, during and after milking and the ways of handling of milk.

Laboratory analyses

Milk samples (100 ml) were aseptically collected in sterile bottles and transferred to the laboratory in an ice box and analyzed within six hours. Total bacterial count was determined by pour plating with appropriate dilutions of the milk samples using nutrient agar as the medium. Plates were incubated at 37°C for 48 hours. Then the colonies were counted manually. The total coliform count was determined by the froth and gas production on the Mac-Conkey broth after incubation period of 24 hours at 37°C.

Statistical analyses

Data were analyzed using Statistical Analysis System (SAS Version 8). Initially simple descriptive statistics and frequency distributions were used to explore the variability of the different parameters involved in the evaluation of the milk hygienic quality. In the next step, General Linear Models were used to screen the independent variables. Mean separation was done using Least Significant Difference (LSD).

Results

Socio economic characteristics of dairy farms

Major farm and household characteristics are shown in Table 1. Around 82% of the household members were above fifteen years old. Around 94% of herd managers were males and 6% were females. The household size varied from one to nine with the mean of 4.66 members/family.

With regard to education, only the herd managers were interviewed. Around 52% of the herd managers have studied up to General Certificate of Education, Ordinary/ Level (G.C.E, O/L) and the illiteracy rate of the herd managers was around 14%.

Twelve percent of the farm managers considered dairying as their main occupation while the remaining 88% considered dairying as part time occupation.

Table 1 Socio economic characteristics of the small scale dairy farms

Parameters	Percentage
Total number farms surveyed (50)	100
Age group of household members (yrs)	
1–14	18
15–40	45
41–60	34
>60	3
Education level of the herd managers (%)	
Illiterate	14
Up to primary	28
Above primary and up to middle	52
Above middle and up to high school	4
Above high school	2
Main occupation of the herd managers (%)	
Livestock rearing	12
Crop cultivation	68
Government job	6
Business	10
Other	4

Practices adopted with regard to milking

All the surveyed herd managers practiced manual milking. 84% milked twice a day others once a day. Eighty percentage of the farmers used waiting yard before milking. The yard was not constructed properly. Milking was done in the shed and no properly constructed milking parlor was observed. The floor was of earthen type (86%) or concrete (14%). Metal and/or plastic buckets were used to collect milk.

94% of the herd managers filtered the milk before delivering to milk collection center. The filters used were metal sieve, plastic sieve or cloth and were 38%, 36% and 26%, respectively. Thirty two percent of the herd managers used restrainers. Restrainer used was rope made of natural fibre or nylon. The rope was used to hold the cow's neck or some times to tie the hind legs to facilitate milking. Only 6% of the herd managers washed the restrainers after each use.

Practices adopted during milking

All the herd managers interviewed adopted full hand method of milking; washed their hands with water before milking but did not use any detergent. They washed the udder and the teats of the cow before milking with water except 7% who used salt water. A small proportion of herd managers used coconut oil as a lubricant to facilitate milking. Around 10% of the herd managers used clean cloths to dry the udder and the rest 90% used their hands to wipe the water from the udder. About 92% of the herd managers allowed the calves to suck before milking to induce milk let down. All herd managers allowed calves to suckle the residual milk. Regarding infection 72% of the herd managers milked irrespective of infection; 10% of the herd managers did not bother whether the animal is infected or not; the rest of the 18% milked the infected animals and discarded the milk.

None of the herd mangers adopted teat dipping with an antiseptic solution after milking.

Raw milk hygienic quality indicators

Total aerobic bacteria

The samples of raw milk collected had an average aerobic plate count (APC) of 22×10^5 colony forming units/ml (cfu/ml). The highest and lowest APC counts recorded were 99×10^5 cfu/ml and 0.9×10^5 cfu/ml, respectively.

Total coliform count

With regard to total coli form count, the mean count/ml observed in the collected milk sample was 47×10^3/ml with a minimum of 0.2×10^3/ml and a maximum of greater than 180×10^3/ml.

Management practices associated with TBC and TCC

Table 2 shows the factors that significantly affected total bacterial counts and coliform counts. Floor type of waiting yard, cleanliness of waiting yard, frequency of milking, material of milking pail, filtering of milk before depositing, drying the udder after washing and leak of milk before milking were not indicated as those were found to be non significant.

Total bacterial count was greater for earth floor than for concrete floor but the differences were not significant.

Total bacterial count was significantly influenced ($P<0.05$) (Table 2) by usage of restrainers and washing of the restrainers after each use.

All the herd managers washed the udder and the teats of the cows before milking. But the mean TBC and TCC were higher than the recommended level.

Usage of filters and filter material had significant influence ($P<0.05$) on the TBC. Surprisingly the results indicated that the TBC was the least for non-filtered milk and highest for plastic filter.

Discussion

Socio economic characteristics of dairy farmers

The average family size of five members per family and 82% of the household members being more than fifteen years of age indicate the availability of labor force for dairy framing as fulltime or part time occupation. Family size also indicates the need for more milk for family consumption which may affect the amount marketed. Bartlett (1980) asserted family size as the most important determinant of labour for farming families. Six percent of the herd managers were females and all of them were widows; it suggests that dairying can contribute for women headed families to generate income to meet their livelihood needs.

Table 2 Mean (±SD) of total bacterial count (TBC) and total coliform count (TCC) in the raw milk for different variables related to management

Variable		No. of farmers	TBC×10^5	TCC×10^3	TBC level of significance
Cows waiting in a waiting yard before milking	Yes	40	23±27	46±64	P<0.05
	No	10	20±27	54±82	
Roof material of the milking parlour	None	24	24±27	30±59	P<0.05(TCC)
	Tiles	1	5.0±0	160±0	
	Palm leaves	5	17±22	5±5	
	Aluminium sheet	14	18±25	66±75	
	Others	6	32±34	90±72	
Material of the filter	Metal	10	18±26	16±28	P<0.05
	Plastic	19	25±29	46±62	
	Cloth	18	21±26	48±71	
Restraining of cattle before milking	Yes	16	6±0	90±0	P<0.05
	No	34	16±18	55±76	
Washing of Cow's restrainers	After every milking	1	42±37	25±33	P<0.05
	Only when dirty	9	22±26	48±68	
	Not washed	6	26±34	41±67	
Calves allowed to suck before milking	Yes	46	32±31	15±12	P<0.05
	No	4	21±26	52±71	

The literacy percentage of 86% suggests that the herd managers could be educated regarding the benefits of hygienic milk production and the need for increased milk production. The possibility of technology transfer will not only pave ways to raise the family income but also will help to promote the nutritional status of the family and society as a whole.

Practices adopted with regard to milking

All of the herd managers adopted manual milking. The reasons for not adopting machine milking may be the high cost involvement, smaller herd size, smaller teat size of the animals, and its sophistication. Among the investigated farmers about 16% adopted once a day milking. The reason for once a day milking attributed to low milk yield of the cows and inadequate marketing facilities for small scale production. The fact is that if the animals were properly managed, twice a day milking will lead to more milk yield compared to once a day milking. Availability of quality breeding materials and enhanced marketing facilities will pave way for increased milk production and milking twice a day.

Practices adopted during milking

Washing the hands and the udder of the animal with water without detergent will not improve the hygienic condition and after washing the udder drying it by wiping the water by hand also will not remove pathogens. On the contrary it will facilitate growth of pathogens and contamination of milk.

Only 18% of the farmers discarded the milk obtained from infected animals. Other farmers have to be educated to follow the same procedure.

Non adoption of teat dipping with antiseptic solution facilitates infection after milking through the teat.

Hygienic quality indicators

Total aerobic bacteria

The mean APC of 22×10^5 cfu/ml obtained in this study exceeds the recommended level of 10^5 cfu/ml (Bramley and Mckinnon 1990) indicating serious faults in production hygiene. Poor hygienic practices adopted before, during and after milking must have contributed for the higher APC counts of the present study. El-Hadi Sulieman (2007) and Mohamed and EL Zubeir (2007) also reported that tropical conditions and poor milk hygiene will lead to higher microbial population.

Farmers have to be educated to ensure hygienic milk production and the importance of keeping the APC count as low as possible.

Total coliform count

With regard to total coli form count, the mean count/ml observed in the collected milk sample was 47×10^3/ml which ranged from $0.2*10^3$/ml to $>180\times10^3$/ml. This variation could be attributed to the quality of milk.

A mean coliform count of 47×10^3/ml observed in the present study exceeds both the values reported for excellent quality milk (<10) and poor hygenic milk (100–1000) by Reinemann et al. (2000).The higher coliform counts of the present study may be due to mixing of contaminated water in raw milk through water used before, during and after milking. Altug and Bayrak (2003) and Farhan and Salik (2007) also have reported that the existence of the Coliforms may be due to inefficient hygienic condition and mixing of contaminated water in milk.

These results justify the value of potable water in the production of safe milk. The microbiological quality of the water supply at the farm could be improved by addition of chlorine or by boiling the water.

Coliforms are frequently occurring organisms in milk and milk products as a possible cause of food borne disease is insignificant, because none of the coliforms are heat resistant and thus, all are easily eliminated from milk by pasteurization (Kyozaire 2003).

Influence of management practices on TBC and TCC

Sraïri et al. (2006) reported that there is a significant relationship between milk hygienic quality and milking practices. In the current study more number of TBC was observed (Table 2) for soil or gravel floor than for concrete floor, but differences between soil and concrete floors were not significant. This maybe attributed to less number of observations for each category. This is in agreement with the results reported by Van Schaika et al. (2005) who pointed that having a yard where cows stood before they were milked with a floor of soil or gravel compared with concrete was linked to high total bacteria count.

In this study all farmers washed the utensils before and after milking without any detergent or disinfectant. This might be the reason for high number of TBC. Gran et al. (2002) reported that the use of detergents and good quality water for cleaning the equipment could be expected to remove milk remains, including microorganisms and thereby affect the microbiological quality of the milk. This stresses the importance of using detergents while cleaning the utensils.

Usage of restrainers had significant influence on the Total bacterial count (Table 2). Here restrainers act as a source of contamination. Using restrainers without washing substantially increased the total bacterial count. This may be due to the poor hygienic condition of the restrainers. Hence it is essential to clean, disinfect and store restrainers in a proper place after each use to maintain a good hygienic condition.

In the current study all the farmers washed the udder and the teats before milking only with water without any detergent or disinfectant and the mean TBC and TCC were higher than the minimum recommended level. McKinnon et al. (1990) reported that a more feasible option to reduce TBC and TCC might be proper preparation of the udder (such as washing the udder and drying the teats before milking, which reduces TBC by 40%) particularly during winter. Vissers et al. (2007) also indicated that the role of teat hygiene should not be neglected because difference by a factor of 100 between the amount of dirt transmitted to milk at the best and worst farms is substantial. In a review article, Van Schaika et al. (2005) reported that bacterial numbers in milk increase when teats are inadequately cleaned and dried.

There was a significant relation between the material used for filtering the milk and the total bacterial count. The non significant difference between non filtered milk and metal filters indicate metal filters do harbor micro-organisms to greater extent. But the higher microbial count for cloth filters and plastic filters indicate that if not properly cleaned after each use they increase the microbial count by substantial amount than non filtered milk. Hence it is essential to clean and disinfect the materials after each use to ensure hygienic quality of milk. Further, the highest number of microbial count for plastic sieve may be due to smaller sieve size of the plastic filters.

Conclusion

From the present study it could be concluded that the milk produced in the study area is of poor hygienic

quality and its quality is far below the standard set internationally with regard to total bacterial count and Coliform count.The management practices adopted before, during and after milking greatly influence the hygienic quality of milk at the field level.

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