Research in
AGRICULTURE, LIVESTOCK and FISHERIES
ISSN : P-2409-0603, E-2409-9325
An Open Access Peer Reviewed Journal

Open Access **Res. Agric. Livest. Fish.**
Research Article **Vol. 4, No. 2, August 2017: 99-106**

PHYSICO-CHEMICAL ANALYSIS AND DETECTION OF ADULTERATION IN RAW MILK COLLECTED FROM GOALAS OF DIFFERENT PLACES OF SADAR UPAZILA IN MYMENSINGH DISTRICT

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ARTICLE INFO

Received
12 July, 2017

Accepted
22 August, 2017

Online
30 August, 2017

Key words
Goala
Raw milk
Quality
Adulteration

ABSTRACT

This research work was carried out to assess the physical, chemical quality and detection of adulteration in raw milk collected from goals of five different places of Mymensingh sadar upazila (BAU Sheshmore, BAU KR market, train going vendor, sweetmeat shop and Dhudmohol) in Bangladesh. Results shows that milk from sweet meat shop had 100% yellowish white colour, normal (milky) flavor and free flowing liquid whereas other sources milk varies with their percentage in terms of physical parameters. Specific gravity of milk from various sources differed significantly ($p<0.01$) and all the chemical parameters of milk sample collected from different sources differed significantly ($p<0.01$). Significantly higher percentage of total solids (12.67±0.10) and fat content (4.36±0.07) was found in milk from goala of sweet meat shop than others. All of the adulteration tests showed negative result that means no adulterant materials was found in the collected milk samples. Considering the results, it could be inferred that there was an ample fluctuation present on qualities of milk samples collected from the goalas of different places of Mymensingh sadar regarding the standard of the parameters and the raw milk samples from sweetmeat shop were of good quality. The results suggested that milk purchase from reliable sources is very much important for consumers due to its quality.

To cite this article: Rahman A, MR Habib, MY Ali, MA Islam and MHU Rashid, 2017. Physico-chemical analysis and detection of adulteration in raw milk collected from Goalas of different places of sadar upazila in Mymensingh district. Res. Agric. Livest., Fish.,4 (2): 99-106.

INTRODUCTION

Milk is an important source of all basic nutrients for mammals. Milk from cows, buffaloes and goats are being used for producing different dairy products including cream, butter, yogurt, ghee, sour milk etc. Consumers always demands nutritionally enriched milk and dairy products (Nicolaou et al., 2011). It supplies nutrients like high quality protein, fat, carbohydrate, vitamins and minerals in significant amount than any other single food (Neumann et al., 2002). According to the Goff and Hill (1993) milk is the lacteal secretions obtained by complete milking of one or more healthy cows excluding that obtained within fifteen days before or five days after calving or such periods as may be necessary to render milk practically colostrums free and containing the minimum prescribed percentage of milk fat (3.5%) and solids-not-fat (8.5%). Milk contains all the essential nutrients for all physiological functions of the human body system (Bendale et al., 2015). It is a precious ingredients ideally quantized makes it valuable alone or a part of food globally (Mc Graw-Hill, 2005). The physico-chemical analysis is an important tool to scrutinize the quality of milk that encompasses with chemical composition, physical properties, microbiological and nutritive value (Czerniewicz et al., 2006).

Adulterated food may be dangerous for health as it may contain various toxic chemicals as well as it may be deprived of nutrients required for proper growth and development of human body (Marcus, 1979). Adulteration of milk is usually done by adding inferior cheaper materials or elements like pond water, cane sugar and powdered milk (Prasad, 1999). Addition of water decrease the milk solids-not-fat contents specially proteins which is very vital for normal growth. So, calculation of added water percentage relies on determination of milk solids-not-fat (Moore et al., 2012 and Santos et al., 2013). Again, milk can be adulterated to increase their profit margin using urea, starch, flour, vegetable oils, detergents etc. Formalin and some antibiotics are also added in milk to increase its shelf life. These adulterants, preservatives and drugs in milk cause very serious health related problems (Afzal et al., 2011). Milk adulteration leads to economic losses, deterioration of the quality of end products as well as risk to consumer's safety (Mabrook and Petty, 2003). Besides the combination of both addition of water and partial skimming may be occur, the economic losses will be higher to the consumers. Incidence of both types of adulteration has been reported by different authors (Khan et al., 1999; Abdel-Hamid, 2002; Arora et al., 2004; Uddin et al., 2016 and Abdel- Sabour, 2007). Men and women had assembled in the market place, each with a bucket of milk. A milk collection point had been started by few 'goalas' (milk collectors). The goalas are testing the water content of the milk, measuring it out into the collection churns and then making careful notes about the amounts in their ledger so they can pay the milk producers each week (CLP, 2014). Though goalas are usually provided raw milk in different places of Mymensingh sadar upazila in Bangladesh but the quality of that raw milk did not study yet. Hence, the current research work was undertaken to know the physical, chemical quality and detect the level of adulterant in raw milk from goalas of different places of Mymensingh sadar.

MATERIALS AND METHODS

Experimental site and duration

Raw milk samples were collected from five goalas of different places of Mymensingh sadar upazila in Bangladesh and all the analyses were performed at the Dairy Technology Laboratory under the Department of Dairy Science, Bangladesh Agricultural University, Mymensingh during the period from April to May, 2015.

Collection of milk samples

Raw milk samples were collected three times from five different goalas and each time 3 samples were collected from BAU Sheshmore, BAU KR (Kamal Ranojit) market, train going vendor, sweetmeat shop and Dhudmohol of Mymensingh sadar upazila in Bangladesh. Each sample contain 500 ml milk which collected by sterilized bottle. The samples were immediately cooled in a cool box containing ice packs. The milk was analyzed in the laboratory within 2 hours from arrival.

Physico-chemical analysis and detection of adulteration

Physical analysis

Sensory analysis was examined by a panel of experienced ten members. The organoleptic properties of milk such as color, flavor and texture were evaluated with the help of eyes, nose and mouth, respectively as per standard score card (ISO, 1995). Specific gravity test of milk was performed using Quevenne Lactometer (S. Brannan & Sons, Leconfield Industrial Estate, Cleator Moor, Cumbria, CA255 QE) according to the procedure described by Aggarwala and Sharma (1961).

Chemical analysis

Total solids, solids-not-fat were performed according to (AOAC, 2003) and protein test was done based on formal titration method described by Horwitz (1975). Fat percent was estimated by Gerber method according to (AOAC, 2003). Acidity test was determined by titrating with 0.1N sodium hydroxide solution using the procedure of Aggarawala and Sharma (1961).

Adulteration detection methods

Detection of starch in milk

After preparation of the sample about 3-5 ml of milk was taken in a test tube. Then 2-3 drops of iodine solution was added to the test tube. Development of blue/blue black color indicates presence of starch which disappears when sample is boiled and reappears on cooling.

Detection of formalin in milk

Measure out 10 ml milk into a test tube. Gently add 5 ml of 90% Sulphuric acid and ferric chloride mixture into the test tube. Formation of purple color ring at the interface of two layers indicates that the milk is adulterated with formalin.

Detection of sugar in milk

Measure out 10ml milk into a test tube and 5ml of Conc. HCl is added to the test tube with milk. The contents in the test tube are mixed well and 0.1g of resorcinol powder is added to the test tube. Mix the contents in the test tube is gently mixed. Now the test tube is placed in a boiling water bath for 5 minutes. the tube in a boiling water bath for 5 min. After the incubation, if a red color is observed, indicates the presence of sugar.

Clot-on-Boiling test (COB) in milk

About 5 ml of milk taken in the test tube and put this on boiling water bath for 5 minutes. Then remove the test tube from water bath without shaking. Note any acid smell or precipitated particles on the sides of the test tube. Sample showing precipitated particles are recorded as positive C.O.B. test. Such milk is rejected on the platform.

Alcohol test in milk

About 5 ml of milk taken in a test tube and add equal quantity of 68% Ethyl alcohol. Then mix the contents of the test tube by inverting several times. Examine the tube and note any coagulation. If coagulation has occurred fine particles of curd will be visible on the inside surface, presence of flake or curd denotes positive alcohol test. Such samples are rejected.

Statistical analysis

The data generated from this experiment were entered in Microsoft Excel worksheet, organized and processed for further analysis. Statistical analyses of all the parameters were analyzed using Statistical Analysis System (SAS) software (SAS Institute Inc., 2009) version 9.1.3. Also, Duncan Multiple Range Test (DMRT) was done to compare the treatment means as described by Gomez and Gomez (1984).

RESULTS AND DISCUSSION

Physical analysis

Colour

Cow's milk collected from BAU KR market showed 66.67% yellowish white and whitish 33.33%. Also, train going vendor milk sample reveals that 77.78% yellowish white and 22.22% whitish whereas milk from Dhudmohol indicates that 22.22% yellowish white and 77.78% whitish in colour (Table 1). Changes in milk colour may be due to the differences in nature of feed, breed, fat and solids contents of the milk because colour of milk depends upon these factors. Similar type of results found Monem (2012) who reported that the color of the most milk samples from Bogra town was yellowish white.

Flavour

From the study of BAU Sheshmore milk sample, it was showed that 11.11% in normal flavour and rest 88.89% milk with no flavour. Among five goalas BAU KR market and sweetmeat shop milk showed 100% normal flavour whereas train going vendor and Dhudmohol milk flavour varies from them regarding to flavour (Table 1).This result agreed with the work of Bari (2001) who found normal (pleasant and aromatic) milk flavour from Bangladesh Agricultural University dairy farm, Mymensingh.

Table 1. Physical properties of raw milk from collected samples

Physical parameters	BAU Sheshmore	BAU KR market	Train going vendor	Sweetmeat shop	Dhudmohol
Colour	100% whitish	66.67% yellowish white & 33.33% whitish	77.78% yellowish white & 22.22%whitish	100% yellowish white	77.78% yellowish white & 22.22%whitish
Flavour	11.11% normal flavour & 88.89% no flavour	100% normal flavour	77.78% normal flavour & 22.22% no flavour	100% normal flavour	55.56% normal flavour & 44.44% no flavour
Texture	100% watery	33.33% watery & 66.67% free flowing liquid	33.33% watery & 66.67% free flowing liquid	100% free flowing liquid	66.67% watery & 33.33% free flowing liquid

BAU: Bangladesh Agricultural University, KR: Kamal-Ranjit

Texture

Result reveals that milk from BAU KR market, train going vendor and Dhudmohol showed 33.33% watery texture and 66.67% free flowing liquid texture, respectively (Table 1). Rashedul (2012) found the texture of raw milk sample were normal whereas Uddin (2012) also found normal texture for all milk samples collected from local markets of Mymensingh sadar upazila. This result agreed with the findings of Mahedy (2012) who revealed that all the collected samples were normal in texture (free flowing liquid).

Specific gravity

Statistical analysis showed that there was a significant ($p<0.01$) difference present in the specific gravity of milk sample collected from different goalas of Mymensingh sadar upazila (Table 2). The results of specific gravity of milk from BAU KR market, train going vendor and sweetmeat shop were in agreement with Bari (2001) who found that the average specific gravity of cow's milk from BAU Dairy Farm was 1.031. Again, Kader et al. (2015) showed slight variation in specific gravity of milk among four samples that varied from 1.026 to 1.034 with an average of 1.031. The specific gravity showed slight variation among four samples that varied from 1.026 to 1.034 with an average of 1.031. The results of specific gravity of milk from BAU Sheshmore and Dhudmohol were quite similar with Lateef et al. (2009) who observed that the specific gravity of cow's milk was 1.02±0.010. According to BSTI (2016) in Bangladesh milk shall contain specific gravity is 1.026-1.035.

Table 2. Specific gravity (Mean±SE) of milk sample collected from goalas of Mymensing sadar

Parameter	BAU Sheshmore	BAU KR market	Train going vendor	Sweetmeat shop	Dhudmohol	p-value	Sig.
Specific gravity	1.020^{b}±0.000	1.030^{a}±0.000	1.030^{a}±0.000	1.030^{a}±0.000	1.023^{b}±0.003	0.0016	**

[a,b]Mean values within a row having different superscripts differ significantly; **Sig: Significant at p<0.01

Chemical analysis

Acidity (%)

The acidity of the entire milk samples collected from BAU Sheshmore, BAU KR market, train going vendor, sweetmeat shop and Dhudmohol were 0.11±0.00, 0.13±0.00, 0.13±0.00, 0.15±0.00 and 0.11±0.00%, respectively (Table 3). Statistical analysis reported that there was a significant difference (p<0.01) existed within the mean acidity of milk sample collected from these places. In some cases acidity of milk from different sources was slightly higher than the findings of Bari (2001) who found that acidity percentage of Mymensingh town was 0.14±0.03. Again, Uddin et al. (2016) found maximum acidity percentage (0.180±0.02) in Mymensingh sadar bazaar. Acidity percentage positively correlated with SNF content in milk.

Total solids content (%)

Resultant average total solids (TS) content of milk from BAU Sheshmore, BAU KR market, train going vendor, sweetmeat shop and Dhudmohol are shown in Table 3. Statistical analysis indicates that the total solids (TS) content of milk sample collected from goalas of different places differed significantly (p<0.01). Through studying raw milk from Mymensingh town Mahedy (2012) reported TS content in milk was 10.95, 10.91 and 10.83%, respectively. Islam et al. (2008) who studied the milk quality of local cows in BAU Dairy Farm and found that the total-solids content of cow's milk was 14.25%. The present study does not agree with this statement.

Table 3. Chemical parameters of milk collected from goalas of different places of Mymensingh sadar

Parameters (%)	Different goalas of Mymensingh sadar (Mean ± SE)					p-value	Sig.
	BAU Sheshmore	BAU KR market	Train going vendor	Sweetmeat shop	Dhudmohol		
Acidity	0.11^{c}±0.00	0.13^{b}±0.00	0.13^{b}±0.00	0.15^{a}±0.00	0.11^{c}±0.00	0.0003	**
TS	8.63^{d}±0.30	11.01^{b}±0.05	10.75^{b}±0.30	12.67^{a}±0.10	9.95^{c}±0.1	0.0001	**
SNF	5.42^{a}±0.23	7.55^{b}±0.04	7.74^{b}±0.17	8.37^{a}±0. 09	6.72^{c}±0.24	0.0001	**
Fat	3.21^{bc}±0.07	3.46^{b}±0.06	3.01^{c}±0.13	4.36^{a}±0.07	3.22^{bc}±0.15	0.0001	**
Protein	1.97^{a}±0.04	2.87^{b}±0.11	2.79^{b}±0.08	3.27^{a}±0.08	2.42^{c}±0.09	0.0001	**
Lactose	2.95^{b}±0.23	4.03^{a}±0.10	4.28^{a}±0.08	4.40^{a}±0.01	3.74^{b}±0.11	0.0001	**
Ash	0.49^{b}±0.02	0.64^{a}±0.02	0.66^{a}±0.01	0.69^{a}±0.00	0.55^{b}±0.03	0.0004	**

[a,b,c] Mean values within a row having different superscripts differ significantly; **Significant at p<0.01

Solids-not-fat content (%)

Result showed that solids-not-fat (SNF) content of milk significantly (p<0.01) differed from each places and the highest SNF value was found in sweetmeat shop which was 8.37±0.09% whereas the lowest SNF (5.42±0.23%) found in BAU Sheshmore milk. The SNF component of milk, which consists of protein, lactose and mineral, may vary with changes in the diet but to a lesser degree than the fat content. Specific factors that have been reported to affect SNF production include nutrition, genetics, disease, stage of lactation, and season of year (Harris and Bachman, 2003). Islam et al. (2008) reported that the average SNF percentage of milk of local cows was 8.7%. In another work, Hossain (2009) showed that higher SNF content in milk collected from Bangladesh Agricultural University Dairy Farm which was 9.86%.

Fat content (%)

Average fat content are shown in Table 3 and it significantly ($p<0.01$) differed among the different places of Mymensingh sadar upazila (Table 3). The highest fat content was found in sweetmeat shop (4.36±0.07%) and the lowest (3.01±0.13%) fat found in train going vendor milk sample. According to the proposed standard of BSTI (2002) the average fat content of milk is 3.5%. Average fat content of milk samples collected from sweetmeat shop was found to be satisfactory compared to BSTI standard. The average fat percentage of this experiment was lower than the work of Asaduzzaman (2009) who found that milk sample collected from BAU Dairy Farm had higher fat content than that of market samples which was 4.43%. Islam et al. (2013) also found higher fat content (4.0, 3.2 and 4.9%) in the milk of Muktagacha Upazila. Again, Uddin et al. (2016) found lower milk fat in Mymensingh sadar bazaar milk samples. The lower fat content milk collected from local market may be due to adulteration with water which reduces the fatcontent of milk samples. This might also be due to the skimming or with drawing of the fat from market milk samples.

Protein content (%)

The protein content of the entire milk samples collected from BAU Sheshmore, BAU KR market, train going vendor, sweetmeat shop and Dhudmohol are shown in Table 3. Uddin et al. (2016) found that average protein value of milk samples from local markets of Mymensingh sadar was 3.34, 3.29, 3.47 and 3.39%, respectively. The average value of protein in this study is agreed with this data but slightly lower than the work of Hossain (2009) who reported that the average values of protein from the milk of BAU Dairy Farm was 3.66%. This might be due to addition of water, genotypic variation and nutritional level of cows.

Lactose content (%)

Table 3 showed that the lactose content of the milk sample collected from different places differed significantly ($p<0.01$). Resultant average lactose content of milk from BAU Sheshmore, BAU KR market, train going vendor, sweetmeat shop and Dhudmohol were 2.95±0.23, 4.03±0.10, 4.28±0.08, 4.40±0.01 and 3.74±0.1%, respectively. The mean content of lactose of this experiment was slightly higher than Mahedy (2012) who revealed that lactose content in milk collected from different sweetmeat shops in Mymensingh town varied from 3.86 to 3.91%, respectively.

Ash content (%)

Ash content of the entire milk samples collected from BAU Sheshmore, BAU KR market, train going vendor, sweetmeat shop and Dhudmohol were 0.49±0.02, 0.64±0.02, 0.66±0.01, 0.69±0.00 and 0.55±0.03, respectively (Table 3). The result of this experiment was similar with Uddin et al. (2016) and Amin (2005) who reported that average ash content of milk collected from Mymensingh town was 0.67%.

Adulteration Tests

Adulteration tests such as COB, alcohol, starch, formalin and sugar test of the entire milk samples collected from BAU Sheshmore, BAU KR market, train going vendor, sweetmeat shop and Dhudmohol were showed negative (Table 4) which indicates that milk was free from adulteration with unwanted and poisonous materials. This finding was supported by Islam et al. (2013), Uddin et al. (2016) and Rashedul (2012) observed the same results in the samples collected from Mymensingh sadar & Muktagacha upazila. Biswas et al. (1997) and Saha et al. (1998) found that the COB tests was negative and indicated that there was no developed acidity in milk.

Table 4. Adulteration test of raw milk samples collected from different goalas of Mymensingh sadar

Adulteration test	Different Goalas of Mymensingh Sadar				
	BAU Sheshmore	BAU KR market	Train going vendor	Sweetmeat shop	Dhudmohol
Clot-on-boiling test	Negative	Negative	Negative	Negative	Negative
Alcohol test	Negative	Negative	Negative	Negative	Negative
Starch test	Negative	Negative	Negative	Negative	Negative
Formalin test	Negative	Negative	Negative	Negative	Negative
Sugar test	Negative	Negative	Negative	Negative	Negative

CONCLUSIONS

The quality and composition of raw milk depends on its physico-chemical parameters that vary from one goala to another as well as dairy farmers. Moreover, the quality and compositions are affected by numerous factors like breeds, forage consumption, feeding system, milking frequency, milking process, seasonal changes, lactation period and adulteration. From the physico-chemical analysis, it observed that milk from goala of train going vendor and sweetmeat shop were far better than others. Adulteration tests were found negative in all places of milk samples and it clearly indicated that there was no adulteration in milk with poisonous materials like formalin and unwanted materials like sugar, starch. These findings will create awareness among the peoples of Mymensingh sadar upazila and increase good quality milk consumption in this area.

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