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#### Sneh Lata Chauhan

Veterinary Public Health and Epidemiology, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

#### Priyanka

Veterinary Public Health and Epidemiology, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

#### Kruti Debnath Mandal

Division of Veterinary Medicine, ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh India

#### Babul Rudra Paul

Division of Veterinary Medicine, ICAR-Indian Veterinary Research Institute, Izatnagar, Uttar Pradesh India

#### Chinmoy Maji

Department of Veterinary Medicine, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

#### Correspondence

##### Priyanka

Veterinary Public Health and Epidemiology, Lala Lajpat Rai University of Veterinary and Animal Science, Hisar, Haryana, India

## Adulteration of milk: A Review

**Sneh Lata Chauhan, Priyanka, Kruti Debnath Mandal, Babul Rudra Paul and Chinmoy Maji**

#### Abstract

In addition to chemical hazards, this paper presents occurrence of common milk adulterants in milk and as different methods used to detect the adulterants both qualitatively and quantitatively. Most of the chemicals used as adulterants are poisonous that cause health hazards affecting human beings. Such adulterants reduce the nutrient value and also lead to contamination and not fit for consumption. The adulterants in milk i.e. urea, formalin, detergents, ammonium sulphate, boric acid, caustic soda, benzoic acid, salicylic acid, hydrogen peroxide, sugars and melamine used for the increasing shelf life, volume etc. lead to serious public health concern. This study is envisaged to be an adulterant based study instead of techniques based one. Different types of quantitative detection techniques depend on the nature of adulterants in milk are used. Quality control tests for milk are very important for adulterant free milk for consumption.

**Keywords:** Milk, adulterants, public health, chemicals

#### Introduction

Milk is the best and cheapest source of nutrition and used by all the age groups in rural as well as in urban areas. It provides appreciable amount of fats and protein and also provides body building vitamins along with furnishing energy giving lactose and many other nutrients, therefore an ideal food for pregnant female and infants. Milk is essential to provide nutrients to maintain health and normal growth of body. Adulterations of milk and dairy products have brought serious risk to human health as well as enormous economic losses to the food industry. An adulterant is a depreciatory term for ingredient found within other substances even though it is not allowed for legal or other reasons. Considering the different type of adulterants possibly mixed in milk, such as melamine, urea, antibiotics, sugar/salt and so forth, a rapid, widely available, high-throughput, cost-effective method is needed for detecting each of the components in milk at once (Abdul *et al.*, 2004) [15].

In order to keep milk temporarily fresh, some unethical methods are usually adapted to prevent the financial losses due to the spoilage of milk during its transportation and sale. For instance, the water is added to increase volume of milk, thickening agents like starch, flour, skimmed milk powder, whey powder or other ingredients to prevent the dilution effect and extend the solids content of the milk. Vegetable oil, sugarcane or urea to compensate the fat, carbohydrate or protein content of diluted milk that leads to hazard. Some chemicals such as hydrogen peroxide, carbonates, bicarbonates, antibiotics, caustic soda and even the most lethal chemical formalin to increase the shelf quality of milk, detergents to enhance the cosmetic nature of milk which give foamy appearance and whitening of milk that lead to gastro-intestinal problem. Most of the times, the adulteration is done intentionally to make greater profits, but sometimes, it may be due to the lack of awareness, proper detecting technology and confusion regarding the appropriate drug administration practices

Adulteration of milk is rampant, a startling six per cent of the samples tested in 2015 by the Ministry of Health had presence of 'detergents' in them confirming that 'synthetic milk' is a huge problem. Different type of methods used to detect adulterants in milk by using techniques i.e. DSC, RP-HPLC, LC-GC, HPTLC, immunoassays: CE, ELISA, FAMPST, FTIR, NIR spectroscopy, PAGE, IEF, DNA-based methods and MALDI-MS that have been developed and quantitative estimation of adulterants can also be done by using these techniques (Singh *et al.*, 2012) [9]. Contaminated milk can be a huge health hazard especially when it has been laced with urea, detergents and other toxic chemicals.

Recent developments in R&D sector, developed many cheap and pen site milk testing kits. These kits even an untrained person can use at home and within minutes detect contamination of common adulterants in milk.

### How is processed packaged milk reliable?

Pasteurization & processing of milk, improves the milk quality by killing pathogenic microbes and other microorganisms that are present in the raw milk. Controlling with the use of reliable & advanced technology, brands provides high quality and great taste of milk. Milk undergoes various type of heat treatment like high temperature-short time (HTST) pasteurization or ultra-high temperature (UHT) treatment.

HTST pasteurization of raw milk is done to improve shelf life up to 48 hours when stored at refrigerated conditions. Ultra-high temperature (UHT) sterilization of raw milk is done to improve shelf life 3 to 6 months at room temperature. In HTST pasteurization process, the milk is heated at 72 degrees Celsius for 15 seconds, immediately after which it is cooled to less than 4 degree Celsius. Such pasteurized milk is then packaged in hygienic containers. On the contrary, The UHT process, milk is heated for a very less time - just about a second or two at a temperature between 135 to 145 degrees Celsius. This is followed by cooling to ambient temperature and then packaged in bottles or packs under sterile condition. With the quality and safety standards and superior taste of its packaged dairy products, we assured on the products. Under current guidelines set in 1954, only milk from cow, sheep, buffalo and goat is considered for the standard not of camel and yak. "There is a need to revisit old standards to ensure people eat and drink quality food," said Pawan Agarwal, CEO, Food Safety and Standards Authority of India, the country's food-safety regulator (FSSAI 2016) [12].

Water is the most common adulterant that reduces the nutritional value in milk. If water has become contaminated with chemicals such as pesticides and heavy metals it poses an even bigger health risk to consumers. Packed milk from reputed brands as well as milk purchased from milk-vendors can be adulterated so it's important to check for them before consuming.

### Common adulteration's in Milk

**Water:** The presence of water can be detected by putting a drop of milk on a polished slanting surface. The drop of pure milk flows slowly leaving a white trail behind it, whereas it will flow immediately without leaving a mark in milk adulterated with water. Lactometric and cryoscopic methods are generally used for the determination of water added to milk.

**Starch:** Starch is one such component that is added to increase SNF content in milk. The test to detect starch in milk uses iodine solution, addition of which turns the milk solution to blue black color due to the formation of starch-Iodo complex, in the presence of starch. Tincture of Iodine or Iodine solution is used to detect starch adulteration in milk. Presence of blue color indicates the presence of Starch.

**Urea:** Add half teaspoon of soybean or arhar powder in a teaspoon of milk in a test tube. Mix up the contents thoroughly by shaking the test tube. After 5 mins, dip a red litmus paper after half a minute, change in color from red to blue indicates the presence of Urea in milk.

**Detergent:** Detergent is added to milk to increase the foaming of milk and thus to have thick milk. Addition of such chemicals will cause health problem especially related to gastrointestinal and kidneys. Shake 5-10 ml of sample with an equal amount of water and lather formation indicates the presence of detergent.

**Synthetic Milk:** Synthetic milk has a bitter taste, giving a soapy feeling on rubbing between the fingers and it get turn yellowish on heating.

**Microorganism:** Milk may contain some harmful microorganisms like bacteria that may cause contamination along with some potentially beneficial microbes. Microbiological analysis of milk is carried out to determine the degree of bacterial contamination in milk and to understand the chemical changes brought in milk as a result of microbial action. Pasteurization is done to destroy such harmful bacteria. If pasteurization of milk is not done properly, it will lead to presence of larger count of bacteria in the milk. Methylene blue Reduction test is used to detect the presence of bacteria in milk by dye reduction test. This test works on the principle that the methylene blue dye is used as indicator i.e. present in an oxidized form, but in the presence of bacteria that leads to the reduction of this indicator indicating microorganisms. The development of blue color on addition of the indicator to the milk will change to white color within a short period indicates the presence of bacteria in the milk and thus denotes improper pasteurization (Ali *et al.*, 2011) [14].

**Table Sugar:** Lactose is the common sugar present in milk. The fat content of the milk is more as compared to the protein content. Table sugar like sucrose is added to the milk to increase the carbohydrate content of the milk and used to increase the density of milk. So that the adulterated milk can now be sale with water and it will not be detected during the lactometer test. The reaction of Ketose sugar with the resorcinol will give a red colored precipitate, indicating the presence of Table sugar in milk.

**Melamine:** Melamine is added to milk and milk powder to increase protein content falsely. It causes renal failure and deaths in extreme cases (Cheng *et al.*, 2010) [1].

**Antibiotics:** Antibiotics are used for therapeutic purpose and 80% of veterinarians use antibiotics for treatment of mastitis disease. These antibiotics in the form of antimicrobial residues are found in milk during the withdrawal period of antibiotics in milk. Presence of tetracycline, aromatic amines, gentamicin residue after mastitis treatment, neomycin residues, sulfamethazine residues, chloramphenicol residues, aflatoxin M1 contamination etc. are also a deep concern as milk adulterants. Intramammary infusion of antibiotics for mastitis therapy is a major reason for milk contamination (Srishti *et al.*, 2013) [11]. Residues of these drugs in milk poses serious health hazards such as allergic reactions, increase in the number of antibiotic resistant, interference in intestinal flora and some of them (such as sulfamethazine residues) may have carcinogenic properties. It may also cause tissue damage. It interferes in the bacterial fermentation process which produces important losses in dairy products. Very low amount of penicillin, tetracycline and other antimicrobial residues are at risk due to their indiscriminate use and lack of awareness among people. (Das *et al.*, 2016).

**Table 1:** Method for detection of common adulterants in milk

Adulterant	Added to	Method of Detection	Adverse effects	Reference
Water	Increase the volume of milk	Freezing point osmometry and freezing point cryoscopic method	Diluting milk: malnutrition Impure water: intestinal problem	Ghulam Shabir Barham and Muhammad Khaskheli 2014 [15, 3].
Starch	Increase the quantity and to maintain SNF value in the milk	Add a few drop of Tincture of iodine or Iodine solution. Formation of blue colour indicates starch.	Diarrhea. Fatal to Diabetic patients.	(Singuluri & Sukumaran, 2014) [10].
Urea	Provide whiteness, increase consistency of milk and improving SNF in milk to imitate natural milk.	Take a teaspoon of milk in a test tube. Add half Teaspoon of soyabean or arhar powder. Mix up the content thoroughly by shaking the test tube. After 5 minutes, dip a red litmus paper in it. Remove the paper in 30 seconds. A change in colour from red to blue colour indicates presence of urea.	Kidney failure	(Kandpal <i>et al.</i> , 2012) [6].
Detergent	Increase the foaming of milk to give it whiteness and thickness	Shake 5-10 ml of sample with an equal amount of water. Leather indicates the presence of detergents.	It causes gastro-intestinal and kidney problems.	(Singuluri & Sukumaran, 2014) [10].
Formalin	Preservative	Take 10 m milk sample. Add 5 m conc. sulphuric acid with a little amount of ferric chloride without shaking. Appearance of violet or blue color at the junction of two liquid layers indicates the presence of formalin.	poisonous effect which can lead to death	(Singh <i>et al.</i> 2012) [9]. (Kamthania <i>et al.</i> 2014) [5].
Chlorine	added to compensate the density of the diluted milk after addition of water.	Sequential Injection Analysis (SIA) Flow Injection Analysis (FIA) Potentiometric detection Conductometric sequential injection analysis	Chlorinated milk can cause clogging in arteries and develop heart problem. Chloride in the milk disturbs the acid base balance in the body and also blood pH.	(Hattersley, 2000) [4].

## Conclusion

On the basis of this review, we can conclude that, the milk adulteration is becoming serious problem for public health concern. Although financial profit is considered to be one of the major reasons for milk adulteration, inadequate supply for the increasing population all over the world has paved the ground for this as well. Although maximum percentage of milk delivered to the consumers is not as per FSSAI standards. Consumption of adulterated milk may lead to serious human health issues due to adverse effects of chemicals. Hence it is important to have an efficient and reliable quality control system like HACCP that will regularly monitor, combined efforts from scientific communities and the regulatory authorities. The human and technology interface, awareness and access to information can play vital role in eradication of the milk adulteration. The World Health Organization (WHO) had recently issued statement to the Government of India that if adulteration of milk and milk products is not checked immediately, 87 per cent of citizens would be suffering from serious diseases like cancer by the year 2025. Quality control tests for milk are very important for adulterant free milk for consumption.

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