THE SCIENCE WORLD
A Monthly e Magazine
ISSN:2583-2212
June 2024 Vol.4(6), 2319-2323

Popular Article

Milk Adulteration in India and Techniques for its Detection

Sadiya Sajad, Shefali Kashyp & Anish Koul
Assistant Professor, MRCVS & RC, Jhajjar, Haryana
Assistant Professor, MRCVS & RC, Jhajjar, Haryana
Assistant Professor, MRCVS & RC, Jhajjar, Haryana
https://doi.org/10.5281/zenodo.12597581

Abstract

Milk is most vulnerable to adulteration among all the food products and can cause serious health issues in consumers. Milk adulteration has always been a matter of apprehension for the government and dairy industries particularly in the developing countries including India. Adulterated milk circulation and its consumption poses a bigger threat to regulators, consumers, and to the milk industry posing serious health hazards leading to fatal diseases. Despite all efforts to combat the constant state of vitriolic froth, the vicious circle goes on affecting the health of masses and also the authenticity of milk and its products. There are numerous detection methods and techniques available globally which are in practice to analyze and differentiate adulterated milk. A number of them are rapid, accurate and easy. However, most of them are complex, expensive, and lab-based techniques that limit their application.

Keywords: Adulteration, Dairy, Food safety, Health, Lab-based techniques, Milk

Milk is one of the best sources of protein, fat, carbohydrate, vitamins and minerals. It is considered to be the 'ideal food' because of the abundant nutrients present in it and is required by both infants as well as adults. However, the history of milk adulteration is very old. Swill milk scandal has been reported in 1850 which killed 8000 infants in New York alone. However, milk and dairy product adulteration came into global concern after breakthrough of melamine contamination in Chinese infant milk products in 2008. The possible reasons behind milk adulteration may include demand and supply gap, perishable nature of milk, low purchasing capability of customer and lack of suitable detection tests. The motivation for the adulteration is economic, but the impact is a real public health concern.

Commonly used adulterants of milk in India and methods for their detection:

1. **Water:** Water being free, unregulated and readily available is the most popular adulterant used. The addition of water changes the composition of milk, lowering the specific gravity, nutritional value, and foamy appearance. Higher specific gravity of pond water than tap water makes it a preferred choice for adulteration. However, pond water is a rich source of nitrates which can easily be detected using nitrate test. Also, lactose proportion is a typical measure for determining milk consistency and finding irregularities. A lactometer is a simple glass tube instrument with readings marked over it, and the readings have been calibrated in terms of specific gravity or density of milk. Lactometer reading above standard reading reflects the mixing of water and lower signifies higher density or thickness of milk, which indicates deceptive mixing of chlorine, salt, or sugar to preserve density after dilution. Freezing point osmometry and the freezing point cryoscopic process are two other methods for determining the additional water content in milk.
2. **Chlorine:** Chlorine is mixed to adjust the density of the thinned milk after infiltrating it with water. Its detection in milk is determined by sequential injection analysis (SIA) based on titration with silver cation and flow injection analysis (FIA) based on pseudo-titrations for the identification of chloride in milk. SIA requires less reagent pouring and may undertake evaluation without the need for machine configuration.
3. **Sodium Chloride:** It is used to make fake milk thicker by increasing the specific gravity of the milk. The addition of salt can also improve the lactometer readings. The addition of salt has no impact on the overall SNF content of milk, but it increases the freezing point depression value greatly, masking the measurement of added water in milk. A qualitative test with silver nitrate and potassium chromate will detect sodium chloride in milk.
4. **Urea:** Urea is a widely used milk adulterant because it is relatively inexpensive, readily available nitrogen-rich compound, but it lowers the milk's nutritional value. The average urea concentration in milk is 18–40 mg/dL. The standard upper limit for urea concentration in milk is 70 mg/dL. The addition of urea in milk provides whiteness, improve uniformity and storage life, and standardize the SNF content of milk. Urea adulterated milk will last for 2 or more days, while ordinary milk spoils in a day. The p-dimethyl amino benzaldehyde (PDMAB) test can diagnose urea in milk. The test suggests that in a low acidic solution at room temperature, urea forms a yellow complex with PDMAB.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 28.06.2024

5. **Cane Sugar:** Cane sugar (sucrose) is used to disguise the presence of extraneous water in milk and to improve the taste of the watered milk. Sugar is added to milk to elevate the lactometer reading and hence the specific gravity of watered milk so that the identification of extra water is disguised by the lactometer measurement. As a result of sugar addition, harmful and spoilage organisms can be prevented from growing in milk. Barfoed's or diacetic tests are used for the detection of sugar content in milk. Seliwanoff method is also used for evaluating sugar @ 0.05%.
6. **Starch:** It is commonly used in milk and various milk products as a thickening agent inorder to boost its SNF content. Starch is made up of amylose and amylopectin, which are polysaccharides. Starch is added to milk to make it denser and to hide the fact that it has been diluted with water. The starch-iodide test is used to detect starch in milk. A strip paper test is used for starch detection in milk in which a strip of paper dyed with an iodide compound reacts with starch to produce a bluish-violet color. It is easy to perform, precise, sensitive, rapid and can detect up to 0.8 mg/L starch in milk.
7. **Whey:** It is added to balance protein. Whey does not alter the lactose configuration of the milk; however, the mixing of whey may increase the acidity quotient, and therefore, a small amount of alkaline solution (e.g., NaOH) can neutralize the increased acidity. This alkaline solution improves the shelf life of the milk. Some smaller unorganized milk distributors prepare whey with cheap muriatic acid, causing severe health problems so identification of whey-adulterated milk becomes necessary. Near-Infra-Red (NIR) spectroscopy can detect whey in milk and the process is identical to that used to detect water in milk. Different samples of whey or water-adulterated milk give different peaks of NIR spectra in the range of 1100–2500 nm, which can be classified using discriminant algorithms. Immunochromatographic assays are also used to detect whey adulteration.
8. **Ammonium Sulfate:** Ammonium sulfate, a water-soluble nitrogenous substance is often used as a milk adulterant to hide the effects of additional water. The addition of ammonium sulfate not only improves the lactometer reading but also enhances the density and the apparent protein content of the milk. The turmeric paper method or Nessler's reagent method can be used to detect ammonium sulfate in milk. The presence of ammonium sulfate salt in milk is confirmed by the appearance of a pinkish-red color on turmeric paper.
9. **Formalin:** Formalin having antiseptic properties is intentionally and unlawfully applied to raw milk as a preservative to extend its shelf life. It should not be added to milk because of its

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 28.06.2024

poisonous nature, though it can hold milk for a long time at room temperature. Hehner's test and the chromotropic acid test are two popular methods that can detect formalin in milk.

10. **Sodium Carbonate/Bicarbonates:** Sodium carbonate and sodium bicarbonates are used to prevent milk deterioration by balancing the inherent acidity of milk as well as the acidity produced by bacteria that cause milk degradation. The only legally approved preservative is sodium bicarbonate, which is used as a stabilizer in condensed and powdered milk with the restriction on its upper limit which should be lesser than 0.3%. The Rosalie Acid Test or the Ash Alkalinity Test can detect carbonates and bicarbonates in milk.
11. **Sodium Hydroxide:** Sodium hydroxide or caustic soda is permitted in processed dairy foods, but it is not legally allowed in fresh milk. The addition of neutralizers to milk, such as sodium hydroxide, is intended to hide the ruined milk's acidity. Milk can be neutralized with lime, soda, or caustic soda; however, this addition always results in enhanced ash content and total alkalinity of the ash. As a result of surface and vessel cleaning by detergents which includes caustic soda, traces of caustic soda may be found in contaminated milk. The rosalic acid test can be used to detect sodium hydroxide in milk. The appearance of a rose-red color indicates the presence of sodium hydroxide in the milk.
12. **Boric Acid:** Boric acid is an antibacterial agent that is frequently employed when milk's microbiological consistency is unsure. However, as an edible additive, it has been considered dangerous by the expert group of FAO/WHO. Paper strip test is used for its detection; if the milk contains boric acid combination changes of paper strip from red to yellow and then back to green are observed.
13. **Hydrogen Peroxide:** Hydrogen peroxide commonly used as shelf life enhancer for milk and milk products can retard rapid microbial escalation in raw milk, thus preventing its spoilage; although the amount used should not exceed 0.05% of the overall weight of the milk to avoid harmful health implications. Hydrogen peroxide in milk can be detected using qualitative procedures like the vanadium pentoxide test and the p-phenylenediamine test.
14. **Benzoic Acid:** Benzoic acid is a preservative for the dairy industry, to combat different bacteria, yeasts, and fungi that cause food spoilage. Many countries including India has banned its use in milk. Solid-phase extraction and ion chromatography can be used to detect benzoic acid in milk.
15. **Melamine:** Melamine is mixed in different dairy products like milk, frozen yogurts and baby milk powder because of its high nitrogen content (66.6%). The infiltration of melamine can

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 28.06.2024

enhance the evident protein content of these dairy foods. According to the EU, the maximum permissible limit of melamine can be 2.5 mg/kg but the infant formula should be melamine free while according to WHO/FAO experts, a limit of 1 mg/kg in the newborn formula can provide an adequate margin of safety. Near-infrared (NIR) and mid-infrared (MIR) spectroscopy are effective techniques to detect melamine in infant formula powder. Similarly indirect competitive ELISA is also useful in raw milk and milk powder.

16. **Soaps and Detergents:** A necessary component of the synthetic milk formulation are soaps and detergents as they act as surfactants with foaming properties. Surfactants enable oil to blend with water, dissolve non-milk fats, and make a foamy solution with the distinctive white appearance of milk. Bromocresol purple test is used for its detection as the detergent containing sample of milk appears violet in colour.
17. **Colour:** Buffalo milk in India is adulterated with colourants (annatto, turmeric, and coal-tar dyes) so that it can be sold as cow milk. Qualitative filter paper method is used for the detection of annatto which turns the filter paper red yellow. Also, capillary electrophoresis (CE) is an analytical technique used for the segregation of food colourants.
18. **Low-Valued Milk:** Milk is also considered adulterated when lower-value milk is combined with higher-value milk like goat milk is often contaminated with cow milk to increase profit. Cow milk is often mixed with buffalo milk which can be detected by Hansa's test. Ewe, goat, and buffalo milk are often supplemented with low-cost cow milk, however, for the identification of cow milk in ewe and goat milk, an optical biosensor (BIACORE 3000) is used. Gas chromatography is used to assess the fatty acids in authentic buffalo's milk, cow's milk, and buffalo's milk adulterated with cow's milk. Cow's milk in sheep and goat's milk is measured using ELISA and PCR techniques.

Apart from the monetary gains which undoubtedly play a major role in adultering milk, the inadequate supply of milk to the rampantly increasing population has also given a boost to milk adulteration. However, with the advent of scientific knowledge a number of milk adulteration techniques have gained momentum for the detection of adulterants in milk and thus, combating this menace.

Official Website
www.thescienceworld.net
thescienceworldmagazine@gmail.com
Published 28.06.2024