

MILK ADULTERATION – A POTENTIAL THREAT FOR HUMAN HEALTH

Abstract

Milk production is part of agriculture because the dairy is associated with agriculture. Milk is a complete food but is perishable due to limited shelf life and by growth of microorganisms. The quality of milk can be affected by the presence of additional water, detergents and disinfectants, antibiotics, pesticides, heavy metals and pathogens. The quality defects are often resulted due to microbial contamination causing the spoilage. The assessment of milk quality and related milk products is carried out by sensory, chemical, and microbiological analyses. With the emphasis on maintaining the quality of milk during production, transport, storage, and distribution this chapter focuses upon the methods of detection of adulterants and latest technological advances in detection of milk adulteration and to detect the good manufacturing practices in milk supply chain in the interest of public health.

Keywords: Milk Adulteration, Human Health.

Authors

Prof. M. Aruna

Department of Homescience
SPMVV, Tirupati, A.P, India.

Dr. L. Anita

Springwood Apartments
Behind Mahila university,
Tirupati , A.P, India.

G. Sai Bramari

Gandhi Residency 204
Jayaprakash Nagar, Yellareddyguda
Hyderabad, Telangana, India.

I. INTRODUCTION

Milk, if present in its natural form has high food value. It supplies nutrients like good quality proteins, fat, carbohydrates, vitamins and minerals in significant amount than any other single food. It is general need for human health, milk proteins supply those amino acids which are needed for proper growth of adults and infants. Buffalo and cow milk contains 7.6 and 4.5% fat, 3.8 and 3.8% protein, 4.9 and 4.9% lactose 0.78 and 0.72% ash, 17 and 13.9% total solids respectively. Milk is the complete food lipids, proteins, lactose and minerals, vitamins A and B and provides dietary Calcium and other minerals.

Milk production is part of agriculture because the dairy is associated with agriculture. Milk is a complete food but is perishable due to limited shelf life and by growth of micro organisms. The quality of milk can be affected by the presence of additional water, detergents and disinfectants, antibiotics, pesticides, heavy metals and pathogens.

Milk adulteration remains a significant concern in various parts of the world. Adulteration refers to the practice of adding low-cost or harmful substances to milk to increase its volume or improve its appearance while reducing its quality and nutritional value. Adulteration not only deceives consumers but can also pose health risks.

Common adulterants found in milk include water, urea, starch, sugar, vegetable oil, formalin (formaldehyde solution), and synthetic milk proteins. These substances can be harmful to human health, particularly if consumed regularly or in large quantities.

It's important to note that data on milk adulteration can vary significantly from region to region, and the prevalence of adulteration may change over time. Governments and regulatory authorities in many countries work to combat milk adulteration through regular monitoring, enforcement of quality standards, and public awareness campaigns.

For the most current data on milk adulteration, I recommend checking reports and publications from reputable sources such as government agencies, food safety authorities, and international organizations like the World Health Organization (WHO) and the Food and Agriculture Organization (FAO). Additionally, academic research and studies related to food safety and milk quality may provide insights into the latest trends and efforts to address milk adulteration.

If you suspect milk adulteration or have concerns about the milk you consume, it's essential to purchase milk from reputable sources and brands that comply with food safety regulations. Proper storage and handling of milk at home can also help maintain its quality and safety. If you have health concerns related to milk consumption, consider consulting a healthcare professional or a registered dietitian for personalized advice.

II. ADULTERANTS OF MILK

As previous mentioned the following chemicals or adulterants are among the most commonly used in milk adulteration:

1. **Water:** The addition of water to milk is one of the most common and straightforward forms of adulteration. It helps increase the volume of milk and dilutes its nutrients, such as proteins and fats.
2. **Urea:** Urea is a nitrogen-rich compound commonly used to adulterate milk to increase its apparent protein content during standard tests. However, urea is harmful to human health if consumed in large quantities.
3. **Starch:** Starch is added to milk to increase its viscosity and thickness, making it appear creamier and more appealing. This adulterant also affects the nutrient content of milk.
4. **Sugar:** Adding sugar to milk can increase its sweetness and improve the taste, but it can also reduce the nutritional quality of milk.
5. **Vegetable Oil:** The addition of vegetable oils, such as palm oil or soybean oil, can increase the fat content of milk and make it appear thicker. However, it reduces the quality of the milk and may lead to digestive issues.
6. **Formalin (Formaldehyde Solution):** Formalin is a toxic and carcinogenic chemical that is sometimes added to milk to prolong its shelf life and prevent spoilage. Its consumption can lead to severe health problems.
7. **Synthetic Milk Proteins:** These can be used to mimic the protein content of milk during quality testing. They are harmful and can negatively affect human health.
8. **Detergents and Chemical Cleaning Agents:** Some unscrupulous individuals add detergents and chemical cleaning agents to milk to improve its whiteness and appearance.

It's important to remember that milk adulteration practices may vary from region to region, and new adulterants may emerge over time. Governments and regulatory authorities work to combat adulteration and ensure the safety and quality of milk and dairy products for consumers.

III. HEALTH IMPACTS OF MILK ADULTERATION

Milk adulteration can have several negative health impacts on consumers. The consumption of adulterated milk can lead to various health problems due to the addition of harmful substances and the reduction of nutritional quality. Some of the health impacts of milk adulteration include:

1. **Gastrointestinal Issues:** Adulterants such as water, starch, and synthetic milk proteins can affect the digestion of milk and cause gastrointestinal discomfort, bloating, and diarrhea.
2. **Reduced Nutritional Value:** Dilution of milk with water or addition of starch, sugar, and vegetable oil decreases the nutritional value of milk. Adulterated milk may have lower levels of essential nutrients like proteins, fats, calcium, and vitamins, leading to nutritional deficiencies.

- 3. Toxicity and Chemical Exposure:** Some adulterants, like urea, formalin, and detergents, are toxic and can have adverse effects on the body when ingested regularly. Long-term exposure to these substances may lead to organ damage and other serious health issues.
- 4. Allergic Reactions:** Synthetic milk proteins or other non-dairy additives may trigger allergic reactions in individuals with milk allergies or lactose intolerance.
- 5. Microbial Contamination:** Poor handling and storage practices during milk adulteration can lead to microbial contamination, increasing the risk of foodborne illnesses.
- 6. Impact on Children:** Adulterated milk can be particularly harmful to infants and young children, as their bodies are more vulnerable to toxic substances and nutrient deficiencies.
- 7. Long-Term Health Risks:** Regular consumption of adulterated milk can lead to chronic health problems, including digestive disorders, kidney damage, liver dysfunction, and compromised immune function.
- 8. Cancer Risk:** Some adulterants, like formalin, are carcinogenic and have been associated with an increased risk of cancer when consumed over time.

IV. MEASURES FOR PREVENTION OF MILK ADULTERATION

It's important to be cautious about the milk and dairy products we consume. To minimize the risk of milk adulteration and its associated health impacts, it's advisable to purchase milk from reputable sources and brands that comply with food safety regulations. Additionally, consumers can perform simple tests at home, such as the purity test or the lactometer test, to check for signs of milk adulteration.

In case of any suspicion of milk adulteration or health issues related to milk consumption, it's best to report the concern to local food safety authorities and seek medical advice from a healthcare professional.

Preventing milk adulteration requires a collective effort from various stakeholders, including government authorities, dairy industry players, consumers, and regulatory bodies. Here are some essential steps that can help prevent milk adulteration:

- 1. Stringent Quality Control Measures:** Governments should implement and enforce strict quality control measures for dairy products. Regular inspections and testing of milk samples can help detect and deter adulteration.
- 2. Public Awareness and Education:** Launching public awareness campaigns about the risks of milk adulteration and how consumers can identify adulterated milk can empower individuals to make informed choices.
- 3. Use of Technology:** Employing advanced testing technologies and rapid detection methods can enhance the ability to identify adulterants in milk more effectively.
- 4. Legal Penalties:** Implementing strong legal penalties and strict enforcement against those involved in milk adulteration can act as a deterrent.

5. **Encouraging Responsible Sourcing:** Encouraging consumers to purchase milk from reputable and trustworthy sources can promote responsible sourcing and reduce the risk of adulteration.
6. **Support for Dairy Farmers:** Providing support and incentives to dairy farmers can help improve their livelihoods and reduce the temptation to engage in adulteration practices.
7. **Traceability Systems:** Implementing traceability systems in the dairy industry can help track milk from farm to table, ensuring transparency and accountability throughout the supply chain.
8. **Encouraging Self-Testing:** Encouraging consumers to perform simple tests, such as purity tests or lactometer tests, at home to check for signs of milk adulteration can help in early detection.
9. **Collaboration between Stakeholders:** Collaborating between government authorities, dairy industry players, consumer organizations, and other stakeholders can lead to more effective strategies in combating milk adulteration.
10. **Consumer Reporting:** Encouraging consumers to report suspected cases of milk adulteration to relevant authorities can help in timely investigation and action.

Preventing milk adulteration is a shared responsibility, and addressing the issue requires a combination of regulatory measures, consumer awareness, and industry commitment to ensuring the quality and safety of milk and dairy products.

V. ADULTERATION OF MILK IN INDIA

Milk adulteration is a significant concern in various parts of India. While it's important to note that milk adulteration practices can change over time and can vary from region to region, some states in India have reported higher instances of milk adulteration compared to others. Some of the states that have been identified as having higher prevalence rates of milk adulteration include: Uttar Pradesh, Rajasthan, Bihar, Madhya Pradesh, Punjab, Haryana, West Bengal, and Tamil Nadu.

These states have consistently ranked among the regions with higher incidents of milk adulteration in various reports and studies. However, it is essential to remember that milk adulteration can occur in other states as well, and the situation may evolve over time due to the implementation of stricter regulations and awareness campaigns.

A study conducted in coastal districts of Andhra Pradesh had shown poor quality of milk samples collected from various collection centers. The random samples were collected and triplicates were maintained to obtain accurate results. All the milk samples have shown contaminants or adulterants and the results are as shown in the table given below.

| S.no | Collection Centre Name | Test Name | Results | S.no |
|------|--|-------------------------------|----------|----------|
| | | Starch | | negative |
| 1. | Collection Centre -1 | sugar | | negative |
| | | urea | positive | |
| | | salt | | negative |
| | | H ₂ O ₂ | | negative |
| | | detergent | | negative |
| | | formalin | | negative |
| | | starch | positive | |
| | | sugar | positive | |
| 2. | Collection Centre -2 | urea | | negative |
| | | salt | positive | |
| | | H ₂ O ₂ | | negative |
| | | detergent | | negative |
| | | formalin | | negative |
| | | starch | | negative |
| 3. | Collection Centre -3 | sugar | positive | |
| | | urea | | negative |
| | | salt | | negative |
| | | H ₂ O ₂ | | negative |
| | | detergent | | negative |
| | | formalin | | negative |
| | | starch | | negative |
| 4. | Collection Centre -4 | sugar | | negative |
| | | urea | | negative |
| | | salt | | negative |
| | | H ₂ O ₂ | | negative |
| | | detergent | | negative |
| | | formalin | | negative |
| | | starch | | negative |
| | | sugar | | negative |
| | | urea | | negative |
| 5. | Tirupati, Balaji Colony Collection Centre | salt | | negative |
| | | H ₂ O ₂ | | negative |
| | | detergent | | negative |
| | | formalin | | negative |
| | | starch | | Negative |
| | | sugar | | Negative |
| 6. | Reference Sample | urea | | Negative |
| | | salt | | Negative |

| | | | | |
|--|--|-------------------------------|--|----------|
| | | H ₂ O ₂ | | Negative |
| | | detergent | | Negative |
| | | formalin | | Negative |

VI. ADULTERATION TESTS FOR COLLECTED SAMPLES FROM COASTAL DISTRICTS OF ANDHRAPRADESH

To address milk adulteration effectively, authorities need to implement robust monitoring and enforcement measures across the entire country. Public awareness campaigns and consumer education are also vital in empowering consumers to recognize signs of adulteration and report suspicious activities to the appropriate authorities. Regular testing of milk samples and strict legal penalties for those involved in adulteration are essential steps in combating this issue.

VII. TECHNOLOGICAL ADVANCES IN TRACING MILK ADULTERATION

Several technologies have been developed and utilized to detect milk adulteration. These technologies aim to identify various adulterants and contaminants present in milk, ensuring its safety and quality. Some of the latest technologies used to find milk adulteration include:

1. **Fourier Transform Infrared Spectroscopy (FTIR):** FTIR is a rapid and non-destructive technique that analyzes the interaction of milk samples with infrared light. It can detect adulterants such as water, starch, and vegetable oils in milk.
2. **High-Performance Liquid Chromatography (HPLC):** HPLC is a powerful analytical technique used to separate, identify, and quantify individual components in a milk sample. It can detect adulterants like synthetic milk proteins and sugars.
3. **Polymerase Chain Reaction (PCR):** PCR is a molecular biology technique used to amplify and identify specific DNA sequences. It can help detect the presence of foreign DNA from contaminants or non-dairy substances in milk.
4. **Enzyme-Linked Immunosorbent Assay (ELISA):** ELISA is an immunological technique used to detect specific proteins or antigens in a milk sample. It can be used to identify milk proteins and other adulterants.
5. **Ultra-High-Performance Liquid Chromatography (UHPLC):** UHPLC is an advanced version of HPLC that provides higher resolution and faster analysis, making it more suitable for routine milk adulteration testing.
6. **Real-Time Polymerase Chain Reaction (qPCR):** qPCR is a variation of PCR that enables real-time monitoring of the amplification process. It is commonly used to detect and quantify pathogens or contaminants in milk.
7. **Isotope Ratio Mass Spectrometry (IRMS):** IRMS is used to measure the isotopic composition of elements in a sample. It can help identify the addition of water, whey, or other substances in milk.

8. **Nuclear Magnetic Resonance (NMR) Spectroscopy:** NMR spectroscopy provides detailed information about the molecular composition of a milk sample, helping to identify adulterants and contaminants.
9. **Near-Infrared Spectroscopy (NIR):** NIR is a rapid and non-destructive technique that measures the interaction of milk with near-infrared light. It can detect changes in milk composition and identify adulterants.

These technologies are continuously evolving and becoming more accessible for routine use in food testing laboratories. Combining multiple testing methods can enhance the accuracy and reliability of milk adulteration detection. Regular testing and monitoring using these technologies are crucial to maintaining the quality and safety of milk and dairy products in the market.

VIII. REGULATORY AUTHORITIES MONITORING MILK ADULTERATION

In India, multiple authorities are involved in monitoring and regulating milk adulteration to ensure the safety and quality of milk and dairy products. Some of the key authorities responsible for monitoring milk adulteration include:

1. **Food Safety and Standards Authority of India (FSSAI):** FSSAI is the central regulatory authority responsible for setting standards and regulations related to food safety in India. FSSAI plays a crucial role in monitoring and controlling milk adulteration by setting maximum limits for various adulterants and contaminants in milk.
2. **State Food Safety Departments:** Each state in India has its own Food Safety Department responsible for implementing food safety regulations within their respective jurisdictions. State food safety departments carry out inspections, sampling, and testing of milk products to ensure compliance with quality standards.
3. **Bureau of Indian Standards (BIS):** BIS is a national standard-setting body that formulates and promotes the adoption of Indian Standards (IS) for various products, including milk and dairy products. BIS plays a significant role in setting quality standards for milk and dairy products.
4. **State Dairy Development Boards:** State Dairy Development Boards and corporations are responsible for promoting dairy development and ensuring the quality of milk and dairy products within their states.
5. **Food Testing Laboratories:** Various food testing laboratories across the country, both government-run and private, conduct tests to identify and quantify adulterants and contaminants in milk samples.
6. **Consumer Awareness and Grievance Cells:** Apart from regulatory bodies, consumer awareness and grievance cells are set up to educate consumers about milk adulteration and provide a platform for reporting complaints related to food safety and adulteration issues.

- 7. Police and Law Enforcement Agencies:** In cases of suspected adulteration or violations of food safety laws, local police and law enforcement agencies assist in investigations and take appropriate legal actions.

These authorities work together to conduct regular inspections, sampling, and testing of milk and dairy products at various stages of the supply chain to ensure that only safe and quality milk reaches consumers. They also conduct awareness campaigns to educate consumers about the risks of milk adulteration and how to identify and report adulterated milk. Continuous monitoring and strict enforcement of food safety regulations are essential to combat milk adulteration effectively.

IX. CONCLUSION

The milk quality assessment is done on the basis of physico-chemical and microbiological properties. The milk samples' analysis should be done for detection of pathogens, and various adulterants in milk samples. The milk quality assessment is usually carried out by methods prescribed by FSSAI. The quality of milk samples is determined by comparing with the standard values recommended by FSSAI. Some of the research results have shown poor quality of the milk. So, the utmost importance should be given to quality over self gains keeping the aspect of public health for building health society in future generations.

REFERENCE

- [1] Bushra Iftikhar Samina Siddiqui and ShafiqurRehman. Assessment of the dietary transfer of pesticides to dairy milk and its effect on human health. (2014). *African journal of Biotechnology*, Vol. 13(3), pp. 476-485, 15 January, 2014 DOI: 10.5897/AJB2013.1199,7ISSN 1684-5315. Academic Journals <http://www.academicjournals.org/AJB>
- [2] Fagnani, R.; Beloti, B.; Battaglini, A. P. P. Tamanini, R.; Dunga, K. D. S. (2011). Organophosphorus and carbamates residues in milk and feedstuff supplied to dairy cattle. *Pesquisa Veterinária Brasileira, Rio de Janeiro*, v. 7, n. 31, p. 598-602.
- [3] Fikrineh N, Estefanos T and Tatek W (2012). Microbial quality and chemical composition of raw milk in the Mid-Rift Valley of Ethiopia. *Afri. J. Agric. Res.* 7(29): 4167-4170.
- [4] Handford CE, Campbell K, Elliott CT. Impacts of Milk Fraud on Food Safety and Nutrition with Special Emphasis on Developing Countries. *Compr Rev Food Sci Food Saf.* 2016 Jan;15(1):130-142. doi: 10.1111/1541-4337.12181. Epub 2015 Nov 2. PMID: 33371582.
- [5] Tanu Palsra*, SK Khurana and BG Mane; Milk Adulteration and Its Impact on Consumer Health: A Review; *Journal of Food Research and Technology* | January-March, 2019 | Volume 07 | Issue 01 | Pages 04-08 © 2019 Jakraya.
- [6] Tolcha Techane. (2023). Effect of Adulterants on Quality and Safety of Cow Milk: A Review. *Int J Diabetes MetabDisord*, 8(1), 277-287.
- [7] Rupak Nagraik, Avinash Sharma, Deepak Kumar, Prince Chawla, Avvaru Praveen Kumar, Milk adulterant detection: Conventional and biosensor based approaches: A review, *Sensing and Bio-Sensing Research*, Volume 33, 2021, 100433, ISSN 2214-1804, <https://doi.org/10.1016/j.sbsr.2021.100433>.
- [8] Mohit Kamthania, Jyoti Saxena, Komal Saxena, D.K. Sharma, Milk Adultration: Methods of Detection & Remedial Measures, National Conference on Synergetic Trends in engineering and Technology (STET-2014) *International Journal of Engineering and Technical Research* ISSN: 2321-0869, Special Issue.
- [9] Riya Chugh and Gurmeet Kaur 2022 *IOP Conf. Ser.: Mater. Sci. Eng.* 1225 012046 DOI 10.1088/1757-899X/1225/1/012046
- [10] Azad, T., Ahmed, S. Common milk adulteration and their detection techniques. *Food Contamination* 3, 22 (2016). <https://doi.org/10.1186/s40550-016-0045-3>.

- [11] https://www.business-standard.com/india-news/food-regulator-to-conduct-nationwide-milk-surveillance-to-curb-adulteration-123052500399_1.html
- [12] <https://www.sconline.com/blog/post/2023/03/06/food-safety-and-standards-authority-of-india-fssai-directed-states-union-territories-to-deploy-food-safety-on-wheels-fsw-mobile-food-testing-vans-to-check-adulteration-of-milk-and-milk-products-consi/>
- [13] Kumar, Arun & GOYAL, S. & Pradhan, Rama & Goyal, Ramesh. (2015). A Study on Status of Milk Adulterants using in Milk of District Varanasi. *South Asian J. Food Technol. Environ.* 1. 140-143. 10.46370/sajfte.2015.v01i02.07.
- [14] Anitha, Layam & SaiBramari, Gannavarapu & Naidu, Kalla. (2020). A STUDY ON ADULTERANTS OF MILK OF SELECTED COASTAL DISTRICTS OF ANDHRA PRADESH. *Journal of Bio Innovation.* 9. 1407-1419. 10.46344/JBINO.2020.v09i06.27.
- [15] Tiwari, Vijay & Bandopdhyay, Anis & M.Bhattacharya, & Raj T.P, Sherin & Nair, Kesavan. (2013). An Assessment and Awareness about adulteration in Milk and Milk Products and its Effect on Human Health in Delhi, *International Journal of Food Safety, Nutrition, Public Health and Technology* (2013), Volume 5, Issue 1, Page(s):1-7.. *International Journal of Food Safety, Nutrition, Public Health and Technology.* 5. 1-7.
- [16] Chauhan, Sneha & Mandal, Debnath & Rudra Paul, Babul & Maji, Chinmoy. (2019). Adulteration of milk: A Review. 2055-2057.