



REGULAR ARTICLE

DETECTION OF ADULTERATION AND QUALITY EVALUATION OF RAW MILK COLLECTED FROM LOCAL MARKETS IN BANGLADESH

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ABSTRACT

This experiment was aimed to detect adulteration and assess the quality of raw milk which were collected from various local markets in Bangladesh. The samples of the raw milk were collected from Narikali Bazar, Sofir Mia Bazar and Sokal Bazar of Jamalpur district in Bangladesh. Parameters were used to detect adulteration such as presence of Formalin, Starch, Cane Sugar, and coloring agent, and to screen the qualities of the samples on the basis of physical tests (color, flavor, taste, texture and specific gravity), chemical tests [acidity, fat, ash, lactose, protein, TS and SNF]-and microbiological tests. From the physical test, it was found that all the samples were yellowish white in color, normal in taste and flavor and free flowing fluid in case of texture. All of the raw milk samples did not fulfill the legal standard of milk composition. However, raw milk samples of Sokal Bazar were higher in fat, protein, lactose, SNF and TS contents than the other two samples. Microbiological parameters also remained high in all raw milk samples than the standard. It was observed that no adulteration was found in any of the collected raw milk samples. This study revealed that hygiene condition did not properly maintain during milking and transportation of the raw milk supplied in the local markets.

Keywords: Raw milk, Adulteration, Food, Milk quality, Bangladesh

INTRODUCTION

As a third world country, Bangladesh suffers from malnutrition severely. It has an average of 1.47 lakh square kilometers with a population of 154 million, of which 28 percent live in urban and 72 percent in rural areas. The sources of a balanced diet are very challenging here for the people. Hasan and Rakib [1] reported that the average milk production per cow per year is about 2190 kg in developed countries, 1220 kg in Asia whereas 206 kg in Bangladesh. Milk is the lacteal secretion of a healthy animal. It can be obtained two weeks before or one week after calving. It usually contains 3.5 % fat and 8.5% not fat solids with no colostrum [2]. In Bangladesh, there is no prominent organization which deals the milk production in rural areas with its distribution to market and milk processing organization. It is usually done by middleman [3]. Most of the dairy farmer's livelihood depends on rearing cow and selling milk [4]. It is very common in rural areas by which dairy farmer of rural area earn money by selling milk and it helps to reduce their poverty and food insecurity [5, 6,

7]. Women farmer also can rear milking cows in the riverine island char areas of Bangladesh which empowers themselves [1, 8, 9]. There are a few organizations especially Milk Vita and other dairy farm where excess milk is readily available as a result it is failed to get attention from concerned authorities [10, 11]. The dairy farmer needs capital for purchasing healthy cow and rearing so that the production can be increased with improved milk quality. The capital can be borrowed from commercial banks of Bangladesh but it needs special attention of government [12, 13].

Milk is the heterogeneous product and an almost complete and well-balanced food for the newly born infant or animal [14, 15]. Farkye [16] and Javaid *et al.* [17] reported that it is a necessary item of daily diet. Milk-fat has nutritive value which is easily consumable and a source of energy. It also helps in lactose assimilation [18]. The protein of milk contains three major proteins viz lactoglobulin, lactalbumin, and casein. Among them, Casein is the principal protein component of milk and tryptophan and

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lysine also are also major amino acid elements in milk. Besides glutamic acid present in cow's milk are 3 times higher than in human milk, which results in a reduction of cholesterol level in blood. The oratic acid of milk protein improves liver detoxification. Another content taurine is responsible for the development of immature brain tissue of mammalian young. Lactose is the major element of milk which helps to utilize calcium properly and good food elements for baby [1]. Moreover, galactose the special component of lactose is essential for the nervous system. Lactose has an influence on the growth and development of baby and adult. More over some are present in large quantities than human requirement [19]. Milk also contains Vitamin E, which cures heart disease. Khan *et al.* [20] reported that in Bangladesh, Milk collector (Goala) collects milk from rural and urban areas and sell it to the market. It is main professions of so many people who lead their livelihood on it. Goalas purchase milk from different smallholder dairy farmers and local markets. Besides dairy farmer sells their milk by themselves in the local market and earn money which helps to reduce poverty and improving food security. There is some established milk processing center in Bangladesh which collects milk from dairy farmers through milk collector and process it for future use by packaging. Islam *et al.* [21] found the supplied milk occasionally adulterated. A successful dairy operation requires knowledge of microorganisms which is usually available in milk [1]. The consumer usually suffers for milk adulteration so they want to get fresh, clean and pure milk and pathogen-free [22, 23]. Global data indicate that during the last 20 y, the world has witness spectacular expansion in the livestock industries. Farrell [24] reported that Milk is expected to increase by 64% in the world by the year 2020. So, it is necessary to increase milk production to mitigate the requirement. Milk can undergo spoilage due to the action of various microorganisms. Undesirable bacteria in milk causes some defects like flavor deterioration, discoloration, souring, and gassiness. Lactose is broken down to glucose and galactose by microbial enzyme lactase and finally, lactic acid is produced from glucose. The adulteration of milk is usually done by adding water, sugar and flour. Adulteration can cause health problems in consumers. For this reason, it is an important matter to know technical knowledge about how milk is adulterated? The study was undertaken with the aim of detecting adulteration and evaluating the hygienic quality (physical, chemical and microbiological) of raw milk from local markets of Jamalpur district in Bangladesh. The specific objectives are (a) to determine the type of adulterants and frequency of adulteration in the raw milk supplied, and (b) to evaluate the quality of raw milk in terms of physical, chemical and microbiological parameters.

MATERIALS AND METHODS

Site selection and collection of sample

The experiment was conducted by the milk samples which were collected from different local markets of Jamalpur Upazila in Bangladesh. Adulteration, organoleptic, chemical, and microbiological test was observed [25]. The samples of milk were collected from the 3 different places of Jamalpur Upazila. These samples were collected from the following places: Narikali Bazar, Sofir Mia Bazar and Sokal Bazar of Jamalpur Upazila of Bangladesh. The present experiment was conducted at Dairy Science laboratory of the Department of Dairy Science, Bangladesh Agricultural University during the period from 1st July to 13th November 2013. Three local markets namely Narikali Bazar, Sofir Mia

Bazar, and Sokal Bazar were selected for this experiment. The pots were cleaned properly which used for sample collections. Three times sample and three samples in each time were collected from these local markets.

Analysis of the samples

Different tests related to detection of adulteration, organoleptic, chemical [25] and microbiological parameters were conducted for determining adulteration and quality status [27].

Adulteration test

Adulteration tests were done through starch, formalin, cane sugar and coloring agents as follows.

Organoleptic evaluation

a) Color: The judging of color was done by eye for the organoleptic test. The color of milk is a blend of individual effects produced by Carotene, which imparts a yellowish color.

b) Flavor: Flavor may be detected by sniffing the products before placing in the mouth and also while in the mouth.

c) Taste: The sample was placed in the mouth, rolled around in the mouth to come in contact with the taste buds located on the various portion of the tongue.

d) Texture: The judging of the texture of milk sample was also done by eye.

Chemical tests

Acidity [25], Fat test [49], Protein percentage [1], Ash content [28], total solids [28], Solids-not-fat (SNF) [25] Specific gravity [25] were tested by following standard methods.

The lactose content was estimated by the following formula: Lactose content of milk = SNF%-(Protein%+Ash %)

Microbiological tests and statistical analysis

The experiment followed the procedures of American Public Health Association for the determination of total viable bacteria and the detection and enumeration of coliform bacteria [26]. It employed Completely Randomized Design (CRD) and done a subsequent test like one-way analysis of variance test by using MSTATC package software. Least Significance Difference (LSD) test was administered for ranking the means.

RESULTS AND DISCUSSION

In this experiment, milk samples collected from three local markets of Jamalpur town i.e. from Narikali Bazar (A), Sofir Mia Bazar (B), and Sokal Bazar (C) were analyzed to detect adulteration and monitor their quality. Results obtained from this experiment are discussed below:

Tests for adulteration

Starch test

Akirul [29] showed negative results of the starch test for all the samples collected from Muktagacha Upazila of Mymensingh District in Bangladesh. Rashedul [30] also found the negative results of the starch test for all milk samples collected from Fulbaria Upazila, Mymensingh. Lateef *et al.* [31] reported that milk dealers maximize their profit margin by dilution and extraction of valuable milk fat. Various products are made by using cream which is extracted from milk [32].

Table 1: Adulteration test results of collected raw milk samples

Items	Narikali Bazar	Sofir Mia Bazar	Sokal Bazar
Starch	Negative	Negative	Negative
Formalin	Negative	Negative	Negative
Cane sugar	Negative	Negative	Negative
Colouring Agents	Negative	Negative	Negative

Formalin test

The formalin test showed negative results. Safi [33] found the negative results formalin test for all the collected milk samples of Mymensingh, Bangladesh. Rashedul [30] also reported the negative results of formalin test for all milk samples collected from Mymensingh, Bangladesh.

Cane sugar test

The results for cane sugar test of all milk samples showed negative results. Addition of sugar in milk is a very common adulteration problem in dairy industry [34] and the SNF content in milk is increased by the addition of sugar and only 0.2% addition increase lactometer reading by one degree of 60 °F. Zia [35] observed that cane sugar is added in milk to increase the solids-not-fat content of milk after addition of water.

Test for the coloring agent

All the milk samples showed negative results in case of the coloring agent. Akirul [29] showed negative results of coloring agent for all the samples collected from Mymensingh, Bangladesh.

Physical parameters

The physical parameters were measured after sample collection (table 1). These parameters were a mainly organoleptic test (color, flavor, taste, texture) and specific gravity of the raw milk samples [36].

Organoleptic evaluation

Color and flavor

All samples were yellowish white in color. Most of the samples agree with Rashedul [30] who reported that the color of the milk sample collected from local market were yellowish white and same as Monem [37]. All the collected milk samples were normal in flavor [38].

Taste

The taste of all milk samples was normal. Bari [38] showed that normal taste of milk collected from BAU Dairy Farm in where milking had been done hygienically. Safi [33] found the taste was slightly sweet and Rashedul [30] reported slightly sweet in taste for all milk samples of Mymensingh, Bangladesh.

Texture

The texture of raw milk sample was examined when milk was bought. All samples were normal texture (Free flowing fluid). Rashedul [30] found the texture of raw milk sample were normal and same as Safi [33]. The physical quality of raw milk collected three local markets of Jamalpur Sadar were almost similar with a few variations in terms of physical qualities.

Chemical parameters

The chemical parameters of total solids (g/kg) raw milk samples such as specific gravity, acidity%, fat (g/kg), protein (g/kg), lactose (g/kg), ash (g/kg), total solids (g/kg), solids-not-fat (g/kg) were shown in the table 2.

Specific gravity

The specific gravity of sample Narikali Bazar, Sofir Mia Bazar, and Sokal Bazar were 1.028 ± 0.00 , 1.027 ± 0.00 , and 1.027 ± 0.00 respectively (table 2). There was no significant difference within the specific gravity of different milk samples. The specific gravity of milk obtained from Narikali Bazar was higher than milk of another market. Islam *et al.* [21] found a higher specific gravity of cow's milk from BAU Dairy Farm than local markets. In another experiment, Salam [45] found 1.027 ± 0.00 average specific gravity for milk of Bhaghabarighat Dairy Plant. Rahman [44] reported 1.023 ± 0.00 for the same plant. Mahedi [40] found that 1.024 ± 0.02 average specific gravity for local market milk of Mymensingh, Bangladesh. Monem [37] found $1.026 \pm 0.$ for local market milk of Bogra, Bangladesh. Milk fat has some influence on the specific gravity of milk. Specific gravity mostly depends on the TS content and increases when the TS content rises.

Acidity percentage

From the table2, acidity percentage of sample Narikali Bazar, Sofir Mia Bazar, and Sokal Bazar were 0.15 ± 0.00 , 0.16 ± 0.01 and 0.16 ± 0.01 respectively. There was no significant difference in the acidity percentage of milk collected from local markets. Acidity percentage of milk sample of Sofir Mia Bazar was higher than other markets. Asaduzzaman [39] reported the average percentage of acidity of milk available at Mymensingh district of Bangladesh was 0.15 ± 0.00 . In another experiment, Mahedi [40] found 0.15 ± 0.00 average percentage of acidity. Microbial activities or enzymatic reaction is responsible for higher acidity in milk [41]. From the normal acidity value of milk obtained from three markets, that means, all the milk samples were fresh during an experiment on the laboratory.

Fat content

The fat content of sample Narikali Bazar, Sofir Mia Bazar, and Sokal Bazar were 37.50 ± 0.50 , 38.66 ± 0.29 , and 38.88 ± 0.29 respectively (table 2). There was a significant difference within the fat content of different milk samples [42]. The highest value of fat was obtained from the milk of Sokal Bazar than other sources in this experiment. The standard value of BSTI-(2002) for the average fat content of milk is 35g/kg. Asaduzzaman [39] found 44.35 gm/kg and Safi [33] found 31.5 gm/kg average fat content of milk for Mymensingh town of Bangladesh.

Table 2: Summary of the results (mean±SD) of physical parameters of raw milk samples

Parameter and sample number	Narikali bazar	Sofir mia bazar	Sokal bazar	Level of significance
Flavor (45)	41.33±1.15	40.33±0.58	42.00±1.00	Non-significant
Appearance (5)	3.33±0.58	3.00±1.00	3.66±0.58	Non-significant

Table 3: Summary of the results (mean±SD) of chemical parameters of raw milk

Parameters	Narikali bazar	Sofir mia bazar	Sokal bazar	Level of significance
Specific gravity	1.028±0.00	1.027±0.00	1.027±0.00	NS
Acidity (%)	0.15±0.00	0.16±0.01	0.16±0.01	NS
Fat (g/kg)	37.50b±0.50	38.66a±0.29	38.83a±0.29	**
Protein (g/kg)	35.86±0.85	36.93±1.50	37.16±1.04	NS
Lactose (g/kg)	42.70±0.96	42.43±2.93	44.66±1.76	NS
Ash (g/kg)	6.66±0.21	7.23±0.93	6.83±0.58	NS
TS (g/kg)	122.73±0.91	125.26±5.33	127.50±1.80	NS
SNF (g/kg)	85.23±2.33	86.60±5.05	86.66±1.76	NS

a,b,c In a row fig. with the same superscription do not differ significantly whereas fig. with dissimilar superscription(a, b, c) differ significantly: **P<0.01, NS=Non-significant.

Protein content

From the table 2, it is found that protein content of sample Narikali Bazar, Sofir Mia Bazar, and Sokal Bazar were 35.86±0.85, 36.93±1.50 and 37.16±1.04 respectively. The average protein content was higher in Sokal Bazar compared to other which was due to nutritional level and genotypic variation of cows.

Lactose content

Lactose content of sample Narikali Bazar, Sofir Mia Bazar, and Sokal Bazar were 42.70±0.96, 42.43±2.93, and 44.66±1.76 respectively (table 2). There was no significant difference between the lactose content of different milk samples [1]. Milk sample of Sokal Bazar resumed more lactose compared to other sources. Mahedi [40] found 39.13±3.2, 39.05±2.05, and 38.61±3.61 g/kg for milk of Mymensingh town of Bangladesh [25]. So, the finding of the results in this study was higher [43].

Ash content

Ash content of sample Narikali Bazar, Sofir Mia Bazar, and Sokal Bazar were 6.66±0.21, 7.23±0.93, and 6.83±0.58 respectively. The ash content of different of milk samples had no significant difference. The percentage of ash in cow's milk collected from mid lactation was 0.75% [43]. Ash content of milk sample of Sofir Mia Bazar almost met the standard value and lower value in case of Narikali Bazar and Sokal Bazar.

Total solids (TS) content

Average total solids (TS) content of milk samples were 122.73±0.91, 125.26±5.33 and 127.50±1.80 respectively. The TS content of milk collected from local markets of Jamalpur Sadar, and Sokal Bazar had higher total solids content than other sources. Rahman [44] found 11.49, 10.78, 10.72 and 12.91 % TS content for milk of Manikgonj Chilling Centre, Tangail Chilling Centre, Takerhat Pasteurization Plant and Bagliabari Dairy Plant respectively.

SNF content

SNF content of sample Narikali Bazar, Sofir Mia Bazar, and Sokal Bazar was 85.23±2.33, 86.60±5.05 and

86.66±1.76 respectively (table 2). The SNF content of milk samples had no significant difference. Islam *et al.* [21] also reported lower SNF contents in local market milk than that of the milk from BAU Dairy Farm, Mymensingh. Rahman [44] reported that the average SNF content of mixed milk collected from different primary co-operative society under Baghabari Dairy Plant was 7.69% [25]. Mahedi [40] found 7.7 average SNF percentage.

Microbiological test

Total viable bacterial count

The average values of the total viable count of sample Narikali Bazar, Sofir Mia Bazar and Sokal Bazar were 8.3±1.25×10⁵, 10.0±1.0×10⁵, 7.6±0.76×10⁵ respectively. There was no significant difference among the samples. Average total viable counts/ml for "Grade A" raw milk is not exceeding 200000 for milk to be pasteurized. In this experiment, the comparatively higher viable bacterial count found in Sofir Mia Bazar milk sample which may be due to poor hygienic milking and utensils [43]. On the other hand, total viable count collected from Sokal Bazar was slightly lower which due to the proper hygienic condition. High bacterial density of above mentioned three local markets milk might be due to unhygienic milking and handling. Monem [37] showed that the total viable bacterial count of Bogra town range from 10×10⁵ to 19×10⁵. So, the finding of the results in this study were lower.

Coliform count

The average values of coliform counts of sample Narikali Bazar, Sofir Mia Bazar, and Sokal Bazar were 63.33±15.28, 70.00±20.00 and 60.00±10.00 CFU/ml respectively. The coliform counts/ml of different milk samples had no significant difference and the coliform counts/ml of milk samples were slightly higher. It is for poor hygienic milking, improper cleaning and unhygienic handling [46,47,48]. Rashedul [30] reported that coliform count of raw milk samples of Fulbaria Upazila in Mymensingh District ranges from 70 to 120.

Table 4: Average total viable count (TVC) and coliform count of bacteria in raw milk samples

Parameter	Narikali bazar	Sofir mia bazar	Sokal bazar	Level of significance
Total viable count CFU/ml	8.3±1.25×10 ⁵	10.0±1.0×10 ⁵	7.6±0.76×10 ⁵	Non-significant
Coliform count CFU/ml	63.33±15.28	70.00±20.00	60.00±10.00	Non-significant

CONCLUSION

The research was aimed to determine the adulteration and evaluate the quality (physical, chemical and microbiological) of raw milk. Total 27 milk samples were collected from three markets taking 9 samples from Narikali Bazar, 9 samples from Sofir Mia Bazar, and 9 samples from Sokal Bazar. This study revealed from chemical parameters that milk samples of Narikali, Sofir Mia and Sokal Bazar had mean acidity (0.15±0.00, 0.16±0.01, 0.16±0.01); fat (37.50±0.50, 38.66±0.29, 38.83±0.29 g/kg); protein (35.86±0.85, 36.93±1.50, 37.16±1.04 g/kg); lactose (42.70±0.96, 42.23±2.93, 44.66±1.76 g/kg); ash (6.66±0.21, 7.23±0.93, 6.83±0.58 g/kg); TS (122.73±0.91, 125.26±5.33, 127.50±1.80 g/kg); SNF (85.23±2.33, 86.60±5.05, 86.66±1.76 g/kg); specific gravity 1.028±0.00, 1.027±0.00 and 1.027±0.00 respectively. The fat content of samples had significant difference while no significant differences in case of other parameters among three markets. However, in adulteration test, all of the test results were negative. No adulteration was found in the sample, though there was fluctuation in parameters (fat, protein, ash, lactose). It was visualized after inspection that all the market samples were yellowish white in color, normal in taste and flavor and free flowing fluid in case of texture. The specific gravity was more or less similar. From the overall experiment, it can be concluded that Milk collected from Sokal Bazar milk was superior in case of Fat, Protein and Lactose content than any other markets of collected milk sample. It is necessary to train farmers about the hygienic aspects of milk production and marketing for the production of better quality milk. A person should be honest who is involved in milk marketing as well as Dairy industry for ensuring safe consumption of milk to the consumers.

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