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Composition and Adulteration Analysis of Milk Samples from Ten Different Towns of Lahore

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Abstract
The present study was conducted to analyze fifty samples of milk, collected from Lahore, Pakistan for physical appearance, composition and adulterants. All samples were examined under laboratory via using electro-photometer, pH meter and Lacto-scan MCC. Experimental results showed that hundred percent milk samples were white in color and pH ranged from 6.7 to 7.9 and containing adulterants (Starch, Urea, H_2O_2, Sorbitol, BA, NaCl, Carbonate, QAC and Formalin). The results showed that out of four most commonly used adulterants (Formalin, NaCl, QAC, Carbonate), Formalin and QAC having carcinogenic and harmful impacts on human health.
Keywords: Adulterants, Composition, Milk adulteration, Milk quality

Introduction

Milk is complete diet with rich nutritional values for all age's people and its high demanded products with respect to high biological potential for nutritional purposes, without health harmful effects (Khan et al., 2008). It is very important component of growing children and balance diet as having 87.20, 3.70, 3.50, 4.90, 8.5, 12.80 and 0.70 percent, water, fat, protein, milk sugar, SNF (Solids Not Fat), dry matter and ash, respectively. (Bashir et al., 2013). Milk protein has 97 to 98 percent digestible all essential and non-essential amino acids. Animal protein is 1/3 contributing factor in milk and its manufacturing products (Cousin, 1982).

Pakistan has ranked 3rd in milk production aspect and contributing annually 43.29 million tons (Bashir et al., 2013). 96% of this total milk production comes from Buffalo (milk production has 1st positions) and cow milk production (cattle milk production has 2nd position), in Pakistan (Khan et al., 2008). Livestock sector has 11% contribution of total GDP production and main source of earning for 30 to 35 million people living in rural areas. Out of total expenditure of a family, milk and milk products has 27% expenditure (Naqvi and Shaheen, 2008).

Milk is easily contaminated by microorganisms due to its high medium affinity. Improper care and unhygienic conditions are source of milk contamination and spoilage. Due to bacterial grow in milk, it is source of numerous milk borne diseases. Even after pasteurization of milk for shelf life enhancement, deterioration begin again after some time and it becomes susceptible for many zoonotic diseases (Gwida and EL-Gohary, 2013) and other milk contamination sources are sick animals, udder infection, unhygienic milking practices, milk collection and delivery services, zoonotic infection, contaminated equipments, grass, air, feed, feces and soil (Bashir et al., 2013; Cosivi et al., 1998; Torkar and Vengušt, 2008). Contaiminated milk is causing serious health problems in human beings (Nirwal et al., 2013).

Variations in natural level of milk ingredients is define as adulteration. Adulteration emerges due to foreign matter addition in milk or extraction of valuable ingredients like fat. Adulterants sources are Cane Sugar (CS), soap, acids, starch, detergents, urea and chemicals as Quaternary Ammonium Compound (QAC), formalin, etc. and their addition for milk composition stability (Singuluri and Sukumaran, 2014). Milk storage or shelf life prolonged by addition of adulterants or preservatives, but there are cause of health hazards (Faraz et al., 2013). Suppliers of milk appear to have found three ways to increase their margin by dilution, extraction of valuable components i.e. milk fat removed as cream and combination of both previous ways with addition of cheap bulking additives, such as low quality flour, to bring total solids to a level which is acceptable to consumer (Gakkhar et al., 2015).

Our experiments results enlighten the sources of adulteration and their different analysis to show realty of available milk contamination and explore presence of serious harmful chemicals.

Material and Methods

The experimental study was carried out in the Quality Operation Laboratory, University of Veterinary and Animal Science and Microbiological Laboratory, Lahore Garrison University in Lahore, Punjab, Pakistan.

Collection of Samples

Milk samples were collected from ten specific sites (Milk shops) in sterilized clean bottles from Lahore, Pakistan. Milk samples were labeled (Table 1) and placed the each specimen in ice packing and then transported to the laboratory for further analysis.

Table 1: Milk sample identity with respect to specific site

Sample No.	Area
DS 1	University Town
DS 2	Gulberg Town
DS 3	Data Ganj-Bakhsh Town
DS 4	Iqbal Town
DS 5	Model Town
DS 6	Shahdara Town
DS 7	TownShip
DS 8	DHA Town
DS 9	Ravi Town
DS 10	Muslim Town

These samples were transferred in to the refrigerator immediately at (4°C). The samples were subjected to following quality tests. Milk samples were collected on different dates from specific site (Table 1).

Composition and adulterants analysis of milk samples

Five sets of twelve test tubes were arranged in microbiological laboratory for twelve chemicals tests for milk adulterants to be carried out on each sample. The chemical adulterants testes are Starch Detection Test, Urea Detection Test, H_2O_2 Detection Test, Detergent Detection Test, Sorbitol Detection Test, BA Detection Test, CS Detection Test, NaCl Detection Test, Carbonate Detection Test, Formalin Detection Test, QACs Detection Test and Hypochlorite Detection Test (Nirwal et al., 2013) and milk composition of included Fat, Protein, Lactose, SNF and PH were analyzed by Lacto-scan MCC (Musaad et al., 2013).

Results

Table 2: Variable Components in Cow and Buffalo Milk

Test Parameter	Cow Milk	Buffalo Milk
Fat (%)	3.9	8.0
SNF (%)	9.0	8.5
Density Kg/m3	1026-1030	1030-1032
Lactose (%)	4.8	4.9
Ash (%)	0.71	0.71
Protein (%)	3.2	4.5
Added Water (%)	0.0	0.0
pH	6.4-6.6	6.7-6.8

Milk Composition

Milk pH, protein, fat, lactose, Solid Not Fat (SNF) was determined by Lacto scan MCC (Musaad et al., 2013). Milk samples were mixed gently 4-5 times to avoid any air enclosure in the milk. Then 25 ml samples were taken in the sample tube and put in the sample holder one at a time with the analyzer in the recess position. Then when the starting button activated, the analyzer sucks the milk, makes the measurements, and returns the milk in the sample tube and the digital indicator shows the specified results (SHAKER et al., 2015).

Adulterants

Milk Adulterants including Carbonate, Sodium Chloride (NaCl), Quaternary Ammonium Compound (QAC), Sorbitol, CS, Formalin, Starch, Urea, Hypochlorite, Hydrogen per oxide (H_2O_2), Soap and Boric Acid (BA) were analyzed using Milk Adulteration Testing Kit (MAT) (Quality Operation Laboratory, University of Veterinary and Animal Science, Lahore) consisting of reagent bottles for each adulterant. 1 ml milk sample and 1 ml reagent was taken in a test tube, and color was observed for specific results according to standard operating procedure (SOP) for MAT (Nirwal et al., 2013).

Table 3: Detection test for milk Adulterants

Adulterants	Positive Results	Negative Results
Starch	Blue color	No color
Urea	Yellow color	No color
Hydrogen peroxide	Chocolate Red color	No color
Detergent	Pink color	No color
Sorbitol	Green Yellow color	Reddish Brown color
BA	Red color	Yellow color
CS	Red color	No color
NaCl	Yellow color	Chocolate Red color
Carbonate	Red color	No color
Formalin	Violet Purple ring	Yellow ring
QAC	Pink color	No color
Hypochlorite	Chocolate color	No color

The presence of milk adulterant indicates color change in milk and marked that milk sample as positive for respected milk adulterant.

Adulterants Analysis of Milk Samples

Five repeats for each sample, total 50 samples data had recorded for twelve chemicals adulterants detection tests (Table 4).

Table 4: Determination of Adulterants in Milk Samples

Adulterants Test	+Ve Samples	Percentage
Starch test	5	10%
Urea test	Nil	0
H_2O_2 test	Nil	0
Detergent test	5	10%
Sorbitol test	Nil	0
BA test	Nil	0
CS test	10	10%
NaCl test	50	100%
Carbonate test	50	100%
Formalin test	25	50%
QAC test	45	90%
Hypochlorite test	Nil	0

Table 5: Composition Analysis of Milk Samples

Sample No.	Fat	SNF	Lactose	Protein	pH
DS-1	01.67%	06.01%	02.68%	02.26%	06.48
DS-2	03.90%	06.91%	03.24%	02.62%	06.83
DS-3	03.69%	06.43%	02.85%	02.43%	06.81
DS-4	03.25%	05.05%	02.17%	01.92%	06.91
DS-5	03.33%	05.12%	02.16%	01.94%	07.03
DS-6	02.78%	06.31%	02.72%	02.35%	06.66
DS-7	01.81%	04.21%	01.59%	01.46%	06.92
DS-8	03.34%	05.02%	02.11%	01.77%	07.11
DS-9	02.38%	05.38%	02.31%	02.06%	06.85
DS-10	03.44%	05.11%	02.25%	01.92%	06.93
Average	2.95%	5.56%	2.41%	2.07%	6.85

The pH range of milk samples was 6.4 to 7.11.

Fat Content

Lipids provide fifty percent calories of total caloric value obtained from milk. Our results showed that maximum fat was observed in DS-10 (3.44%) followed by DS-4 (3.25%), DS-1 (1.67%), DS-2 (3.90%), and DS-8 (3.34%), while minimum was observed in DS 7 (1.81%), followed by DS-5 (3.33%),, DS-9 (2.38%), DS-6 (2.78%), DS-3 (3.69%), respectively (Table 5).

Protein

The protein in milk, casein, is of high quality. It contains all the amino acids needed for body building and tissue repair. Results showed that maximum protein was observed in DS-10 (1.92%) followed by DS-4 (1.92%), DS-2 (2.62%), DS 3 (2.43%), DS-8 (1.77%) while minimum was observed in DS-1 (2.26%) followed by DS-6 (2.35%), DS-7 (1.46%), DS-9 (2.06%), DS-5 (1.94%) respectively (Table 5).

SNF

This studied showed that maximum SNF content was observed in DS-10 (5.11%), followed by DS-1 (6.01%),

DS-4 (5.05%), DS-2 (6.91%), DS-3 (6.43%), while minimum was observed in DS-6 (6.31%), followed by DS-7 (4.21%), DS-9 (5.38%), DS-5 (5.12%), DS-8 (5.02%) respectively (Table 5).

Lactose

Experimental results showed that maximum Lactose was observed in DS-10 (2.25%) followed by DS-4 (2.17%), DS-2 (3.24%), DS-3 (2.85%) DS-8 (2.11%) respectively while minimum was observed in DS-1 (2.68%) followed by DS-6 (2.72%), DS-7 (1.59%), DS-9 (2.31%), DS-5 (2.16%) respectively (Table 5).

Adulteration

Out of 50 milk samples analyzed for adulteration, 100% addition of Carbonate, NaCl and QAC was observed. Other adulterants include Sorbitol (10%), CS (7%), Formalin (12%), and Starch (6%). Negative results were shown by Urea, Hypochlorite and H_2O_2, Soap and BA (Table 5).

Table 6: Qualitative Analysis of Milk Samples

S/No.	Date	Starch	Urea	H_2O_2	Detergent	Sorbitol	BA	CS	NaCl	Carbonate	formalin	QAC	Hypochlorite	pH
							DS-1							
01	02-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	+ve	-ve	6.2
02	09-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	+ve	-ve	6.4
03	16-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	+ve	-ve	6.4
04	23-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	+ve	-ve	6.6
05	30-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	+ve	-ve	6.6
							DS-2							
01	02-06-2014	-ve	-ve	-ve	+ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	-ve	6.6
02	09-06-2014	-ve	-ve	-ve	+ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	-ve	6.7
03	16-06-2014	-ve	-ve	-ve	+ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	-ve	6.7
04	23-06-2014	-ve	-ve	-ve	+ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	-ve	6.9
05	30-06-2014	-ve	-ve	-ve	+ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	-ve	6.9
							DS-3							
01	02-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	6.9
02	09-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.2
03	16-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.1
04	23-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.2
05	30-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.3
							DS-4							
01	02-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	+ve	-ve	6.8
02	09-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	+ve	-ve	7.1
03	16-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	+ve	-ve	7.2
04	23-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	+ve	-ve	6.9
05	30-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	-ve	+ve	-ve	7.0
							DS-5							
01	02-06-2014	+ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	7.1
02	09-06-2014	+ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	7.0
03	16-06-2014	+ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	7.2
04	23-06-2014	+ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	7.2
05	30-06-2014	+ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	7.3
							DS-6							
01	02-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	6.5
02	09-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	6.6
03	16-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	6.6
04	23-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	6.7
05	30-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	6.5
							DS-7							
01	02-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.1
02	09-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.2
03	16-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.3
04	23-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.3
05	30-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.4
							DS-8							
01	02-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.0
02	09-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.1
03	16-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.1

04	23-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.2
05	30-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	-ve	+ve	-ve	7.3
							DS-9							
01	02-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	6.4
02	09-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	6.6
03	16-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	6.7
04	23-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	6.6
05	30-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	6.7
							DS-10							
01	02-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	6.9
02	09-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	6.8
03	16-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	7.0
04	23-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	7.1
05	30-06-2014	-ve	-ve	-ve	-ve	-ve	-ve	-ve	+ve	+ve	+ve	+ve	-ve	7.2

DS Meaning sample identity and location (Table 1).

Positive results indicate the presence of certain adulterants in the milk samples, while negative results indicate that milk quality is good, and can be recommended for daily consumption.

Discussion

Calculated Adulterants percentage in milk samples

Market milk samples randomly collected from different milk sale points of Lahore city, were examined for different adulterants. The NaCl and Carbonate were the most common adulterants (100%) found to be in all of milk samples, followed by QAC (90%), Formalin (50%), cane sugar (20%), starch and Detergent (10%). While urea, boric acid, sorbitol, hydrogen peroxide and Hypochlorite were not found in any sample from a total of 50 samples (Table 4)

Determined Milk samples composition

Lipids provide fifty percent calories of total caloric value obtained from milk. Our results were confirmed by the findings of Webb et al. (1974), which showed that maximum fat was observed in DS-10 (3.44%) followed by DS-4 (3.25%), DS-1 (1.67%), DS-2 (3.90%) and DS-8 (3.34%). On the other hand, minimum fat was observed in DS 7 (1.81%), followed by DS-5 (3.33%), DS-9 (2.38%), DS-6 (2.78%) and DS-3 (3.69%), respectively. This difference in percent fat content may be due to the difference in feeding, management practices, season and breed of the animals. The standard of fat content in cow milk sample is about 3.9% (de Carvalho et al., 2000). The protein in milk, casein, is of high quality. It contains all the amino acids needed for body building and tissue repair. Results showed that maximum protein was observed in DS-10 (1.92%) followed by DS-4 (1.92%), DS-2 (2.62%), DS 3 (2.43%), DS-8 (1.77%) while minimum was observed in DS-1 (2.26%) followed by DS-6 (2.35%), DS-7 (1.46%), DS-9 (2.06%), DS-5 (1.94%) respectively. The protein content in milk differs from breeds to breeds and animals to animals. The standard of protein content in cow milk sample is about 3.2% (Joslyn and Heid, 1963). This studied showed that maximum SNF content was observed in DS-10 (5.11%), followed by DS-1 (6.01%), DS-4 (5.05%), DS-2 (6.91%), DS-3 (6.43%), while minimum was observed in DS-6 (6.31%), followed by DS-7 (4.21%), DS-9 (5.38%), DS-5 (5.12%), DS-8 (5.02%) respectively. The standard of SNF content in cow milk sample is about 9%. Experimental results showed that maximum Lactose was observed in DS-10 (2.25%) followed by DS-4 (2.17%), DS-2 (3.24%), DS-3 (2.85%) DS-8 (2.11%) respectively while minimum was observed in DS-1 (2.68%) followed by DS-6 (2.72%), DS-7 (1.59%), DS-9 (2.31%), DS-5 (2.16%) respectively (Table 5) (Webb et al., 1974).

Qualitative analysis of milk revealed that twelve (carbonate, CS, NaCl, Formalin, QAC, starch, urea, H_2O_2, QAC, sorbitol, BA and hypochlorite) chemicals were main adulterants, it was found urea, H_2O_2, detergent, sorbitol, BA, carbonate, hypochlorite adulterants (Table 6) were not found in all collected samples from specific site (Table 1). Starch and Detergent were found in milk samples from DS-5 and DS-2, respectively. CS was found in DS-1 and DS-4, NaCl and Carbonate were the most common adulterants (100%) found to be in the all of milk samples, Formalin was found in DS-1, DS-2, DS-5, DS-9, DS-10 and QAC were found in all milk samples except DS-2 (Table 6). Both Formalin and QAC are carcinogenic and dangerous for human health. Data obtained in the present study conclude that milk quality is not completely as per standards and adulteration in milk is still in practice and has not been checked completely (Nirwal et al., 2013).

Conclusion

The experimental study was carried out in the Quality Operation Laboratory, University of Veterinary and Animal Science and Microbiological Laboratory, Lahore Garrison University in Lahore, Punjab, Pakistan. Results enable us to conduct the information about the quality of milk available to general public in the specific area of Lahore Pakistan. Further this study told us that these (Starch, Cane sugar, Detergent, NaCl, Carbonate, QAC, Formalin) adulterants are widely and commonly in use throughout the milk shops in this area. The results

of this research shows that these four (Formalin, NaCl, QAC, Carbonate) adulterants are most commonly in use. Out of these four adulterants, two (Formalin and QAC) are very carcinogenic and hazardous for human health. Unfortunately no milk sample was free from adulterants in all selected sites while the NaCl and Carbonate were the most common adulterants (100%) found to be in the all of milk samples. At the government level serious measures must be taken to avoid distribution and availability of such poisonous milk for good health insurance.

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