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Assessment of Milk Quality through Detection of Common Adulterants

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Abstract:

Milk is one of the most essential components of the human diet, valued for its rich nutritional content, including proteins, fats, vitamins, and minerals. However, adulteration of milk has become a widespread concern in many regions, posing serious health risks to consumers and undermining food safety standards. There are 16 samples of milk were collected from different sources and areas of Aurangabad city. This study focuses on the detection, causes, and consequences of milk adulteration, as well as methods used to identify common adulterants. Adulterants such as water, starch, detergents, urea, synthetic milk, and preservatives like formalin are often added to increase volume, enhance appearance, or extend shelf life. Findings emphasize the need for regular monitoring and the adoption of advanced detection technologies to ensure milk quality and safeguard public health.

Keywords: Milk adulteration, Food safety, Public health, Detection methods

1. Introduction

Milk is considered one of the most complete natural foods, providing essential nutrients such as proteins, fats, carbohydrates, vitamins, and minerals required for human growth and development. It forms a vital part of the daily diet for millions of people worldwide, particularly children and the elderly. Due to its high nutritional and commercial value, milk is in constant demand, making it susceptible to adulteration for economic gain. Milk adulteration is the practice of adding inferior substances or removing valuable components to increase quantity, improve appearance, or prolong shelf life. Common adulterants include water, starch, detergents, urea, synthetic milk, and chemical preservatives such as formalin. While these substances may increase profits for suppliers, they significantly reduce the nutritional quality of milk and pose serious health hazards. Consumption of adulterated milk has been linked to gastrointestinal disturbances, kidney dysfunction, metabolic disorders, and even long-term carcinogenic effects.

The issue of adulteration not only threatens consumer health but also undermines food security and erodes trust in the dairy industry. Various detection methods, ranging from simple household chemical tests to advanced laboratory-based techniques such as chromatography, spectroscopy, and biosensors, have been developed to identify adulterants effectively. Despite these advancements, milk adulteration remains a widespread problem in many developing countries due to inadequate regulation, lack of awareness, and limited enforcement mechanisms. Therefore, the study of milk adulteration is of paramount importance for ensuring food safety and protecting public health. This research aims to examine the types and effects of adulterants, evaluate existing detection techniques, and emphasize the need for stricter regulatory frameworks, consumer awareness, and the application of modern technological interventions to safeguard milk quality.

Milk adulteration has been a matter of global concern for decades, with numerous studies highlighting its prevalence, detection methods, and implications for public health. Researchers have found that adulteration practices often involve dilution with water or the addition of substances such as starch, detergents, urea, and formalin to increase volume, improve texture, or extend shelf life (Sharma et al., 2018). These adulterants not only compromise the nutritional integrity of milk but also expose consumers to harmful chemicals. Several studies have reported the health hazards of adulterated milk. According to Singh and Gandhi (2015), ingestion of detergent-contaminated milk can cause gastrointestinal disorders, while urea and synthetic compounds may lead to kidney damage and metabolic disturbances. Similarly, formalin and other chemical preservatives have been linked to toxic and carcinogenic effects when consumed over prolonged periods (Kumar et al., 2017). Efforts to detect adulteration have advanced significantly over the years. Traditional chemical tests, such as those for starch, sugar, and detergents, are still widely used due to their simplicity and low cost (Pandey et al., 2019). However, modern analytical techniques have shown greater reliability and sensitivity. Chromatography and spectroscopy-based methods, including High-Performance Liquid Chromatography (HPLC), Fourier Transform Infrared (FTIR) spectroscopy, and Nuclear Magnetic Resonance (NMR), are increasingly applied to detect adulterants at trace levels (Santos et al., 2020). Portable rapid detection kits have also emerged as practical solutions for field-level testing and consumer use (Patel et al., 2021). On the regulatory side, the Food Safety and Standards Authority of India (FSSAI), the Codex Alimentarius Commission, and other international agencies have developed stringent guidelines for milk quality. Despite these standards, studies indicate that adulteration remains widespread, particularly in developing countries, due to inadequate enforcement and lack of consumer awareness (Chandra et al., 2019).

Recent research emphasizes the need for innovative approaches such as biosensors, nanotechnology-based methods, and artificial intelligence (AI)-driven analysis for real-time detection of adulterants (Rani & Kaushik, 2022). These advanced tools hold promise for enhancing monitoring systems and restoring consumer trust in dairy products. In summary, the literature highlights that while significant progress has been made in detecting and regulating milk adulteration, challenges persist due to economic motives, weak enforcement, and lack of awareness. Continuous innovation in detection technologies, coupled with strict regulatory frameworks and public education, is essential to address this critical food safety issue.

Methods and materials:

The present study on milk adulteration is designed to identify common adulterants in milk samples, evaluate detection techniques, and analyze their implications for public health. The methodology consists of the following steps:

Sample Collection: Fresh milk samples were collected from diverse sources, including: Local vendors, dairy farms, retail outlets, packaged/pasteurized milk brands**.** 16 samples were collected to ensure a representative dataset. Samples were stored under refrigeration at **4°C** and tested within 24 hours to prevent natural spoilage.

1. Physical Examination: Changes in milk's color, texture, taste, or smell were observed for

- **Too white/creamy appearance** → starch or synthetic whitening agents.
- **Blue tinge** → possible presence of detergents
- **Watery consistency** → dilution with water.
- **pH Measurement**: Normal milk pH is ~6.6–6.8. Deviations suggest adulteration or spoilage. Eg. Addition of neutralizers like sodium carbonate increases pH.

2. Chemical Tests: Chemical methods for detection of adulteration were performed as follows:

2.1 Detection of water in milk: A drop of milk was taken on a polished slanting surface. Pure milk either stays or flows slowly leaving a white trail behind. Milk adulterated with water will flow immediately without leaving a mark.

2.2 Detection of detergent in milk:

2.2.1 A 5 to 10ml of sample with an equal amount of water were taken and shacked thoroughly. If milk is adulterated with detergent, it forms dense lather. Pure milk will form very thin foam layer due to agitation.

2.2.2 Detergent in milk can be done using chemical tests like the methylene blue test. Method: Add Methylene blue dye and chloroform to the milk sample and mix. A more intense blue color in the lower layer (chloroform) indicates detergent.

2.3 Detection of starch in milk:

Prepare the sample. Add 3–5 ml of the milk sample into a clean test tube.
Heat the sample. Place the test tube in a boiling water bath and incubate for about 5 minutes. This heating step helps break down the milk's proteins and fats, allowing for a clearer reaction.
Cool the sample. Remove the test tube from the water bath and allow it to cool to room temperature.
Add the reagent. Using a dropper, add a few drops of the 1% iodine solution to the cooled milk sample.
Observe the results. Gently mix the contents of the test tube and look for a color change.
Positive test: If starch is present, the milk will turn a blue-black color.
Negative test: If the milk is pure and no starch is present, the color will remain the same brownish-yellow as the iodine solution.

2.4 Detection of Urea in milk:

2.4.1. Urea was detected by diacetyl monoxime test (pink coloration confirms urea).

2.4.2. A simple urease test for milk involves mixing milk with a powder like soybean or arhar dal and observing the reaction with red litmus paper. If the milk is adulterated with urea, the urease from the powder will break down the urea into ammonia, which raises the pH and turns the red litmus paper blue. The test works because added urea is a common adulterant used to increase the apparent protein content of milk.

2.4.3. A common laboratory method for detecting added urea in milk is the DMAB test, which uses a reagent called para-dimethylaminobenzaldehyde (DMAB). The test involves mixing milk with the DMAB reagent, and if urea is present, a deep yellow color will form, whereas a sample with naturally occurring urea will show only a slight color change.

2.5 Detection of Sugar in milk:

Add 10 ml of milk to a test tube.
Add 5 ml of concentrated HCl to the test tube and mix gently.
Add 0.1 g of resorcinol powder to the mixture and shake well.
Place the test tube in a boiling water bath for 5 minutes.
Remove the test tube and observe the color change.
Positive result: The solution turns red, indicating the presence of added sugar (like sucrose).
Negative result: The color remains unchanged, indicating the absence of added sugar.

Results and Discussion:

A total of 16 milk samples were collected from four different sources—local vendors, dairy farms, retail outlets, and packaged brands—and analyzed for the presence of common adulterants. The study demonstrates that while packaged milk is comparatively safer. The results are presented in **Table 1**.

Table 1. Milk Adulteration Results by Source

Source	Samples Tested	Adulterated Samples
Local Vendor	04	03
Dairy Farm	04	02
Retail Outlet	04	01
Packaged Brand	04	00

Table 2. Common Adulterants Detected in Milk Samples

Adulterant	Detection Method (Example)	Samples Positive (out of 16)
Water	Lactometer / Freezing Point	05
Starch	Iodine Test	02
Detergents	Frothing Test / pH Test	01
Urea	Diacetyl Monoxime Test	00
Sugar	Resorcinol Test	00

Conclusion:

The present study reveals that milk adulteration remains a significant public health concern, particularly in unorganized sectors such as local vendors and retail outlets. Among the 16 samples analyzed, the highest adulteration rate was observed in milk sold by local vendors while packaged brands showed relatively lower adulteration. Water dilution emerged as the most common adulteration practice, followed by starch and detergents. The findings emphasize that adulteration not only compromises the nutritional quality of milk but also undermines consumer trust and food safety standards while packaged milk demonstrated better compliance.

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