PHYSICAL AND CHEMICAL QUALITY OF MARKET MILK SOLD AT TANDOJAM, PAKISTAN

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ABSTRACT

The present study was conducted to evaluate the quality of milk sold at Tandojam, Pakistan. A total of 125 milk samples (25 samples from each source) collected from five milk marketing agencies viz direct seller (DS), milk collection center(MCC), milk vendor shop (MVS), hotel (HT) and buffalo dairy farm (DF), which served as control. Acidity of milk obtained from DS, MCC, MVS and HT averaged 0.13, 0.15, 0.12 and 0.13, respectively compared to 0.14 for DF milk. The pH values of milk from MVS (6.54) and HT (6.53) were significantly different (P<0.01) from DS (6.65) and MCC (6.66) and relatively similar (P>0.05) to that of DF milk i.e. 6.65. Viscosity, specific gravity and freezing point of milk procured from DS (1.48, 1.026 and –0.460, respectively), MCC (1.58, 1.026 and –0.470, respectively), MVS (1.34, 1.026 and –0.440, respectively) and HT (1.46, 1.027 and –0.480, respectively) were significantly (P<0.001) lower than DF milk (1.86, 1.031 and -0.551, respectively). Chemical quality of milk procured from DS, MCC, MVS and HT compared to DF milk (control) averaged 13.45, 14.18, 13.19 and 14.06% vs. 16.30% for TS content, 8.25, 8.81, 8.06 and 8.51% vs. 9.79% for SNF content, 5.20, 5.41, 5.13 and 5.54% vs. 6.51% for fat content, 3.85, 3.96, 3.91 and 4.23% vs. 4.35% for protein content, 2.70, 2.77, 2.56 and 3.20% vs. 3.56% for casein content, 3.65, 4.03, 3.34 and 3.52% vs. 4.53% for lactose content and 0.75, 0.78, 0.74 and 0.76% vs. 0.91% for ash content, respectively. All the attributes of chemical quality of milk supplied through four agencies were significantly lower (P<0.05) than DF milk.

Key words: Milk, physical quality, chemical quality, marketing sources.

INTRODUCTION

Milk is one of the most important foods of human beings. It is universally recognized as a complete diet due to its essential components like proteins, lactose, milk fat, minerals and vitamins in a highly digestible form and is recommended as compulsory part of daily diet for the expectant mothers as well as growing children (Shah and Khan, 1982). Historical evidence indicates that the nations which used to obtain highest calories from milk and milk products were more civilized and capable of having sound administration.

In the year 2007-2008, Pakistan produced 42.199 million tons of milk; of which 62.17% was contributed by buffaloes, 34.21% by cows and 3.60% collectively by sheep, goats and camels. Taken this percentage, the per capita availability of milk for consumption was estimated as 182 liters per annum of which 80% was available for human consumption in fluid form (market milk) or in the form of milk products, 15% as wastage due to traditional and unscientific milk handling, processing and marketing system and 5% was fed to calves (Athar *et al*., 2003; Anonymous, 2008).

Unfortunately, due to unorganized and non-regulated marketing system, the quality of milk is hardly maintained at consumer level. Addition of water and ice is common which affects the physical as well as chemical quality of milk by altering the proportion of different constituents. The composition of milk obtained from different sources studied by Izhar and Masud (1991) indicated the gradual deterioration in the quality of milk and in several instances it was so low that it failed to meet even the minimum legal requirements. Ullah *et al*. (2005) also investigated the effect of severity of mastitis on protein and fat contents of buffalo milk. Thus, a large segment of population is deprived of the consumption of energetic milk.

Milk supply to Tandojam takes place through different marketing channels i.e. direct sellers, milk collection centers, milk vendor shops and hotels and dairy farms from the surrounding areas, and is based on unorganized marketing system. Thus, milk for consumption is hardly assumed to be of high quality. Keeping this in view, the present study was undertaken to evaluate the quality of market milk collected from different marketing sources at Tandojam, Pakistan.

MATERIALS AND METHODS

Collection of samples

A total of 100 samples (25 from each source) were collected from different milk marketing channels i.e. milk vendor shops (MVS), direct sellers (DS), milk collection centers (MCC) and hotels (HT). All the samples were brought to the Laboratory of Dairy Technology, Sindh Agriculture University, Tandojam, Pakistan for analysis. Parallel to this, 25 samples of buffalo milk from dairy farm (DF) taken as control were analyzed to establish quality standard hypothesis for Tandojam area.

Physical analysis of milk

Acidity percentage was determined according to the method of Association of Official Analytical Chemists (AOAC, 1990). The samples were titrated with N/10 NaOH solution using titration kit with phenolphthalein as an indicator. The volume of alkali used was noted, and calculation was made using following formula:

$$\text{Titrable acidity (\%)} = \frac{\text{N/10 NaOH (ml)} \times 0.009}{\text{Weight of milk sample}} \times 100$$

The pH of milk was recorded using a pH meter (Hanna Instruments, HI 8417, Italy). The instrument was first calibrated using buffers of pH 7.0 and 4.0. Then the pH of samples was measured.

Specific gravity of milk was determined by using pycnometer (AOAC, 1990). The density of milk was measured against the density of standard (water). Firstly, preweighed pycnometer was filled with standard reference fluid (water) to some predetermined level at 20°C and weight was noted. Then, milk sample was filled in a similar pycnometer to similar level and temperature, and weighed. Specific gravity of milk was calculated by the following formula:

$$\text{Specific gravity} = \frac{\text{Weight of milk sample}}{\text{Weight of distilled water}}$$

Viscosity of milk was determined with viscometer at 20°C (AOAC, 1990). The rate of flow of a given volume of milk was compared with the rate of flow of the same amount of water. The viscosity of milk was calculated according to the following formula:

Viscosity (cP) = Flow time of milk at 20°C × Specific gravity of milk ×1.002/flow time of water at 20°C.

Freezing point of milk was determined using cryoscope (AOAC, 1990).

Chemical analysis of milk

The milk samples were analyzed for total solids contents. For this purpose, fresh milk sample was thoroughly mixed and 2-3g was transferred to a pre-weighed flat bottom dish (AOAC, 1990). After evaporation on steam bath, it was transferred to a hot air oven at 101°C. Dried sample was transferred to a desiccator having silica gel as desiccant. After 1 h, the dish was weighed and kept in an oven for further drying (~30 min). It was again transferred to the desiccator, cooled and weighed as before. The heating, cooling and weighing processes were repeated until constant weight was achieved. Total solids content was calculated by the following formula:

$$\text{Total solids (\%)} = \frac{\text{Weight of dried sample}}{\text{Weight of milk sample}} \times 100$$

Fat content was determined by Gerber method (James, 1995). Milk sample (11 ml) was mixed with commercial sulfuric acid (10 ml) in butyrometer and closed with rubber cork. The mixture was mixed and placed in a water bath at 65°C. Sample was centrifuged in Gerber centrifuge machine for 3 to 5 min at 1000 rpm. The fat percentage was noted on the butyrometer scale. Solids not fat (SNF) content was determined by difference as reported by Harding (1995), using the following formula:

SNF content (%) = TS (%) – Fat (%)

Protein content was determined according to the method of British Standards Institution (BSI, 1990). The sample (5-6g) was digested using micro-Kjeldhal digester in the presence of catalyst (0.2g copper sulfate and 2g sodium sulfate/potassium sulfate) where sulfuric acid (20-30 ml) was used as an oxidizing agent. The digested sample was diluted with distilled water (250 ml). Then 5 ml portion from the diluted sample was distilled with NaOH (40%), using micro-Kjeldhal distillation unit where steam was distilled over 2% boric acid (5 ml) containing an indicator for 3 minutes. The ammonia trapped in boric acid was determined by titrating with 0.1N HCl. The nitrogen percentage was calculated using following formula:

Nitrogen (%) = 1.4 (HCL, sample - HCL, blank) Normality HCL/Weight of sample taken

The protein percentage was determined by conversion of nitrogen percentage to protein assuming that all the nitrogen in milk was present as protein i.e.

Protein percentage = N (%) × F

Where, conversion factor “F” = 100/N (N%) in dairy products (i.e. 15.66) (James, 1995).

Casein content was determined according to the method of AOAC (1990). Ash (%age) was determined by Gravimetric method, as described by AOAC (1990) using muffle furnace at 550°C. The lactose content was determined according to the following formula:

Lactose (%) = TS% - (Fat% + Protein% + Ash%)

Statistical analysis of data collectd was performed using the computer programme SPSS Release 7.5.1 (SPSS, 1996).

RESULTS AND DISCUSSION

Marketing system of milk at Tandojam area is unorganized and is carried out through direct sellers (milk passes directly from the producer to the consumer) and indirect marketing channels where several agencies operate between producer and consumer. The channels in marketing of milk involved in this area include direct sellers, milk collection centers, milk vendor shops and hotels. A wide variation was observed in physical as well as chemical quality of milk from these sources. The results of several workers substantiate the findings of the present work (Hui, 1993; Shah, 1996; Prasad, 1997; Memon, 2000). They attributed this variability to genetic, physiological and/or environmental factors.

Physical quality of milk

There was significant difference (P<0.01) in the acidity percentage of DF milk compared to the other sources (Table 1). However, the acidity of milk was relatively similar (P>0.05) at DS vs. MCC, MVS and HT, MCC versus MVS and HT. Wherever, milk obtained from MVS was significantly different (P<0.05) from that of HT milk. Shah (1996) also reported similar trend for acidity of milk sold by different agencies at Latifabad, Hyderabad.

Mean pH of milk obtained from various sources varied between 6.53 and 6.66 and was within the normal range (Table 1). Relatively similar observations were made by different workers (Memon, 2000; Inayat, 2002). The results of titrable acidity and pH values of milk in the present study are not correlating to each other. The reason could be attributed to addition of water, ice or chemical preservative in pure raw milk to extend its shelf life.

Viscosity of DF milk in the present study varied between 1.61 and 2.10 centipoise (cP) with an overall average of 1.86 ± 0.02 cP (Table 1). These results are in line with the study conducted by Prasad (1997). However, the milk obtained from DS, MCC, MVS and HT showed lower viscosity (Table 1). Statistically, viscosity of milk from various channels was significantly lower (P<0.001) than control group. This can be attributed to condition and quality of protein or fat (i.e. percentage, size of fat globules or clusters of fat globules in milk), temperature and period of storage of milk and/or water adulteration (Prasad, 1997).

The DF milk showed the highest specific gravity (1.031 ± 0.001), while the specific gravity of milk obtained from other agencies was significantly (P<0.001) lower (~1.026) than control group. These results suggest the water adulteration in milk from these agencies, since water is lighter than milk, and its addition would lower the specific gravity of milk.

The DF milk had the lowest freezing point, varying between -0.52 and -0.57, while the other sources had lower values of freezing point of milk (Table 1). These results are in agreement with the work of Shah (1996) and Prasad (1997). A number of factors including individuality, breed differences, developed acidity, colostrum, mastitis, stage of lactation, nutrition and season can affect freezing point of milk (Packard, 1995).

Chemical quality

Total solids content of DF milk in the present study averaged 16.30 ± 0.14%. Similar value was reported by Prasad (1997). However, Memon (2000), Chaudhry (2002) and Inayat (2002) reported lower total solids contents (between 14.60 and 15.78%). Total solids contents of milk collected from different channels averaged between 13.45 and 14.18, and were significantly (P<0.001) lower than control group (Table 2).

Solid not fat (SNF) contents of milk obtained from DF averaged 9.79 ± 0.10% (Table 2), and did not meet the reported work of Prasad (1997) and Inayat (2002). Average SNF content of DF milk is relatively within the prescribed standard of Pakistan Pure Food Rule 1965 (Awan, 2000). SNF contents of milk obtained from different agencies were significantly (P<0.001) lower than control. These results do not meet the legal minimum standard of Pakistan Pure Food Rule for buffalo milk (9.00%) but relatively similar to that of cow milk (8.50%). It appears that different agencies at Tandojam sale either pure cow milk or it was adulterated with buffalo milk. However, all the physical attributes of milk from these agencies particularly freezing point recorded in the present investigation also suggest water adulteration.

Fat content of milk obtained from DF varied between 5.90 and 7.20%, with an average of 6.51 ± 0.06% (Table 2). These results are in line with earlier studies (Prasad, 1997; Memon, 2000; Chaudhry, 2002; Inayat, 2002). However, the fat contents of milk obtained from various channels were relatively similar (P>0.05) and were significantly lower (P<0.01) from control group. Variation in the fat content of milk might be due to individuality of buffaloes caused by differences of capacity under the identical conditions of environment, feeding and management. Such differences of individuality are better thought of as the result of genetic factors (Harding, 1995; Prasad, 1997).

Protein contents of milk obtained from DS, MCC and MVS were relatively similar (Table 2) and in line with the values reported by Prasad (1997). However, these were lower compared to control group (Table 2).

Table 1: Mean values (± SE) for acidity, pH, viscosity, specific gravity and freezing point of milk from different sources (ranges are given in parentheses)

Source of milk	Acidity (%age)	pH value	Viscosity (centipoise)	Specific gravity	Freezing point
Dairy farm	0.14 ± 0.04	6.65 ± 0.01	1.86 ± 0.02	1.031 ± 0.001	-0.551 ± 0.03
(control)	(0.11-0.19)	(6.56-6.76)	(1.61-2.10)	(1.023-1.037)	(-0.5.2- -0.567)
Direct seller	0.13 ± 0.05	6.59 ± 0.05	1.48 ± 0.04	1.026 ± 0.001	- 0.460 ± 0.12
	(0.08-0.21)	(6.09-6.99)	(1.21-1.91)	(1.016-1.036)	(-0.324- -0.561)
Milk collection	0.15 ± 0.04	6.66 ± 0.02	1.58 ± 0.03	1.026 ± 0.001	- 0.470 ± 0.13
center	(0.12-0.21)	(6.42-6.83)	(1.13-1.91)	(1.015-1.036)	(-0.335- -0.558)
Milk vendor	0.12 ± 0.05	6.54 ± 0.01	1.34 ± 0.02	1.026 ± 0.001	- 0.440 ± 0.08
shop	(0.07-0.16)	(6.41-6.76)	(1.21-1.61)	(1.020-1.028)	(-0.352- -0.495)
Hotel	0.13 ± 0.03	6.53 ± 0.03	1.46 ± 0.02	1.027 ± 0.001	- 0.480 ± 0.09
	(0.09-0.15)	(6.40-6.92)	(1.11-1.71)	(1.020-1.032)	(-0.349- -0.549)
Significance					
DF v/s DS	***	n.s	***	***	***
DF v/s MCC	***	n.s	***	***	***
DF v/s MVS	***	***	***	***	***
DF v/s HT	***	**	***	***	***
DS v/s MCC	n.s	n.s	*	n.s	n.s
DS v/s MVS	n.s	n.s	**	n.s	n.s
DS v/s HT	n.s	n.s	n.s	n.s	n.s
MCC v/s MVS	n.s	***	***	n.s	*
DS v/s HT	n.s	**	*	n.s	n.s
MV S v/s HT	*	n.s	*	*	**

Significance: ***** P<0.05, ** P<0.01, *** P<0.001, n.s -non significant.

Table 2: Mean values (%, ± SE) for total solids content, solid not fat, fat content, protein, casein, lactose and ash content of milk

Source of milk	Total solids content (%age)	Solids not fat content (%age)	Fat content (%age)	Protein content (%age)	Casein content (%age)	Lactose content (%age)	Ash content (%age)
Dairy farm	16.30 ± 0.14	9.79 ± 0.10	6.51 ± 0.06	4.35 ± 0.08	3.56 ± 0.06	4.53 ± 0.13	0.91 ± 0.01
(control)	(15.00-17.72)	(8.80-10.63)	(5.90-7.20)	(3.57-4.91)	(2.67-5.91)	(3.49-5.82)	(0.66-0.99)
Direct seller	13.45 ± 0.26	8.25 ± 0.18	5.20 ± 0.17	3.85 ± 0.12	2.70 ± 0.12	3.65 ± 0.12	0.75 ± 0.02
	(11.07-16.54)	(6.69-10.64)	(3.10-6.50)	(2.23-5.35)	(0.89-4.02)	(2.36-4.70)	(0.63-1.00)
Milk collection	14.18 ± 0.22	8.81 ± 0.16	5.41 ± 0.12	3.96 ± 0.09	2.77 ± 0.09	4.03 ± 0.09	0.78 ± 0.02
center	(12.66-16.37)	(7.49-10.87)	(4.60-6.70)	(3.23-4.91)	(2.00-3.57)	(3.27-5.04)	(0.62-1.00)
Milk vendor	13.19 ± 0.25	8.06 ± 0.19	5.13 ± 0.13	3.91 ± 0.19	2.56 ± 0.15	3.34 ± 0.13	0.74 ± 0.03
shop	(10.87-15.13)	(6.25-9.85)	(3.90-6.60)	(2.18-5.80)	(0.89-4.02)	(1.58-4.60)	(0.49-1.01)
Hotel	14.06 ± 0.25	8.51 ± 0.17	5.54 ± 0.13	4.23 ± 0.12	3.20 ± 0.10	3.52 ± 0.14	0.76 ± 0.02
	(11.13-16.20)	(6.63-10.22)	(4.30-6.50)	(3.12-4.81)	(2.24-4.24)	(2.40-5.66)	(0.53-1.00)
Significance							
DF v/s DS	***	***	***	**	***	***	***
DF v/s MCC	***	***	***	**	***	**	**
DF v/s MVS	***	***	***	*	***	***	***
DF v/s HT	***	***	***	n.s	n.s	***	***
DS v/s MCC	*	**	n.s	n.s	n.s	**	n.s
DS v/s MVS	n.s	n.s	n.s	n.s	n.s	*	n.s
DS v/s HT	n.s	n.s	n.s	*	**	n.s	n.s
MCC v/s MVS	**	**	n.s	n.s	n.s	**	n.s
DS v/s HT	n.s	n.s	n.s	n.s	*	**	n.s
MV S v/s HT	*	n.s	*	n.s	**	n.s	n.s

Significance: * P<0.05, ** P<0.01, *** P<0.001; n.s -non significant.

The higher percentage of protein content in DF milk could be attributed to managemental practices. However, hotel milk was relatively similar to that of dairy farm milk (P>0.05) in protein contents.

Casein content of milk obtained from DS, MCC, and MVS averaged 2.70, 2.77 and 2.56%, respectively (Table 2). These findings were significantly lower than DF (P<0.01). However, casein content of hotel milk was relatively similar (P>0.05) to that of dairy farm milk. Milk available at hotels is usually heated which may denaturize whey proteins (Packard, 1995) and results in the higher amount of casein.

Lactose content was highest in DF milk and lowest in milk from vendor shop (Table 2). Similar findings were reported by Prasad (1997). However, the lactose content of milk obtained from DS, MCC, MVS and HT were significantly different from control group (P<0.01). Sharif, *et al.* (2007) recorded a reduction of the lactose contents in buffalo milk with the severity of sub-clinical mastitis.

Ash content of DF milk averaged 0.91% in contrast to DS (0.75%), MCC (0.78%), MVS (0.74%) and HT (0.76%) milk (Table 2). The ash contents of milk collected from DS, MCC, MVS and HT were significantly lower (P<0.01) compared to DF milk.

Conclusions

Based on the results of the present study, it can be concluded that the quality of milk sold by different marketing agencies (i.e. DS, MCC, MVS and HT) at Tandojam area was lower compared to DF milk, probably due to adultration. Therefore, regular check up of milk should be carried out by the local authority for quality at various critical control points according to "Pakistan Pure Food Rule" at Tandojam area.

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