A Preliminary investigation on milk quality in Ampara District of Sri Lanka

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Abstract: *The present study was carried out to investigate the factors affecting keeping quality of raw milk in lactating cows in Ampara District of Sri Lanka. In this study, a total of 110 raw milk samples were randomly collected from 7 milk chilling centers and details on milking practices were collected from the farmers through structured questionnaire and interview. Milk samples were collected aseptically from milk cans and dispatched to laboratory for keeping quality test. Result showed that 42 % of the collected milk from farmers had poor keeping quality. The buffalo milk showed a significantly poor keeping quality ($p< 0.05$) compared to that of cow milk. Also the poor keeping quality was higher in milk collected from plastic milk containers (76.1%) compared to that of metallic containers (37.8%).Other factors that significantly contributed to poor keeping quality were presence of contaminants (73.5%),milk from cow in late lactation (63.1%), higher fat percentage in milk (66.6%), the time interval between milking to chilling (92.8%) and poor hygienic practices (76.4%).*

Keywords: *Cow milk, keeping quality*

1. INTRODUCTION

Livestock is growing agricultural subsectors in many developing countries. In Sri Lanka, livestock sector contributes 0.8 % to total GDP (Central Bank of Sri Lanka 2015). It is basically from expansion and increased dairy and/or poultry production within the country (Livestock Statistical bulletin 2015). Therefore, milk production has played an important role in livestock production of the country. Livestock is an integral part of the agricultural economy in Sri Lanka and enhances food security, reduction of malnutrition and poverty. Dairying has been identified as the priority area for investment and development in the livestock many developing countries (Birthal et al. 2002). At present, Milk production increased by 12.1 percent to 374 million liters in 2015 compared to the growth of 1.4 percent recorded in the previous year, owing to favorable producer prices for milk and growing demand for raw milk from large milk collectors with the increased capacity of milk factories (Central Bank of Sri Lanka 2015).Ampara District of Sri Lanka which has total cattle and milking cow population of 95,140 and 25,350, respectively (Central Bank of Sri Lanka 2015) and daily cow milk production is 31,140 liters which is a high milk production District in Eastern Province of Sri Lanka(Central Bank of Sri Lanka 2015). However, dairy farmers are facing many challenges to maintain the quality of milk production in most of the areas, including this district of the country due to various reasons (Deshapriyaet.al, 2004& 2007, Abeygunawardana et. al 2017).

Milk quality is affected by hygienic practices, time between milking to chilling, types of milk collection utensil and foreign materials present in milk (Marshall 1992). Milk is the most easily contaminated and perishable commodity as it is an ideal medium for bacterial growth. Hence, the employment of hygienic practices right from milking at the farm level to the factory is essential (Kurwijila 2006). The keeping quality of milk is a function of on-farm hygiene and the milk handling practices. Milk produced by the farmers often goes bad since husbandry practices are at household level and milk quality is always compromised. Therefore, the causes of high bacterial load in milk and the factors affecting the clean milk production have to be addressed in Ampara District of Sri Lanka.

Proper hygienic condition is an essential that can reduces the chances of spoilage thus reducing the magnitude of milk losses to the farmer (Holloway et al. 2000).Planning for improved production, advisors and extension workers need to help farmers in ways that will be technically feasible, socially acceptable and economically viable in reducing milk spoilage and milk loss. The report from this study therefore will work as basis for improving milk quality and reduce the chances of milk spoilage and loss thus profitability of the dairy enterprise & enhanced incomes for farmer with improved livelihood in rural community of this area.

In this context, the objective of this study was to determine the keeping quality and identify the associated factors with keeping quality of raw milk in lactating cows which can directly affect the quality of raw milk received to milk chilling centers from dairy farmers and to provide appropriate pathway to enhance milk quality through facilitating clean milk production in Ampara district of Sri Lanka.

2. MATERIALS AND METHODS

2.1. Study area

The study was carried out in Ampara District, Eastern Province of Sri Lanka. Ampara District located at 7°05′N latitude 81°45′E longitude and the elevation is 7.65 m above sea level. Land area of Ampara District is 4,415 km^2 and mean temperature, annual rainfall and relative humidity were 28.4°C, 1,973.7mm and 89%, respectively.

2.2. Sample collection

In this study, 110 milk samples were randomly collected from dairy farmers from 7 milk chilling centers in Ampara District. A pre-tested questionnaire was used to collect the information on farmers to find out the associated factors, in relation to poor keeping quality of raw milk.

2.3. Information from farmers

Data were collected from farmers on management aspects, herd sizes, housing systems, farming system, feeding system, milking system, milking frequency, hygiene practices; types of milking equipment, induction of milk flow, source of water, hygiene of milking and washing methods of milking parlor and floor type of the shed. Information on cows such as breed, age, parity, stage of lactation, infected quarters, milk production and diseases were collected from the interview.

2.4. The Alcohol Test

The test was done by mixing equal amounts (2ml) of milk and 68% of ethanol solution in Petridish. If coagulation/clotting were formed, that milk sample was categorized as alcohol positive. If milk was not formed the coagulation/clotting that treat as alcohol negative.

2.5 Resazurin test.

10 ml milk was taken into a sterile test tube. Then, 1 ml of resazurin solution was added and tube stoppered. Then, the dye was gently mixed into the milk and marked the tube before the incubation in a water bath with 37^{o}C up to 5-7 min. Then, the test tube was placed in a Lovi bond comparator with resazurin disk and compared it calorimetrically with a test tube containing 10 ml milk of the same sample without the dye (Nixon et al. 1945).

2.6 Determination of Fat (The Gerber method)

In the Gerber method, 10 ml of Con. Sulphuric acid was added to the butryometer. Then, 10.94 ml of well mixed milk was added by using 10.94ml of pipette. After, 1ml of Amyl alcohol was added and inserted stopper. Finally, the butryometer was shaken carefully until the curd dissolved. The butryometer was placed in the water bath at 65ºC and kept it there until a set was ready for centrifuging. The butryometer was placed in the centrifuge with the stem (scale) pointing towards the center of the centrifuge. Then, centrifuge was rotated for 4 min, at ll00 rpm. After, the butryometer was removed from the centrifuge and put the butryometer in a water bath maintained at 65ºC for 3 min. Then, the final reading was taken and noted as percentage (Kleyn et al. 2001).

2.7 Determination of Solids Not-Fat (SNF)

The milk sample was mixed gently and poured it gently into a 300ml of measuring cylinder. The lactometer was sung slowly into the milk. Then, the last Lactometer degree (ºL) was read and recorded just above the surface of the milk. If the temperature of the milk was different from the calibration temperature(Calibration temperature of lactometer was 20^{0} C)of the lactometer, the temperature correction was calculated for each ºC above the calibration temperature was added 0.2ºL; for each ºC below calibration temperature was subtracted 0.2 ºL from the recorded lactometer reading.

$$SNF\ \% = \frac{CLR}{4} + 0.22\,F + 0.72$$

CLR = Corrected lactometer Reading, F= Fat content in milk

2.8 Data analysis

The association between the keeping quality of raw milk and risk factors such as hygiene practices, breeds, types of milking equipment, milk fat percentage, foreign materials, duration after milking to chilling, adulteration and stage of lactation were statistically analyzed in logistic regression model using statistics package for social science (SPSS version 20.0) software. All the risk factors were explained in odds ratio (OR) value which mean an odds ratio is a measure of association between an exposure and an outcome. *P* values less than 0.05 were considered the level of significance of the result.

3. RESULTS AND DISCUSSIONS

The present study was conducted using the details of 110 dairy farmers. Around 42 % of milk from farmers was positive to alcohol and resazurin test. If both alcohol and resazurin result was positive, that indicated the poor keeping quality of milk. The frequency and percentages of different factors that affect the keeping quality are shown in Table 1.

When the factors associated with keeping quality of milk was analyzed, only seven variables significantly (P< 0.05) associated with keeping quality of milk in binary logistic regression analysis. Poor milk quality was relatively higher in buffalo milk as explained in odds ratio (OR) value 24.3 based on the cattle breed milk (Table 2). Further, factors such as stage of lactation, types of equipment, duration after milking, fat percentage, hygienic practices and foreign materials associated with keeping quality test analysis.

Table 1: Frequency and percentage of different factors

Factors		No. of animals	%
Breed	Cattle	67	60.9
	Buffalo	43	39.1
Stage of lactation	Late stage	38	34.5
	Mid stage	51	46.4
	Early stage	21	19.1
Types of equipment	Plastic	42	38.2
	Metallic	68	61.8
Foreign materials	Present	53	48.2
	Not present	57	51.8
Time duration	0-1 hr	17	15.4
	1-2 hr	50	45.5
	2-3 hr	21	19.1
	> 3 hr	22	20.0
Fat percentage	2- 4	25	22.7
	4- 6	53	48.2
	6- 8	32	29.1
Hygiene	Poor	51	46.4
	Good	59	53.6

Table 2: Binary logistic regression analysis of potential risk factors for keeping quality of milk

	Sig.	OR	95.0% C.I. for OR	
			Lower	Upper
Breeds				
Cattle	Reference			
Buffalo	.014	24.386	19.34	32.513
Stages of lactation				
Early	Reference			
stage	.031	3.524	1.412	6.252
Mid stage	.011	7.437	2.585	15.952
Late stage				
Types of equipment				
Metallic	Reference			
Plastic	.045	9.496	.956	94.097
Time duration (hours)				
00-01	Reference			
01-02	.022	.449	0.270	15.326
02-03	.044	4.086	0.537	4.404
>03	.023	10.212	5.213	25.021
Foreign materials				
Not	Reference			
present	.001	16.549	6.170	19.326
Present				
Fat %				
2-4	Reference			
4-6	.007	4.675	.870	18.326
6-8	.089	15.416	.553	21.404
Hygiene practices				
Good	Reference			
Poor	.006	24.575	2.537	27.054

Of the 43 buffalo milk samples, 29 samples (67.4%) were positive to keeping quality test and of the 67 cattle milk samples, 14 (20.8%) were positive to keeping quality test (Figure 1). Buffalo milk had more chances for poor keeping quality than cattle milk in terms of OR value. The OR value for buffalo milk was 24.3 times more than cattle milk (Table 2). This can be due to formation of higher amount of lipid peroxidation products as result of high fat content buffalo milk (Hussain et al. 2012). It has reported that higher fat content of milk can increase spoilage of milk thus reduce the keeping quality (Fox 1995,Kurwijila1989).

The association between keeping quality of milk and stage of lactation of cows showed in Figure 2. The lactation stage was categorized into early, mid and late lactation based on the lactation stage. Result indicated that, the highest poor keeping quality was recorded in a late stage of lactation (63.1%) and the lowest was in early lactation (33.3%). Mid and late lactation had more chances for poor keeping quality in terms of OR value, which was expressed for mid and late lactation of cows were 3.5 and 7.4 times more than early stage of lactation (Table 2).The fat, lactose and protein contents of milk vary according to stage of lactation (Cerbulis et al. 1975).It has been reported in similar studies that poor keeping quality of milk could be high at late stage of lactation (Islam et al. 2012, Alemu et al. 2013).

Highest prevalence of poor keeping quality (76.1%) was found when plastic milk collection utensils were used and the lowest (37.8%) was in metallic milk collection utensils (Figure 3).Use of plastic milk collection cans had more chances for poor keeping quality in terms of OR value for use of plastic milk collection utensils was 9.4 times more than use of metallic milk collection utensils (Table 2).All dairy utensils such as buckets, milking cans and strainers should be thoroughly cleaned immediately after use. Studies show that non-metallic utensils used in many parts of the developing world contain many crevices, cracks and corners that cannot be easily cleaned, hence plastic buckets that harbor spoilage microorganisms than metallic utensils (Lore et al. 2005).

The keeping quality was poorest (73.5%, OR 16.5) when foreign materials present in milk (Figure 4, Table 2). It is reported that poorly constructed milking sheds, wind blows with dust particles, pieces of straw and feed materials that may land in milk as foreign particles (Kurwijila1989). In addition, dirty milking places tend to breed flies which may fall in milk as foreign materials causing contamination and spoilage. The soil serves as primary source of foreign matter in milk introducing microorganisms and spores in resting stages which receive nutrients for growth and multiply to increase in numbers to cause milk spoilage (Mbabazi 2005)

Highest level poor keeping quality (92.8%) was found in milk when held more than three hours at ambient temperature before chilling (Figure 5). In terms of OR value for long duration after milking was 10.2 times more than short duration after milking (Table 2).Usually, raw milk should contain less than 5,000 bacteria per milliliter of milk, but these bacteria multiply and deteriorate the milk with time under favorable conditions. It is stated that Just after milking, milk should be transported to chilling centers within short time duration which is very important because less time lead for less bacterial count and good quality raw milk. (Lore et al. 2005, Deshapriya et al, 2004 & 2007, Weerasinghe et al. 2017). Further, lowering the temperature of milk preferably to chilling temperature, the microbial quality can be improved. Therefore, holding the milk at ambient temperature increases microbial population in a tropical climate present in Sri Lanka.

The quality was very poor (66.6%, OR 15.4) in milk when the fat content is high when compared to low fat milk (Figure 6, Table 2). Fox (1995) reported that if fat percentage of milk is high that may spoil quickly.

Figure 7 shows the effect of hygienic practices on the keeping quality of milk. As shown, the highest prevalence of poor keeping quality was recorded in poor hygiene (76.4%, OR 24.5) and lowest was recorded in good hygiene (11.9%)(Table 2). This factor was considered based on the animal, environmental and good milking practices. If milking was done by hand without washing and disinfecting the hand, pathogenic microbes which are in hand as normal residents can be transmitted into uninfected quarter, leading to intra-mammary infections and thus poor keeping quality(Shittu et al.2012). Therefore, it has been recommended that using disinfectant hands before hand milking, can reduce the transmission of pathogenic microorganisms from cow to milk and human to milk (Sharma N. 2010).

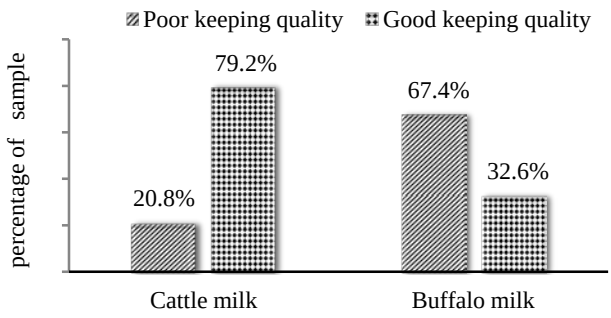

Figure1: Keeping quality analysis for cattle/buffalo milk

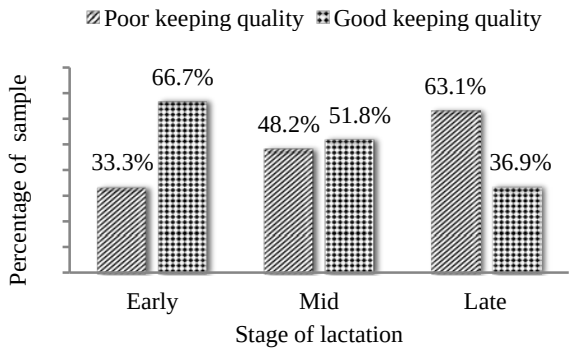

Figure 2: Association between keeping quality and stages of lactation

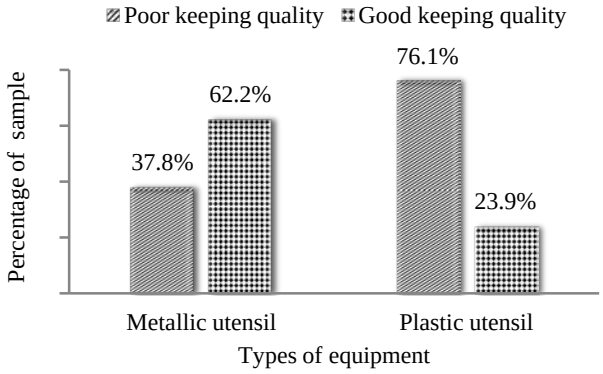

Figure 3: Relationship between keeping quality and types of equipment used

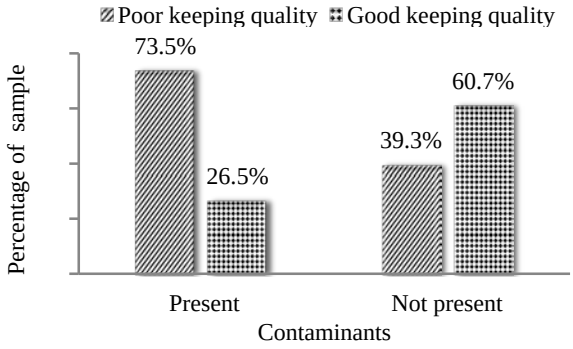

Figure 4: Effect of contaminants on keeping quality of milk

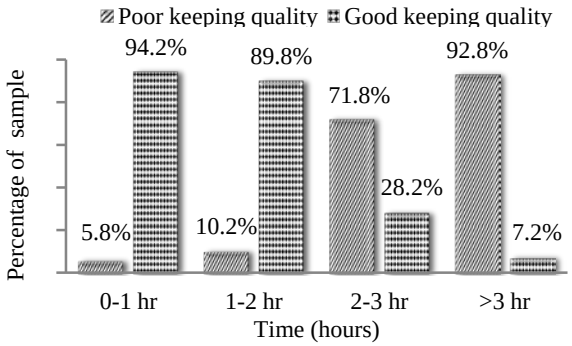

Figure 5: The effect holding time of milk in ambient temperature on keeping quality.

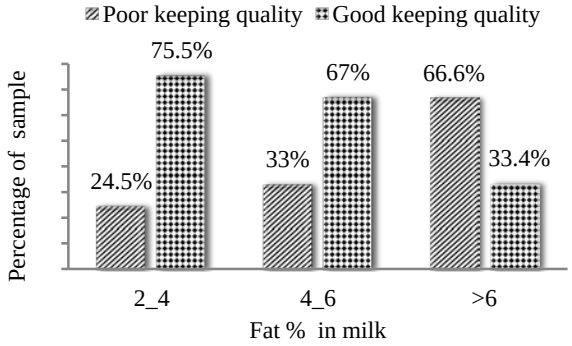

Figure 6: The effect of fat percentage on keeping quality

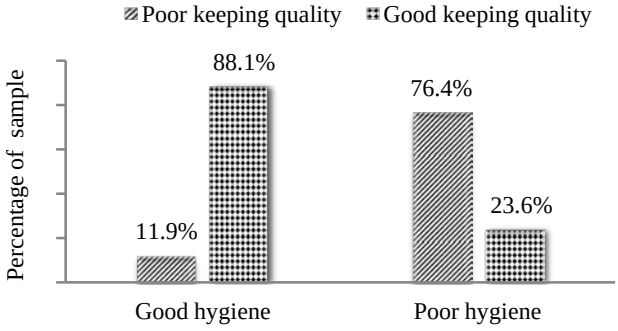

Figure 7: The effect of hygienic milking practices on keeping quality of milk**4.**

CONCLUSION

Overall poor keeping quality of milk in lactating cows in Ampara District of Sri Lanka is 42%. This finding is also in line with other published data where the milk quality is comparatively poor. It is found that the poor keeping quality of milk is associated with several factors; including stage of lactation, time duration between milking to chilling; types of equipment, presence of foreign materials, fat content and hygienic milking practices. Therefore there is urgent need of addressing the all steps in milk value chain within the country to upgrade the quality of raw milk. It is utmost important to educate specially the small farmers on clean milk production procedure. It could also be suggestive to impose hygienic quality based payments rather than only compositional quality based payments to encourage farmers to produce good quality milk.

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