**DOI:** https://doi.org/10.54393/pjhs.v4i11.1176

PAKISTAN JOURNAL OF HEALTH SCIENCES

https://thejas.com.pk/index.php/pjhs

Volume 4, Issue 11 (November 2023)

**Original Article**

# Adulteration: Supply of Raw Milk and Prevalence of Adulterated / Prepared Milk

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## ARTICLE INFO

***Key Words:***
Raw Milk, Milk Quality, Adulterants, Semi Synthetic Milk

***How to Cite:***
Ibrahim, T., Wattoo, F. H., Sarwar Wattoo, . M. H., & Mustafa, G. (2023). Adulteration: Supply of Raw Milk and Prevalence of Adulterated / Prepared Milk : Adulteration of Milk. Pakistan Journal of Health Sciences, 4(11). https://doi.org/10.54393/pjhs.v4i11.1176

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Received Date: 6th November, 2023
Acceptance Date: 26th November, 2023
Published Date: 30th November, 2023

## ABSTRACT

Raw milk adulteration is one of the food fraud to gain financial benefits by removing fat and cream from whole milk and compensating it by addition of different adulterants to make it near to wholesome milk. **Objectives:** To analyze milk adulterants to not only describe about the prevalence of different milk adulterants but also confirm the sources of adulterants being used for the synthesis of semi synthetic or prepared milk due to their characteristics which they impart to form a sort of wholesome milk. **Methods:** In this regard total of 190 raw milk samples from cow and buffalo sources along with control and in house standards were taken to detect most prevailing adulterants in raw milk samples through automated and/or titration based manual recommended methods. **Results:** The analysis of different adulterants in milk samples showed water in 148(77.89%) raw milk samples, Detergent in 62(32.9%), Cane Sugar 41(21.8%), Caustic Soda 32(16.8%), Sodium Salts 31(16.4%), Starch 21(11.1%), Formalin 18(9.4%), Urea 15(8.05%), Foreign Fat 12(6.4%), Hydrogen Peroxide 04(2.3%), Glucose 02(1.3%), Boric Acid 02(1.1%) and sulfate salts 02(1.1%) in raw milk samples. **Conclusions:** The assessment of quality of fresh milk showed poor quality milk with the provision of different sort of adulterants in 77.89% raw milk samples and alarming sign of semi synthetic milk in 2.63% samples.

## INTRODUCTION

Raw milk / Fresh milk is the ideal as well as complete food for infants and children due to presence of all basic nutrients like protein, carbohydrates, fats, vitamins and minerals [1]. It is the normal, clean and pure secretion obtained from the udders of a healthy cow, buffalo, goat or sheep [2]. Milk composition is influenced through various factors like genetic/nutritional status of animals, environmental conditions and stage of lactation. An average milk composition comprises of water 87.00 %, lactose 4.00 % - 5.00 %, protein 3.00 %, lipids 3.00 % - 4.00 %, minerals 0.80 % and vitamins 0.10 % [3]. In Pakistan, there are more than 67.00 million cattle and buffaloes, 89.00 million sheep and goats and 0.20 million camels. Pakistan is blessed with high yielding genetic dairy animals such as Nilli / Ravi buffaloes, Sahiwal Cows, Kajli Sheep and Beetle Goat. Milk is produced throughout the year. However, milk production is extensively reduced during summer months due to heat stress and scarcity of fodder so milk is watered to increase volume. To maintain its composition, starch, flour, urea, cane sugar, vegetable oil etc. are added as chemical adulterants [4]. Adulterants are articles that are not of natural origin, substance, or quality but are claimed to be the part of foreign substance that may degrade the product's quality or which have been combined, coated, or treated with substances that are illegal or whose quality or purity does not meet the required criteria or anything that has a poisonous or otherwise harmful element to human's health [2]. The different sort of adulterants that manipulate the quality of milk are water, sodium carbonate, sodium bicarbonate, caustic soda, formalin, urea, detergents, ammonium sulphate, boric acid, benzoic acid, salicylic acid, hydrogen peroxide,

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starch, sugars, melamine, skimmed milk powder, reconstituted milk, rice flour, vegetable oil, animal fat and whey powder [5, 6]. Milk is adulterated for financial benefit or to overcome the gaps associated, conditions of sanitary processing, storage, transportation and marketing conditions [6]. Almost 93.00% samples from educational canteen show some of the adulterants like water, urea, formalin, hydrogen peroxide [7]. Water was found to be the most common adulterant in most of the milk samples in Pakistan, followed by detergent 25.00 %, rice flour 22.00 %, caustic soda 18.00 %, salt 17.00 % and cane sugar 14.00 % respectively [8]. Recent studies in Pakistan shows about 80.00 % of sold milk is adulterated [9]. Synthetic / Semi synthetic milk is a sort of adulterated milk contains vegetable oil as a source of milk fat, urea as a nitrogen component, and detergent to make it frothy with a desired specific gravity, which is then mixed with natural milk to create value added milk [10].

## METHODS

A prospective study was conducted through collection of samples, sample processing, conducting stability study and analyzing different adulterants. In this context a total 190 numbers of raw milk samples were analyzed to know the presence of different adulterants. 126 out of 190 were collected along with control sample from various sources of milk suppliers like milk collector, milk man as milk distributor or milk retailer, middle man as dhodhie (common name) and end users. 64 samples were received from same sources at the reception of Nutrition Division, NIH. Control sample was self-collected fresh milk sample from healthy buffalo origin having lactation period from 2 – 4 months. Milk samples were collected through recommended method [11] through authorized agent free from infectious disease in the presence of concerned parties in a dry clean container, preserved in cold chain container (2 – 8°C) with proper labeling. A stability study was conducted to know the shelf life of collected fresh milk samples at 02-08°C for 0 to 5 days based upon the quantity and duration of utilization of fresh milk at domestic level. The fall in the concentration of certain important parameters after four days were very negligible like fat decreased from 5.0 % to 4.98 (0.40%), SNF decreased from 8.03% to 7.97% (0.65%) & total solid decreased from 13.03% to 12.95% (0.61%). It means that fresh milk samples remained stable for 04 days at 02-08°C [12]. 250 – 500 ml sample in the form of homogenous milk sample at 20°C through recommended method [13] before analysis. Urea was analyzed by reacting milk samples with p-Dimethyl Amino Benzaldehyde reagent. Appearance of distinct yellow color indicates presence of added urea. Starch was analyzed by adding a few drops of tincture of Iodine or Iodine solution. Formation of blue color indicates the presence of starch. Detergent was analyzed by reacting milk sample with bromocresol purple to get violet blue color in case of presence of detergent as adulterant. Formalin was analyzed by reacting with concentrated sulfuric acid from the sides of the wall without shaking. Appearance of violet or blue ring at the intersection of two layers indicated presence of formalin. Boric acid was analyzed by reacting milk samples with concentrated hydrochloric acid. This mixture converted a yellow strip (filter paper dipped in aqueous turmeric solution) into red strip and even green due to action of one drop of ammonia solution. Neutralizers include Sodium carbonate, Sodium bicarbonate was analyzed by reacting milk samples with rectified spirit and Rosalic acid. The appearance of red color indicated the presence of such compounds while sodium hydroxide was analyzed by alkalinity test. Sodium sulfate was analyzed by reacting milk sample with TCA and barium chloride solution as indicator and formulation of milky white precipitation. Potassium nitrate was analyzed by reacting milk sample with and diphenyl amine sulphate or diphenylbenzidine reagent for the formulation of blue color. Appearance of blue colour indicates the presence of nitrates. Pure milk sample will not develop any color. Hydrogen peroxide was analyzed by reacting milk samples with Vanadium Pentoxide reagent. The appearance of red color indicated Pink or red colour. Glucose gives deep blue color when reacted with modified Barfoed's reagent and heated until boiling, cool and added phosphomolybdic acid. Sucrose/ Sugar reacted with hydrochloric acid and resorcinol. The red coloration indicated the use of sugar in the milk. Sodium chloride was analyzed by reacting milk samples with Silver Nitrate reagent and Potassium Dichromate as indicator. The appearance of yellow color indicated presence of sodium chloride [14, 15]. Edible oil gives the butyro refractive index in the range of vegetable oil (> 43.5) instead of animal origin fat (40 – 43.5) [16, 17]. Milk powder was analyzed by reacting acetic acid treated milk samples with phosphomolybdic acid to get bluish precipitates for presence of milk powder as adulterant [18].

## RESULTS

The analysis of 190 fresh milk samples with respect to different adulterants along with supporting physical & chemical quality parameters showed prevalence of water in 148(77.89%), Detergent in 62(32.9%), Cane Sugar 41(21.8%), Caustic Soda 32(16.8%), Sodium Salts 31(16.4%), Starch 21(11.1%), Formalin 18(9.4%), Urea 15(8.05%), Foreign Fat 12(6.4%), Hydrogen Peroxide 04(2.3%), Glucose 02(1.3%), Boric Acid 02(1.1%) and sulfate salts 02(1.1%) as depicted in Figure 1 given below.

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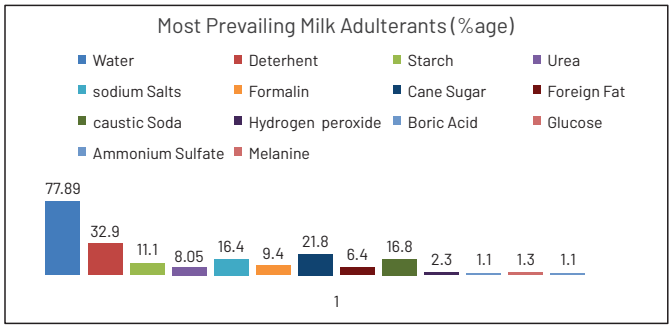


**Figure 1:** Prevalence of Milk Adulterants

Figure 2 showed an alarming sign of preparation of synthetic/semi synthetic milk, conversion of 01 liter of milk into 50 liters of milk through addition of water and compensatory adulterants to give them original like composition of fresh raw milk. The findings of synthetic milk in above depicted picture showed addition of water in 01 liter of milk followed by substandard milk powder, Detergent, Cane Sugar, Edible Oil, Formalin, Sodium bicarbonate. The identification of such practices have been made through analysis of butyro refractive index value (BR Value at 40°C) which is more than 43.5 in case of addition of foreign fat from plant sources. The prevalence of synthetic milk was 2.63%.

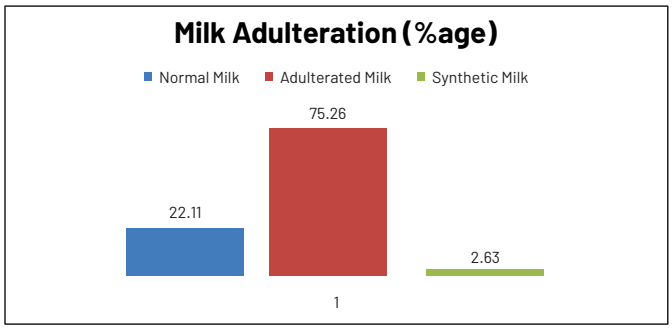


**Figure 2:** Prevalence of synthetic/semi synthetic Milk

As per Table 1, the analysis of 190 (100 %) fresh milk samples with respect to different adulterants along with supporting physical & chemical quality parameters showed the mean values as per prevalence of water with 0.779 (77.89 %), Detergent with 0.326 (32.90 %), Cane Sugar 0.216 (21.80 %), Caustic Soda 0.168 (16.80 %), Sodium Salts 0.163 (16.40 %), Starch 0.111 (11.10 %), Formalin 0.095 (9.40 %), Urea 0.079 (8.05 %), Foreign Fat 0.063 (6.40 %), Hydrogen Peroxide 0.021 (2.30 %), Glucose 0.011 (1.30 %), Boric Acid 0.011 (1.10 %) and sulfate salts 0.011 (1.10 %).

**Table 1:** Prevalence of adulterants-one-sample statistics

| Parameters (Adulterants) | N (No of Samples) | Mean ± SD (Prevalence of adulterants) | Std. Error Mean |
|---|---|---|---|
| Water in Milk | 190 | 0.779±0.416 | 0.0302 |
| Detergent in Milk | 190 | 0.326±0.470 | 0.0341 |
| Starch in Milk | 190 | 0.111±0.314 | 0.0228 |
| Urea in Milk | 190 | 0.079±0.270 | 0.0196 |
| Cane Sugar in Milk | 190 | 0.216±0.412 | 0.0299 |
| Caustic Soda in Milk | 190 | 0.168±0.375 | 0.0272 |
| Sodium Salts in Milk | 190 | 0.163±0.370 | 0.0269 |
| Formalin in Milk | 190 | 0.095±0.293 | 0.0213 |
| Foreign Fat in Milk | 190 | 0.063±0.243 | 0.0177 |
| Hydrogen peroxide in Milk | 190 | 0.021±0.143 | 0.0104 |
| Glucose in Milk | 190 | 0.011±0.102 | 0.0074 |
| Boric Acid in Milk | 190 | 0.011±0.102 | 0.0074 |
| Sulfates in Milk | 190 | 0.011±0.102 | 0.0074 |

## DISCUSSION

Multiple studies have been conducted to know the prevalence of different adulterants in milk. To identify the changes in the milk quality which extremely suffer during summer months as described by [4] due to heat stress, scarcity of fodder. To compensate the scarcity of milk, it is unfortunately very easily adulterated and possible reasons behind it may include demand and supply gap, perishable nature of milk, low purchasing capability of customer and lack of suitable detection tests as stated by [1]. This is carried out either for financial gain by [6] or to increase their margin from the sale of milk through its dilution, extraction of valuable components like cream, fat and addition of cheap additives to balance the quality parameters of milk. In recent studies in Pakistan about 80 % of milk sold is adulterated [9]. Almost 93 % samples from educational canteen shows some of the adulterants like water, urea, formalin, hydrogen peroxide [7]. Adulterants in milk mainly include addition of vegetable protein, milk from different species, addition of whey and watering which are known as economically motivated adulteration [19]. Milk adulterants which have been identified in most of the studies are water or water with contaminants, sodium carbonate, sodium bicarbonate, caustic soda, formalin, urea, detergents, ammonium sulphate, boric acid, benzoic acid, salicylic acid, hydrogen peroxide, starch, sugars and melamine. In Pakistan water is the most common milk adulterant as 76.00 % followed by detergent 25.00 %, rice flour 22.00 %, caustic soda 18.00 %, salt 17.00 % and cane sugar 14.00 %. Unfortunately, milk is being very easily adulterated which may affect the quality and safety of milk. This situation is significantly worse in developing and underdeveloped countries due to the absence of adequate monitoring and lack of proper law enforcement system [8]. Milk is transported through a middle man called dhodhie. Such milk is watered to increase volume. To maintain its composition, starch, flour, urea, cane sugar, vegetable oil, etc., are added as chemical adulterants [4]. Synthetic or semi synthetic milk can be identified by reasons that it turns dark yellow in 3-6 hrs, more slippery in touch, bitter in

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frothy with targeted specific gravity then added in natural milk to form value added milk to get only substantial profit [10]. The analysis of different adulterants in milk samples showed such findings that helped in the discrimination of satisfactory and unsatisfactory milk samples through provided pure raw milk free from adulterants. These findings also supported the previous study of determining possibility of adulteration through physical and chemical quality parameters which showed adulteration possibility of around 76.6% [12].

## CONCLUSIONS

The assessment of quality of fresh milk shows poor quality milk with the provision of different sort of adulterants (77.89%) and alarming sign of semi synthetic or prepared milk (2.63). The analysis of milk adulterants confirms the sources of adulterants being used for the synthesis of semi synthetic or prepared milk due to their characteristics which they impart to form a sort of wholesome milk.

## Authors Contribution

Conceptualization: TI
Methodology: FHW
Formal analysis: MHSW
Writing-review and editing: GM, MHSW, FHW

All authors have read and agreed to the published version of the manuscript.

## Acknowledgement

This study was supported by Nutrition Division of NIH and we are thankful to Chief Nutrition Division of NIH and Executive Director of NIH.

## Conflicts of Interest

The authors declare no conflict of interest.

## Source of Funding

All authors have read and agreed to the published version of the manuscript.

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