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Adulteration in Packaged Milk Products: Impact on Women's Health and Wellbeing

Sweety Santra[1], Rajee Johnson[2], Ms. Kajal Bansal[3]

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Abstract:

Packaged milk offers convenience and is a popular choice for many urban dwellers with busy schedules, especially those working in metropolitan areas. Milk adulteration is a widespread issue for public health, notably affecting women's health and reproductive well-being. The inclusion of common adulterants such as water, urea, starch, and harmful preservatives like formaldehyde compromises the nutritional integrity and safety of milk. Women, particularly during their reproductive years, rely on the essential nutrients in milk—such as proteins, calcium, vitamins, and minerals—to support overall health, hormonal balance, and foetal development. Adulterants dilute these vital nutrients, leading to deficiencies that can affect reproductive health, including menstrual irregularities, reduced fertility, and complications during pregnancy. This study examines the widespread issue of milk adulteration in packaged milk products and its potential impact on women's health, particularly in urban areas of Bangalore. The research explores how adulteration affects the physical properties of milk, including viscosity, pH, surface tension, and density, and relates these changes with reported health issues in women from Bangalore. This research emphasizes necessity for strict quality control protocols and increased public awareness to combat milk adulteration, ensuring the well-being and safety of women.

Keywords: *Milk Adulteration, Women's Health, Reproductive Wellbeing, Nutritional Deficiencies, Physical parameters*

Authors:

1. *BSc Forensic Science 4th semester, Garden City University, Bengaluru, INDIA.*
2. *Assistant Professor, Department of Forensic Science, Garden City University Bengaluru, INDIA.*
3. *Assistant Professor, Department of Forensic Science, Garden City University Bengaluru, INDIA*

Introduction

Milk is a complex biological fluid secreted from the mammary glands of mammals that meet the nutritional needs of neonates of the species from which the milk is derived. Due to its nutritive value, milk is significant to young and old people **(Kapoor *et al.*, 2021)** Milk is considered to be the 'ideal food' because of its abundant nutrients required by both infants and adults. It is one of the best sources of protein, fat, carbohydrates, vitamins, and minerals. The milk and dairy products industry is a vital food sector in many countries around the globe. Dairy-derived foods can cater to major nutritional requirements of people including infants and the geriatric population **(Haldar *et al.*, 2022).**

Milk has contributed 5% to the national economy than any other farm commodity in the past 5 years. In the Indian scenario as per the government of India's admission, more than 70% of the milk available in India does not conform to Food Safety Standards Association India (FSSAI) standards. Millions of parents in our country today trust this milk for their children. Such milk is watered or skimmed to increase the amount of milk to increase their profit and cover the high demand and in this situation, they (the supplier) maintain its composition of starch, flour, urea, cane sugar, vegetable oil, etc., are added as adulterants and this activity called adulteration **(Kapoor *et al.*, 2021).** Forensic toxicology is essential in ensuring the safety and integrity of milk, a staple in many diets. When it comes to detecting adulteration, scientists employ a range of sophisticated standard techniques are used to uncover any harmful additives or fraudulent practices.

- Chromatography: Techniques like High-Performance Liquid Chromatography (HPLC) and Liquid Chromatography-Mass Spectrometry (LC-MS) help researchers identify and quantify foreign proteins, fats, and chemicals that shouldn't be present in pure milk.

- Spectroscopy: Methods such as Fourier Transform Infrared Spectroscopy (FTIR) and Near-Infrared Spectroscopy (NIR) allow for rapid screening of milk composition, providing a quick snapshot of its quality.

- Immunoassays: Enzyme-linked immunosorbent Assays (ELISA) are used for sensitive detection of specific adulterants, ensuring that even trace amounts of harmful substances can be identified.

- DNA-based Methods: Polymerase Chain Reaction (PCR) techniques help in identifying the species of milk, which is crucial for detecting any fraudulent mixing with cheaper alternatives.

- Physical Tests: Simple yet effective tests, such as measuring electrical conductivity and freezing point, can indicate water addition, a common form of adulteration.

These advanced methods not only protect consumers but also promote transparency in the dairy industry. By ensuring that milk is pure and safe, forensic toxicology plays a vital role in maintaining public trust and health **(Chauhan *et al.*, 2019).**

Despite food legislation, adulteration remains uncontrolled, furthermore, legal steps laid down in the PFA Act are extremely difficult to maintain **(Faraz *et al.*, 2013)** Milk and dairy product adulteration has become a global concern. The situation is significantly worse in developing and underdeveloped countries due to the absence of adequate monitoring and lack of proper law enforcement **(Azad and Ahmed, 2016)** Contamination deals with the unwanted deterioration of the quality of food; adulteration is defined as a process by which the quality of a product is reduced through the addition of an inferior substitute or removal of vital products. the knowledge about the specific effects of adulteration of milk on human health is very low **(Tiwari *et al.*, 2012).** The nature of adulterants generally encountered in milk and milk products are water, removal of fat, addition of skim milk powder, reconstituted milk, and thickening agents such as starch, flour, glucose, urea, salt, and chlorine **(Singuluri, 2014).**

Nowadays milk is being adulterated in more sophisticated ways that demand cutting-edge research for the detection of adulterants. Milk adulteration detection techniques need to be very specific and rapid because defrauders have escaped condemnation claiming less effectiveness of the conventional detection techniques **(Garcia *et al.*, 2011)** The existing common detection techniques are often inconvenient and inaccessible in these countries, making it challenging to tackle the various methods of fraudulent milk adulteration **(Azad and Ahmed, 2016)** Milk adulteration poses a significant risk to public health, affecting essential nutrients crucial for women, particularly in relation to reproductive health.

Health effects of adulterants

Starch - Its adulteration in milk causes diarrhoea and irritation of the colon. It is very harmful for diabetic

patients. Water is added to milk to increase the volume, but diluted milk is not preferred economically; hence, starch is added to maintain density and solid constituents. Undigested starch irritates the gut and causes diarrhoea.

Ammonium sulphate - It is intentionally added to manipulate the lactometer reading. Its presence falsely increases the density of milk. Even in low amounts, it can irritate the gastrointestinal tract with symptoms of nausea, vomiting and diarrhoea. Being a neurotoxin, it can cause confusion and behavioural changes. **(Choudhary and Sharma, 2024).**

Detergents are added to emulsify and dissolve the oil in water giving a frothy solution, which is the desired characteristic of milk. Commercial urea is added to milk to increase non-protein nitrogen content. Cane sugar, starch, sulphate salts, urea and common salts are added to increase solid-not-fat (SNF) **(Azad and Ahmed, 2016).**

Aim

The present study explores methods to assess the extent of adulteration in various packaged milk samples available in the Bangalore region by analyzing physical parameters, while highlighting the negative impact of these adulterants on women's health.

Methodology

Samples

Six different packaged milk samples were collected from various regions in Bangalore, representing commonly consumed brands. Additionally, one standard sample was obtained that adheres to the Food Safety and Standards Authority of India (FSSAI) 2024 gui 2.2 Procedure

Survey

We carried out a survey across various areas of Bangalore to understand people's daily milk consumption habits, the brands they prefer, and the issues individuals are experiencing after consuming these popular packaged milk brands.

Assessing the physical parameters of collected packaged milk samples

- pH: Standard pH paper was used to measure the pH of each milk sample.
- Density: Measured using a specific gravity bottle Specific gravity bottle with a precise volume of 25 ml
- Specific gravity bottle with a precise volume of 25 ml was used to measure the density of the milk samples. Using raw milk as a reference, the mass of each milk sample was computed to determine its density.
- Viscosity: Ostwald's viscometer was used to determine the milk samples' viscosity. Each milk sample and a blank sample were tested, and the time it took for each liquid to pass through the viscometer was recorded in order to look for differences that might indicate adulteration.
- Surface Tension: A stalagmometer was used to measure the milk samples' surface tension. Surface tension variations from standard raw milk were determined by counting the number of drops that formed in both the milk samples and a blank sample of water.

Assessing the physical parameters after introducing common adulterants

We introduced adulterants, namely ammonium sulfate and starch, into the standard milk samples to observe whether their addition would cause noticeable changes in the physical parameters, such as viscosity, surface tension, and density. We began by adding small amounts of each adulterant, ranging from 0.25g to 0.50g, to track any resulting alterations.

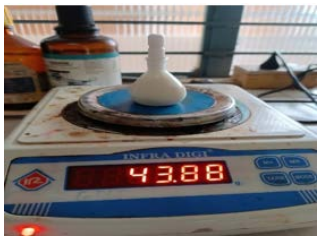

Figure No. 1: Specific gravity bottle for measuring density

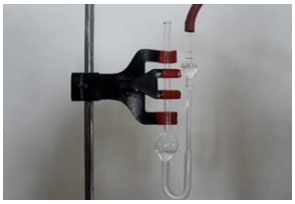

Figure No. 2: Ostwald's Viscometer for measuring Viscosity

Results

Survey analysis

Out of 68 responses from women aged from 15 to 50 years all over Bangalore, 21 reported health issues like gastric problems and bloating (30.8%), 26 reported feeling super filled and having stomach gas (38.2%) after consuming packaged milk.

Physical parameters of collected packaged milk samples

Assessing physical parameters like pH, density, surface tension, and viscosity is crucial for determining milk quality. In the analysis of milk (both packaged and raw) samples from various regions of Karnataka, deviations from standard physical parameters suggest potential adulteration (Table: 1, Graphs: 1 -3).

Table No. 1: Experimental values of the milk samples

Sample no.	Viscosity	Surface tension	Density	pH
Standard	0.003	0.045	1.02	6
s1	0.001	0.096	1.03	6
s2	0.001	0.095	1.02	6
s3	0.002	0.059	0.96	6
s4	0.002	0.049	1.02	6
s5	0.001	0.053	1.02	6
s6	0.001	0.044	0.96	6

Figure No. 3: Change in Viscosity of the samples

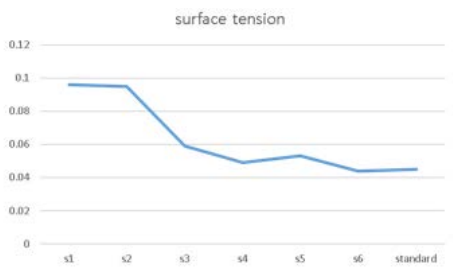

Figure No. 4: Change in Surface tension of the samples

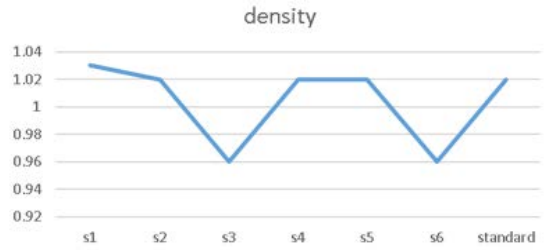

Figure No. 5: Change in density of the samples

Based on the data, we can observe noticeable changes in the physical parameters, indicating the presence of adulterants in the samples. Literature commonly identifies adulterants such as starch, benzoic acid, ammonium sulfate, formalin, sucrose, urea, and detergent, which can alter these parameters and pose health risks.

Assessing the physical parameters after introducing common adulterants

When starch was added to the milk samples, noticeable changes in the physical parameters were observed at 0.5g, whereas ammonium sulfate caused significant changes at just 0.25g. The results confirmed that the addition of these adulterants—starch and ammonium sulfate—led to alterations in the physical parameters.

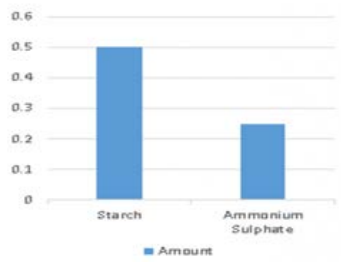

Figure No. 6: Amount at which changes were visible

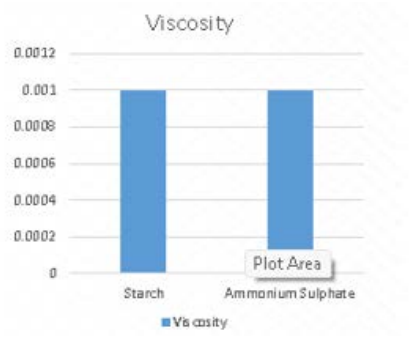

Figure No. 7: Change in viscosity after adding adulterants

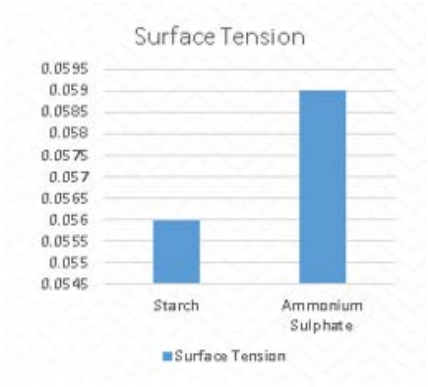

Figure No. 8: Change in surface tension after adding adulterants

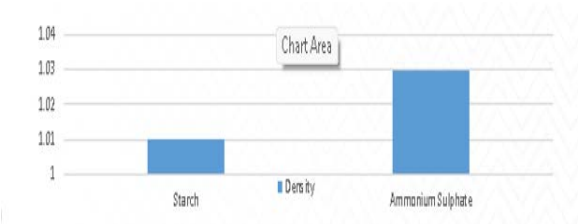

Figure No. 9: Change in density after adding

Discussion

Milk adulteration is a critical issue that poses significant health risks, particularly when unprocessed starches and harmful chemicals are introduced to enhance the product's quality or quantity. The addition of unprocessed starches such as wheat flour, maize, and corn starch to milk is prevalent, primarily to increase the solid-not-fat (SNF) content. However, these starches can lead to gastrointestinal disturbances, including diarrhoea, particularly when consumed in large quantities **(Infante *et al.*, 2023).**

The findings from this study highlight a significant concern regarding the adulteration of packaged milk samples. Deviations in physical parameters, such as viscosity and surface tension, suggest that these milk products do not meet the standard composition of raw milk. This raises red flags about the presence of adulterants, particularly starch and ammonium sulphate, which were detected during testing. These adulterants are known to alter the physical properties of milk, making it less safe for consumption and potentially harmful to health.

The survey data supports this, revealing that a considerable portion of the female respondents reported health issues following the consumption of packaged milk. Specifically, 30.8% experienced gastric discomfort and bloating, while 38.2% reported feeling overly full and suffering from stomach gas. These symptoms are commonly associated with the presence of adulterants, particularly starch and ammonium sulphate, which have been linked to gastrointestinal disturbances. Moreover, these adulterants may pose risks beyond immediate digestive issues, potentially affecting reproductive health over time.

The correlation between the physical alterations in milk due to adulteration and the health complaints reported by the surveyed women suggests a direct link between milk quality and consumer well-being. This underscores the urgent need for stricter quality control measures and more robust testing procedures to ensure that milk products meet safety standards, ultimately protecting public health, particularly that of vulnerable groups such as women.

The findings reported in the present study highlight an urgent need for enhanced quality control measures within the dairy industry. Current practices often lack rigorous testing protocols for detecting harmful adulterants. Implementing advanced detection methods such as near-infrared spectroscopy could significantly improve the identification of adulterants like starch and chemical additives in milk products. **(https://vikaspedia.in).**

In addition to regulatory measures, increasing public awareness about the dangers of milk adulteration is crucial. Consumers should be educated on how to identify potential adulterants through simple home tests or by understanding labelling practices. Initiatives aimed at informing the public about food safety can empower consumers to make informed choices and demand higher quality standards from producers **(https://eatrightindia.gov.in/dart/)**

From the serious health implications associated with milk adulteration; it is imperative that forensic toxicology departments across states take an active role in investigating these issues. By conducting regular surveillance and analysis of milk products, these departments can help mitigate risks associated with food fraud and protect public health. **(https://adulterationkills.blogspot.com).**

Limitations

- The study focused primarily on analysing the physical parameters of milk, such as viscosity and surface tension, which may not fully reflect the complexity of milk composition.

- A more extensive investigation, including a wider range of adulterants, would offer a deeper and more comprehensive understanding of the issue.
- Since the study was conducted in a specific region or country, its findings may not be generalizable to other areas with differing agricultural practices, regulatory standards, or consumer behaviour.
- The conclusions of the study may be constrained by the sample size and the variety of milk products tested.
- The absence of advanced instruments like chromatography and spectroscopy limited the ability to obtain precise and reliable data.

Conclusion

The issue of milk adulteration is not just a technical problem; it directly impacts the lives of women, especially in bustling urban areas like Bangalore. As many women rely on milk for essential nutrients to support their health and reproductive well-being, the presence of harmful adulterants can lead to serious health concerns. This research sheds light on the urgent need for better quality control and public awareness to safeguard the milk we consume. By addressing this issue, we can help ensure that women have access to safe, nutritious milk, ultimately fostering healthier families and communities.

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