MILK ADULTERANTS IN QUETTA: A THREAT TO PUBLIC HEALTH

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Abstract
Milk a natural rich lacteal secretion that provides all essential nutrients required by body. This study was designed to detect milk adulterants along with various physiochemical factors in milk sold in Quetta market. A total of (n-120) raw milk samples were collected hygienically and subjected to milk adulteration Kit (UVAS Lahore). Results revealed that overall, 11.66 % samples revealed adulteration with any single chemical adulterant. Water and powdered milk were the major adulterants found almost in all samples. On towns basis Zarghoon town samples were more adulterated (18%) than Chiltan town samples (5%). Other parameters such as, Electrical Conductivity, pH, Fat percentage, Total Solids and Solid Not Fat were observed below than normal values in most of the samples. Adulterants like Urea, Hydrogen Peroxide, Sorbitol, Boric acid, Quaternary Ammonium Compound, Carbonate, Soap and Alcohol were not detected in any sample. However, Sodium chloride (1.66 %), Formalin (3.33 %), Hypochlorite (2.5 %), Starch (2.5 %) and sugar (4.16 %) were detected. This study explores the potential public health hazard due to adulterated milk sold in retail outlets in Quetta market. There is dire need of regular monitoring of milk and its products by concerned food authority to ensure quality natural and pure milk to the city.

Keywords: Adulterants, Boric acid, Quetta, Raw milk, Urea

INTRODUCTION

It is the lacteal secretion of the mammary glands from different animals like camel, goat, sheep, buffalo, and cow. It is used for variety of purposes like feeding young children, animals, and preparation of different nutritional products such as Yogurt, Sour milk, cream, and butter (1). Milk is one of the important nutritional diets in daily life consumed by human beings in all ages especially by children for their nourishment. Milk is the secretion of mammary gland and is the rich source of proteins, carbohydrates, vitamins, and minerals (2).

Milk adulteration is a fraudulent practice involving dilution or addition of some low-quality, inexpensive, and sometimes health hazard substances. Producers adopt such practices owing to high profit and meeting the increasing gap between production and demand. It is intentionally an act of degrading the quality of food offered for sale by maturing of inferior products or removal of valuable ingredients (3). Milk man adds different adulterants to milk in our societies for different purposes such as, Formalin, can sugar, rice flour and other different chemicals.

The adulterated milk may cause various harmful diseases to the Public through added water to increase the volume of milk. Addition of contaminated water may reduce its nutritive value and pose serious health risks to children and infants. Similarly, starch can cause diarrhea when it is undigested in
colon and may become fatal to diabetic patients. In the same vein, gastro-intestinal complications are caused by detergents (4).

Though Pakistan is the 5th largest producer of fresh milk, but the country faces the problem of supply of low-quality adulterated milk. Water is the most common adulterant added to milk to increase the volume of milk for profitable commodity. In hot summer days due to increased demand and decreased in supply chain, water is added (5). Pond water, rich source of nitrates is usually added to maintain the viscosity and increased volume of the milk, whilst its consumption may cause waterborne GI tract problems (6).

Pakistan is an agriculture-based country with 11.4 % share in the national GDP, employing more than 43 % labor force of the country. It contributed 58.3 % to the agriculture value added during 2021-2022 fiscal year.

Livestock is the sub sector of agriculture and different domestic animals like, cattle, buffaloes, sheep, goats, and camels are reared for milk purpose. These animals produce 56 million tons of milk (7). In Pakistan, although most of the pasteurized milk is sole out in packed form, however, large quantity of the milk is still supplied to major cities in its raw form with dubious quality.

Quetta, being the capital city of the province where more than 2 million people are living. The demand for milk for both adults and children is met from the milk supplied from dairy farms. Although very fewer dairy farms are established in and around the city. The demand for milk increases many folds in summer season. This study was designed to evaluate and screen the raw milk for any chemical adulterants in the area.

MATERIALS AND METHODS

A total of (n=120) milk samples (250 ml each) were collected equally from sale outlets from both Zarghoon and Chiltan towns of Quetta. The Milk samples were collected in sterile container and transported in cold chain to the Nutrition and toxicology laboratory of CASVAB for further analysis.

MILK ADULTERANTS ANALYSIS

Milk samples were analyzed using the methodology of Abbas et al., (2013) (8). Different common chemical adulterants such as, hypochlorite, soap, sorbitol, cane sugar, sodium chloride, carbonates, urea, formaldehyde, boric acid, starch, hydrogen peroxide (H₂O₂) and Quaternary Ammonium Compounds (QAC) were analyzed using commercial Milk Adulterants Kit (UVAS, Lahore).

EVALUATION OF MILK FOR PHYSIOCHEMICAL PARAMETERS

Physiochemical parameters including Specific Gravity, Electrical Conductivity, Fat Percentage, Total Solids, Solid Not Fat and Organoleptic tests were performed to evaluate the milk quality.

Specific Gravity was determined by Lactometer as milk sample was poured in a 500 ml glass cylinder and Lactometer was placed slowly into milk and allowed it to float freely on milk surface Reading was noted at the top of the liquid meniscus. Similarly, Electrical Conductivity was determined using EC Meter (Jenway, UK) in a way that milk samples were kept in small beaker and the probe was dipped into it till stable reading and lastly, the reading was noted and recorded in μS/m.

FAT PERCENTAGE DETERMINATION

Gerber method was used for the determination of fat percentage. Briefly; 10 ml Sulphuric acid (H₂SO₄) was poured in a butyrometer with the help of a pipette under fume hood. Then 11 ml milk sample and 1ml of Iso amyl alcohol was added. The meter was locked tightly, and the contents were shaken well until white droplets disappeared and placed it into water bath for 5 mints at 650 °C. Later, the butyrometer was placed in a gerber centrifuge in diametrically opposite direction and centrifuged for 5 mints at 1100 rpm with cork side down. Finally, butyrometer was put into water bath again for 5 mints in such a way that stoppers remained downward, and the fat percentage was noted on the scale as described by James et al., 1995 (9).
TOTAL SOLIDS (TS)

The solids were estimated from the lactometer reading by using the following formula.

\[ \text{TS} \% = 0.25 \times \text{L} + 1.22 \times \text{fat} \% + 0.72 \]

Where, TS means total solids, while L stands for lactometer reading observed.

SOLID NOT FAT (SNF)

Once the Total Solids determined. The SNF was calculated using following formula.

\[ \text{SNF} = \text{TS} - \text{Fat} \% \]

ORGANOLEPTIC TESTS (SMELL, TASTE AND COLOR)

Different parameters such as color (naked eye), Flavor (Sniffing), Taste (Tongue) and Texture (naked eye) for the presence of any particulate matter.

ADULTERANTS DETECTION TESTS WITHOUT HEAT REQUIREMENT

Various tests like Urea, Hydrogen peroxide, Sorbitol detection test, Quaternary Ammonium Compounds (QAC), Boric Acid test, Sodium Chloride (NaCl) test, Carbonate, Formalin, and Hypochlorite Test were performed as per kit protocol. Similarly, starch, detergent and cane sugar test that required heat were also performed.

STATISTICAL ANALYSIS

Data collected were subjected to statistical analysis using SPSS version 20 and analyzed accordingly.

RESULTS

Overall, 11.66 % samples were adulterated with single chemical adulterant. Different adulterants such as urea, Hydrogen Peroxide, Sorbitol, Boric acid, Quaternary Ammonium Compound, Carbonate, Soap, and Alcohol were not detected in any sample. However, Sodium chloride (1.66 %), Formalin (3.33 %), Hypochlorite (03%), Starch (03%) and Sugar (05%) were detected (Table I and Fig. 2).

Table I. Prevalence of milk adulterants from raw milk samples collected from retail outlets in Quetta, Pakistan. (n= 120: 60 milk samples each from Zarghoon and Chiltan Town)

<table>
<thead>
<tr>
<th>Adulterants</th>
<th>Zarghoon Town</th>
<th>Chiltan Town</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium Chloride</td>
<td>2</td>
<td>0</td>
<td>2 (1.66 %)</td>
</tr>
<tr>
<td>Formalin</td>
<td>4</td>
<td>0</td>
<td>4 (3.33 %)</td>
</tr>
<tr>
<td>Starch</td>
<td>2</td>
<td>1</td>
<td>3 (2.5 %)</td>
</tr>
<tr>
<td>Sugar</td>
<td>3</td>
<td>2</td>
<td>5 (4.16 %)</td>
</tr>
<tr>
<td>Hypochlorite</td>
<td>2</td>
<td>1</td>
<td>3 (2.5 %)</td>
</tr>
<tr>
<td>Total</td>
<td>13 (21.66 %)</td>
<td>4 (6.66 %)</td>
<td>17 (14.16 %)</td>
</tr>
</tbody>
</table>

Fig. 1. Results showing different chemical adulterants present in raw milk samples collected from retail outlets in two different towns of Quetta, Pakistan
Table II. Results of different chemical adulterants present in raw milk samples collected from retail outlets in Quetta, Pakistan

<table>
<thead>
<tr>
<th>Adulterant</th>
<th>Percent Positivity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urea</td>
<td>0%</td>
</tr>
<tr>
<td>H₂O₂</td>
<td>3%</td>
</tr>
<tr>
<td>Sorbitol</td>
<td>12%</td>
</tr>
<tr>
<td>Quaternary Ammonium Compound (QAC)</td>
<td>0%</td>
</tr>
<tr>
<td>Boric Acid</td>
<td>0%</td>
</tr>
<tr>
<td>NaCl</td>
<td>0%</td>
</tr>
<tr>
<td>Carbonate</td>
<td>0%</td>
</tr>
<tr>
<td>Formalin</td>
<td>4%</td>
</tr>
<tr>
<td>Hypochlorite (Hypochlorite)</td>
<td>0%</td>
</tr>
<tr>
<td>Starch</td>
<td>3%</td>
</tr>
<tr>
<td>Soap</td>
<td>0%</td>
</tr>
<tr>
<td>Sugar</td>
<td>0%</td>
</tr>
<tr>
<td>Alcohol</td>
<td>2%</td>
</tr>
</tbody>
</table>

*H₂O₂= Hydrogen Peroxide; QAC= Quaternary Ammonium Compound; NaCl= Sodium Chloride; Hypo= Hypochlorite

Fig. 2. Results showing different chemical adulterants present in raw milk samples collected from retail outlets in Quetta, Pakistan

Fig. 3. Lactometer readings of all milk samples collected from retail outlets in Quetta, Pakistan

DISCUSSION

In the present study 120 raw milk samples were collected from retail milk shops from both Zargooh and Chiltan town Quetta, Balochistan. All the samples were subjected to organoleptic, physical, and chemical tests for the screening of common milk adulterants.

Milk is essential for good health of human being and considered a complete diet. It is used in different forms like, milk, curd, and cheese etc. It is a complete balance diet full of most of the essential nutrients.

Almost all the samples were within normal limits in term of organoleptic tests (taste, smell, flavor, and texture) with pleasant aromatic smell, slightly sweetish taste and whitish in color in this study. This may be suggestive of least level of adulteration of the samples in the area.

Specific gravity determination is one of the main techniques for the estimation of water adulteration (normal value: 1.032-1.036). In this study water was the main milk adulterant found in raw milk samples collected from retail outlets of Quetta, Pakistan. Although other adulterants both (physical and chemical)
were also detected but in very less percentage (Fig. 3). In this study 88% samples were adulterated with water with the average specific gravity was 1.023. These findings corroborate with a study from Quetta where raw milk was collected with average Sp. gravity of 1.025 (10). Similarly, a study from Tandojam District Bangla Desh also support our findings in which 1.021 mean SP gravity was observed (11). While, in Tandojam Pakistan the average Sp. gravity (1.021) was observed from raw milk collected from different sources. In another study from Hyderabad, Sindh 91% of milk samples were found adulterated with water (12). Our findings suggest that the quality of milk at Peshawar might be better than Quetta in terms of specific gravity as study from Peshawar showed 32% milk sample slower than normal Sp. gravity. This might be due to strict vigilance of provincial food Authority. Water is lighter than milk and addition of water decreases the Sp. gravity of milk. It is a simple and efficient technique that easily and quickly determines the water value added to raw milk samples using Lactometer.

The Electrical Conductivity (EC) might be a good technique to screen the milk contaminated with clinical and sub clinical mastitis was also measured to estimate the milk from animals suffering from clinical or sub clinical mastitis. Although from retail outlets as the milk is mixed from different animals. So, the milk is mixed, and it is difficult to predict mastitis milk. However, it may help to overlook the herd status of mastitis.

In this study the average EC 4.62 ± 0.49 (Normal: 4-5.80 m/) was recorded. This study reflects that overall no mastitic milk was present during sampling period. The variation in conductivity values may also be possibly due to difference in electrolyte level in milk coming from different species of animals at retail outlets.

pH is the hydrogen ion concentration present in milk samples that determines its acidity or alkalinity. Lactobacilli are the common habitant of milk and if milk is contaminated with lactobacilli, it degrades the milk lactose into lactic acid with the passage of time and ultimately, the pH lowers down. Although in this study the Overall pH 6.50 ±0.06 found was in the normal range (6.5-6.7). However, 39 samples were observed below normal pH (6.5). This might be due to stored milk for some time that decreases the pH value rendering milk more perishable, or the milk may possibly be collected from infected mastitic animal.

Fat is one of the important components of milk that determines the price of milk in Pakistani market (2). Normally packed milk is sold with standard 3.5% fat, but the raw milk may contain more fat % up to 7% depending upon the species, breed and feed offered etc. (13).

In this study the average fat contents observed were 3.43 %. These findings are in line with a previous study from Quetta, in which 2% average milk fat % was recorded (10). But contradict from study carried out at Tandojam in which 3.1-6.5% fat have been reported. This higher fat percent from Sindh may be since Sindh is an agriculture land with more buffalo population.

Total solid determination is the sole and best criteria for the evaluation of adulterants in raw milk samples. Normally milk contains 84 -86% water and remaining 12-13% are the total solids (14). In this study TS 11 ± 0.098 were observed. The adulterated milk may contain lower TS and SNF (15). These findings were in line with a previous study from Quetta, Pakistan indicating 7-9%. However, our study deviates from the other studies in which a relatively higher TS % have been observed (2,16-18). Starch @ 2% is generally added to milk to increase the sp gravity of milk leading to higher milk TS (19, 20). Starch in higher concentration may cause diarrhea in users due to its accumulation in colon and it may also be serious concern in diabetic patients (21). Similarly, in this study average Solid not Fat (SNF) is 7.4. Our study is in close agreement with previous study from Quetta with 6.8 6% SNF. Obviously, it is much lower than normal revealing more adulterated milk with water or skimmed milk (10). These results do not meet the minimum standard of Pakistan (9%) under pure food rule 1965 (22). However, Prasad, 1997 and Inayat, 2002 have reported a much higher SNF % in their milk samples from different areas (16, 18).

Chemical adulterants such as Urea, Hydrogen Peroxide, Sorbitol, Soap, detergents, Quaternary Ammonium Compounds, Boric acid, Carbonate and Alcohol etc. are other common adulterants generally added during malpractice Particularly in low-income areas for varying purpose like preservation, taste
development, increasing viscosity and higher protein content (23). But in our study, luckily no sample was found positive for these adulterants.

Formalin is another injurious chemical that may be added in milk for preservative purposes to increase the shelf life (24). In this study only formalin (3.33%) samples were found positive for formalin. It is added in milk in different concentrations. For example, in a study by Lateef et al., (2009) show 46.66% samples contaminated with it (25). While Wadekar et al., (2011) reported 12%, 10% and 2% samples contaminated with formalin in summer, rainy and winter season (26). In another study only 2% milk samples were adulterated with formalin (27). Formalin decreases the pH value and is potent carcinogenic that may cause serious lethal effects on the consumers (28).

In this study, other milk adulterants such as, cane sugar (4.16%), sodium chloride (1.66%), hypochlorite (2.5%) and starch (2.5%) were detected. These results corroborate with the findings from Peshawar, Pakistan where almost 3-5% different adulterants such as, urea, formalin and synthetic oil were recorded (29). Similarly, in a study from Hyderabad, Pakistan cane sugar (31%), starch (27%), formalin (20%), skimmed milk powder (19%), hydrogen peroxide (15%), vegetable oil and boric acid (12%), caustic soda (11%), glucose (10%) and hypochlorite (5%) were found in milk samples from Hyderabad, Pakistan. While in another study from India 3% Sodium chloride addition was done (30).

It is of the interest that milk men add cane Sugar to counter the dilution of milk with sugar to extend the solid contents of milk or may possibly be added by masking the effects of water dilution with better taste (19, 31). The cane sugar may also help to increase the sp gravity of milk (32).

CONCLUSION

In conclusion, this study provides base line data about composition, nutritional status and adulterations present in raw milk samples collected at retail outlets in Quetta, Pakistan. Although water was the main adulterant in subjected milk samples but the presence although in less numbers of other adulterants such as, sugar, salt, detergent, and formalin warn the food authorities to construct strict policy for regular monitoring of the milk samples in the area. So that threat to the public health could be minimized.

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