



Effect of Modified Pre-Milking Sanitizing Approaches on Raw Milk Quality Obtained from the Dairy Farmers of Tawau Area, Sabah

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ABSTRACT

The aim of the study was to investigate the raw milk hygiene and quality among the small holder dairy farmers in Tawau area. A total of 216 samples were collected from the respective dairy farmers and milk collecting centre located at Mile 15, Tawau. Preliminary results indicated that the quality of the raw milks obtained at farm level contained were inferior with high bacteria load ($>$ than 10^7 CFU/ml). The total coliform (2.9-3.8 CFU/mL) and Staphylococcus count (2.3-3.6 CFU/mL) were relatively high in certain samples. However, none of the food borne pathogens was found. Trace back study revealed that the causes of contamination were attributed by poor hygienic handling among the dairy farmers and insufficient for immediate chilling of raw milk. A significant reduction in bacteria load was observed if the raw milk chilled immediately at farm. The implementation of modified pre-milking sanitizing practices improved the microbiology quality of the raw milks obtained from respective dairy farms. Future study will focus more on the effect of prolong storage towards the microbiological quality of raw milk.

Introduction

Milk is a food of good nutritional value which ensures benefits from its consumption. However, it serves as a good medium for microbial growth namely *Lactobacillus*, *Leuconostoc*, *Lactococcus*, *Streptococcus*, *Enterococcus*, yeast, moulds and *Enterobacteria*. Studies showed that foodborne pathogens include *Listeria monocytogenes*, *Salmonella*, *Campylobacter*, *Staphylococcus aureus*, *Bacillus cereus*, *Clostridium botulinum* and *Shigella* were associated with contaminated raw milk Millogo et al. (2009). Meanwhile, the detection of coliform bacteria or pathogens in milk can be considered as an indicator of the hygienic level along the milking process. The high bacterial count and the presence of pathogenic bacteria not only degrade the milk quality and shelf-life of milk, but it also poses a serious threat to consumers. Hence, many dairy programs have been carried out to improve the production as well as the quality of raw milk. This includes: keeping and storing the milk in clean containers at refrigerated temperature (4°C) immediately after the milking process, control and modification of the milking process or environment to eliminate cross-contamination on raw milk harvested from the milk utter.

The milk production in Sabah is moving towards self-sufficiency with an annual production that exceeds 7 million liters. Nevertheless, most of the small-scale farmers neglect the importance of good hygiene practices along the milking line which will affect the raw milk quality and also create economic losses for them. Therefore, this study

is undertaken to investigate the raw milk hygiene and quality among the dairy farmers in Tawau area and on what dairy programs can be implemented to improve the milk quality and production in that area.

Materials and Methods

Sample Collection

An approximately 100-300 ml of raw milk samples were collected from 8 different farmers in Tawau area. In addition, the milk was taken from the respective collector churns that were sent by each farmer to the Milk Collecting Center (MCC), station Mile 8, Tawau before being transported back to the Food Bioprocessing Laboratory, Faculty of Sustainable Agriculture, Universiti Malaysia Sabah (UMS). The milk samples were stored properly using a cooler box containing dry ice that maintained the temperature at 4-5°C.

Microbiological Analysis of Milk Samples

The milk samples were tested for total plate count (TP), total coliform (TC) and total Staphylococcus (TS) count using respective agar media, namely the plate count agar (PCA), violet red agar and Baird-Parker agar (BPA). The milk samples were also tested for the presence of pathogenic organisms, namely *Listeria monocytogenes*, *E. coli* H7:O157 and *Salmonella typhimurium* as per ISO (1990).

Modified Premilking Teat-Cleaning and Sanitization Procedures

Slight modification on the premilking teat-cleaning and sanitizing procedures were introduced to the farmers. During the milking stage, each farmers will be provided with an individual wet water wash wipe (50% ethanol v/v), an iodine-based dip for 15s and individual dry towel. The use of hot water to clean the milking utensils namely the milking teats, chunks, milk collectors and the milking area was implemented after every milking session.

Statistical Analysis

The data were collected and analyzed using analysis of variance (ANOVA) which applied a Duncan multiple test. The statistical analysis was performed using SPSS version 17.0 (SPSS Inc. Chicago).

Results and Discussion

Comparison of the Microbial Quality between Dairy Farmers and Milk Collecting Center (MCC)

A total of 216 raw milk samples were collected from eight farmers and MCC. The bacteriological quality of most raw milk samples was low, with a total plate count exceeding 10^6 CFU/ml (Table 1). The poor microbiological quality of the raw milk could be associated to improper hygienic practices throughout the milking process (Gran et al., 2002). Farm F5 recorded the highest TPC (7.24 log CFU/ml) which might due to improper milking procedures among farmers. In addition, ineffective sanitizing routine on farm shelter that leaving herds' manure in contact with cows' udder also contributed to the high bacterial level in raw milk. On contrary, both the coliform (2.31 – 3.80 log CFU/ml) and

Staphylococcus counts (2.11 – 3.47 log CFU/ml) were high in all tested samples. The high in *Staphylococcus* counts revealed the poor personal hygiene among personnel throughout milking line. Meanwhile, the bacterial load of milk samples obtained from MCC was slightly higher than the farm level (Table 1). For instance, the TPC count obtained from farmer F4 was 5.78 ± 0.17 and their count increased to 6.13 ± 0.18 log CFU/ml at the MCC level. The significant increase ($p < 0.05$) of the TPC was attributed to the delay in chilling down the fresh milk to 4-5°C by farmers after milking process. The current result was in accordance to the statements given by International Dairy Federation (1990) on the violation of any temperature will result in the increase of microorganisms in the milk.

Meanwhile, a comparison on the milk quality obtained from bulk tank and chilled milk from farm level was conducted (Table 2). The result showed that the fresh milk that immediately chilled to 4-5 °C after milking process had significant lower ($P < 0.05$) bacterial load (3.36 ± 0.10 log CFU/ml) as compared to milk obtained from the bulk tank without refrigeration (6.72 ± 0.15 log CFU/ml). Meanwhile, the spoilage bacteria (coliform and *Staphylococcus*) were notably reduced below detectable level. This indicated that immediate cooling on fresh milk after milking can reduce the proliferation of microorganism. It also ensures safer fresh milk with better quality to be sent to MCC for further process. According to Richter et al. (1992), the fresh milk withdrawn from a healthy cow normally has low microbial count (< 1000 CFU). However, the load may increase to 100 fold or more if external contamination or temperature abuse taken place along the milking chains.

Table 1 The microbiology quality of raw milks obtained from individual farms and MCC

Load (log CFU/ml) Sample	Total plate count		Total coliform count		Total <i>Staphylococcus</i> count	
	Farm	MCC	Farm	MCC	Farm	MCC
F1	5.13±0.12 ^f	5.22±0.03 ^f	2.31±0.12 ^d	2.65±0.22 ^e	2.11±0.04 ^f	2.32±0.16 ^e
F2	6.52±0.13 ^c	6.38±0.12 ^d	3.19±0.03 ^b	3.36±0.27 ^b	2.54±0.05 ^c	2.75±0.20 ^{bc}
F3	6.89±0.18 ^b	6.96±0.27 ^b	3.29±0.04 ^b	3.51±0.25 ^a	2.72±0.13 ^{bc}	3.13±0.04 ^{ab}
F4	5.78±0.11 ^{ef}	6.13±0.14 ^{de}	2.84±0.22 ^c	2.97±0.17 ^d	2.65±0.08 ^c	2.98±0.13 ^b
F5	7.24±0.17 ^a	7.58±0.17 ^a	3.80±0.18 ^a	3.20±0.23 ^c	3.23±0.16 ^a	3.47±0.06 ^a
F6	6.97±0.15 ^b	6.70±0.07 ^c	3.66±0.09 ^a	3.41±0.18 ^{ab}	3.07±0.17 ^b	3.15±0.15 ^a
F7	6.16±0.09 ^d	6.59±0.16 ^c	3.21±0.16 ^b	3.15±0.05 ^c	2.32±0.14 ^{de}	2.46±0.15 ^{cd}
F8	5.95±0.22 ^e	6.07±0.22 ^e	2.70±0.17 ^c	3.42±0.24 ^a	2.26±0.07 ^e	2.53±0.18 ^c

MCC – Milk Collection Center; Means with different letters within a row are significantly different ($P < 0.05$); Same alphabet horizontally shows no significance difference at 0.05

Table 2 Comparison of microbial loads among bulk and chilled samples

Samples	Total Plate Count (log CFU/ml)	Total Coliform Count (log CFU/ml)	Total <i>Staphylococcus</i> count (log CFU/ml)
*Bulk tank	6.72±0.15 ^a	3.19±0.18 ^a	3.22±0.20 ^a
**Chilled tank	3.36±0.10 ^b	2.28±0.15 ^b	2.12±0.17 ^b

Figures in bracket represent number of samples tested; *Milk obtained from bulk tank (temporary) without refrigeration; **Milk that immediately chilled to 4-5 °C after milking process; Means with different letters within a row are significantly different ($P < 0.05$)

Detection on Pathogenic Organisms for All tested Samples

Fresh milk normally contains low level of bacterial load as well as presence of certain pathogenic bacteria. Nevertheless, the presence of indicator organisms such as *E. coli* and coliform bacteria indicates contamination might occurs during the milk supply chain. Generally, the occurrence of pathogenic organisms in the raw milk samples was low among all tested samples (Table 3). A total of 16 samples (out of 150) was tested positive for the presence of *E. coli* among the milk samples obtained from respective farmers. Nevertheless, samples obtained from farmer F3, F5 and F8 recorded highest prevalence of *E. coli* (25.0%). However, this *E. coli* was not originated from the food borne species (*E. coli* O157: H7). Their presence in milk usually associated with faecal contamination of water sources or poor hygiene practices during milking process. The result was in accordance to the finding of Chye et al. (2004).

Another pathogen that related to the food hygiene and quality was *Staphylococcus* spp (*Staphylococcus aureus*). They tend to degrade the milk quality once they multiplied tremendously and the whole batch of milk will spoil prior sending for processing. It was observed that the *Staphylococcus aureus* was the second prevalence pathogenic bacteria that detected in this study. They were found in the range of 11.1-33.3% among the tested samples and this phenomenon might due to different milking technique among the farmers. In fact, the *Staphylococcus aureus* was originated from infected cattle with mastitis problem or improper handling practices. According to Rysanek et al. (2007) mastitis was usually caused by contagious pathogens namely *Staphylococcus aureus* and *Streptococcus agalactiae* than mastitis caused by environmental pathogens such as *Streptococcus uberis* and *Escherichia coli*. Hence, an effective post-milking practices including proper disinfection on cattle's teat or workers' hand are imperative to solve the prevalence of these pathogens in raw milk.

Both the *Salmonella* and *Listeria* spp were seldom detected in whatever period of this study. Only 5 and 3 (of 150 samples) raw milks were found positive to the presence of *Salmonella* and *Listeria* spp, respectively Till date, the occurrence of Salmonellosis in local raw milk product was still low, however they still pose a health threatening diseases especially typhoid fever to the consumers who consumed any milk product that might contains *Salmonella* spp. The present of *Salmonella* spp

in raw milk was mostly due to the post-processing contamination starting from the milking system to the supply chain. Most of the processors use heat treatment such as pasteurization to eliminate the heat sensitive *Salmonella* spp that may found in raw milk.

Effect of Pre-milking Treatments on the Raw Milk Quality

The implementation of pre-milking cleaning practice resulted in a slight improvement on the raw milk microbiological quality (Table 4). Both the microbial load on the teat as well as the raw milk was significantly reduced to an accepted level prior further processing. For instant, the microbial load of the teat reduced 19% (F4) while the raw milk also showed steady reduction of 12.7% for similar tested sample. This clearly indicated the use of hot water to sanitize the milking utensils is very effective to minimize the proliferation of microorganisms. Besides, the use of individual dry towel and hot water wash wipe (50% ethanol) throughout milking process also contributed to the decrease of microbial load. Studies done by Bonfoh et al. (2006) revealed that the importance of proper cleaning on the utensils and personnel hygiene in maintaining the quality of raw milk. The current study revealed that the combination of hot water wash wipe with low ethanol concentration is a promising and cost effective approach to disinfect the cow's teat. Furthermore, this approach did not pose any side effects as compared to those using chemical disinfectants. Hence, in the future more premilking cleaning practices should be implemented among the farmers in order to upgrade the quality of raw milk within Sabah regions.

Conclusion

In accordance with this research result, raw milk quality of local farmers within Tawau region was very low. High bacterial loads as well as presence of several pathogenic bacteria in above samples might affect the raw milk quality or pose threats to consumer. This study suggested that dairy farmers should chill the raw milk immediately after milking and reduce the holding time prior sent to MCC for a better raw milk quality. Furthermore, the use of modified pre-milking treatment was able to reduce the microbial count to an acceptable level in whatever duration of the study and it should be practiced by small holder dairy farmers in order to improve their raw milk quality.

Table 3 Prevalence of pathogenic bacteria in raw milk obtained from different farmers

Farmer	Number of samples	Num. of positive sample (%)			
		<i>E-coli</i>	<i>Staphylococcus aureus</i>	<i>Salmonella</i> spp.	<i>Listeria</i> spp.
F1	18	1(5.6)	2(11.1)	-	-
F2	12	1(8.3)	2(16.7)	1(8.3)	1(8.3)
F3	12	3(25.0)	2(16.7)	1(8.3)	-
F4	12	1(8.3)	2(16.7)	-	1(8.3)
F5	12	3(25.0)	4(33.3)	1(8.3)	1(8.3)
F6	12	2(16.7)	3(25.0)	-	-
F7	12	2(16.7)	3(25.0)	1(8.3)	-
F8	12	3(25.0)	2(16.7)	1(8.3)	-
Total	150	16 (10.7)	20 (13.3)	5 (3.3)	3 (2.0)

Table 4 The teat total plate count (TPC) levels before and after pre-milking cleaning procedures

Sample	Teat (log CFU/ml)			Raw milk (log CFU/ml)		
	Before	After	Difference	Before	After	Difference
F1	3.22	2.98	-0.24(7.5%)	5.45	5.01	-0.44(8.1%)
F2	4.07	3.54	-0.53(13%)	6.14	5.36	-0.78(13%)
F3	3.97	3.21	-0.76(19%)	6.53	5.97	-0.56(8.6%)
F4	3.76	3.02	-0.74(20%)	5.98	5.22	-0.76(13%)
F5	5.48	4.86	-0.62(11%)	7.19	6.62	-0.57(7.9%)
F6	4.02	3.75	-0.27(6.7%)	6.31	6.07	-0.30(3.8%)
F7	3.45	3.07	-0.38(11%)	5.87	5.35	-0.52(9.8%)
F8	4.11	3.72	-0.39(9.5%)	5.34	5.06	-0.28(5.2%)

Figures in bracket indicate the difference in percentage (%)

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