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Adulteration of milk and its health hazards on community testing purity and its evaluation

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Abstract

Milk is one of the most popular and nutritionally beneficial foods in the world, supplying vital nutrients such as proteins, lipids, vitamins, and minerals. But milk adulteration has become a major worldwide concern, particularly in poorer nations where quality control is frequently inadequate. Intentional introduction of chemicals such as water, starch, urea, detergents, formaldehyde, and chemical preservatives to increase volume or extend shelf life is considered adulteration. Sometimes, hormones like oxytocin are illegally administered to dairy animals to boost milk output, which results in hormone residues in the milk. In addition to lowering milk's nutritional content, these behaviors also have major health consequences for the population at large, especially youngsters, expectant moms, and older people.

Keywords: Milk Adulteration; Food Adulteration; Synthetic Milk; Contaminants in Milk; Chemical Adulterants; Physical Adulterants

1. Introduction

Because it is a good source of high-quality proteins, fats, carbohydrates, vitamins, and minerals, milk in its natural state has great nutritional value (Neumann et al., 2000). al. 2002). Because it is easily digested, it is easily absorbed and is particularly beneficial for babies, nursing mothers, youngsters, and the elderly. Milk proteins also provide amino acids necessary for the healthy development of adults and children (Afzal et al. 2011). If, however, it is tainted, it is not only of lower quality and a financial burden to the user, but it can also be harmful to consumers.

For example, if someone with a cow's milk allergy consumes ovine or caprine milk that has been adulterated with cow's milk or whey, they may experience serious symptoms (Pesicet al. 2011.9 [{1}] Milk is consumed by people of all ages in rural areas as well as being the finest and least expensive source of nourishment. similar to cities. It provides a respectable quantity of fat and protein as well as body.producing vitamins as well as lactose, which provides energy, and other essential nutrients. As a result, milk is a great food for pregnant women and babies since it gives the body the nutrients it needs.maintain the body's health and normal development. Milk and dairy items have been tampered with. brought severe risk to human health as well as significant financial losses to the food A depreciatory word for an ingredient present in other materials is an adulterant.even if it is prohibited for legal or other reasons. Considering the various kinds of milk may contain contaminants like melamine, urea, antibiotics, sugar/salt, and other substances. Each requires a fast, affordable, high-throughput, and widely accessible detection method.of the elements in milk simultaneously (Abdul et al., 2004) [{2}]

The deliberate lowering of the quality of food for sale through any of the following means constitutes milk adulteration:

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through the replacement of some vital elements or the introduction of foreign compounds. Milk utilized by the milk consumed by the public is either adulterated or has had some of its vital components removed. so contaminated that it has little nutritional value and may even be harmful to the general population health. In milk and milk products, the most common adulterants are water, fat removal, redevelopment of milk, inclusion of skim milk powder, thickening ingredients such as starch, flour, glucose, urea, salt, chlorine, etc. (Kumar et al., 2015).

- The reason why milk is adulterated is to increase its volume before adding starch and other redeveloped milk.
- The viscosity is increased by adding powders (Das et al., 2015).
- The majority of our diet consists of milk and dairy products, and a significant amount of our food is consumed there. milk and milk-based products (Maurya et al., 2017).
- Milk adulteration is a social problem. It can be found in both developed and developing nations.
- The food industry is extremely concerned about the severe health consequences of eating adulterated milk.
- The most frequent adulterants discovered in milk are chlorine, hydrated lime, sodium carbonate, and starch.
- ammonium sulfate and formaldehyde. The nutritional content of unprocessed milk is considerable. It provides essential nutrients such as
- The average amount of vitamins, minerals, carbohydrates, lipids, and proteins, all in a readily digestible form (Swathi) Kauser and 2015).{3}

1.1. Adulteration

Refers to anything that is currently used or may be used to make food that is unsafe, of poor quality, mislabeled, or contaminated. The most prevalent the milk contains a number of chemical adulterants, including starch, chlorine, sodium carbonate, formalin, and ammonium sulfate. These adulterants include urea, starch, flour, detergent, and others. in the milk to raise profit margins. {4}

2. Different kinds of milk adulteration

2.1. Water Dilution

The most popular and easiest adulteration is the addition of water. The proportion of all milk components (fat, protein, solids-not-fat, etc.) is lowered.

2.2. Fat Removal / Partial Skimming

Milk is occasionally skimmed (fat removed) or partially skimmed, then sold or combined as whole milk. This lowers the fat content, altering its nutritional worth.

2.3. Introduction of Foreign or Plant Proteins

Soy, pea, almond, or other non-milk proteins can be added from less expensive sources to replicate protein level. Additionally, combining milk from various species (such as cows, goats, and buffalo) to make money.

2.4. Compounds of nitrogen that are not proteins (such as urea and melamine)

These are used to artificially increase protein measurements, which frequently depend on nitrogen levels. Urea and melamine are typical. These pose a risk to one's health.

2.5. Chemical Neutralizers and Preservatives

Formalin (formaldehyde), boric acid, hydrogen peroxide, and other chemicals can be added to extend shelf life or prevent spoilage. Acidity is neutralized and coagulation is prevented using neutralizers like sodium bicarbonate and sodium hydroxide.

2.6. Solids, Fillers, and Carbohydrates Added:

Substances such as starch, sucrose, maltodextrin, glucose, and salt are added to increase thickness or density or to conceal dilution (for example, in order to deceive density or lactometer tests.{5}

2.7. Reasons for adulteration

The gap between supply and demand is exacerbated throughout the summer as a result of higher demand and lower milk production.

- Milk's Physical Properties: Milk's watery and opaque nature allows for the addition of several contaminants.
- Decayed Moral Society: Ruined moral standing combined with a desire for financial gain.
- A spoiled socioeconomic structure: People from low-income backgrounds participate in the business in order to improve their financial situation and social standing.
- Milk's Perishable Nature: In order to increase the shelf life of subpar milk, unethical manufacturers/traders employ preservatives, neutralizers, and other methods.
- Weak Customer Buying Power: It induces the provider to dilute the milk and offer it at a lower price.
- Unorganized State of the Dairy Sector: The majority of the milk is acquired and marketed by unregulated dairies, which are free to mix the milk.
- Insufficient, quick, and reliable testing: There are no public analytical laboratories where consumers may have their samples analyzed. .{6}

3. Side effect of oxytocin adulterated milk on human health

The posterior pituitary gland releases oxytocin, a hormone that is found mostly in mammals. The injection used to induce milk in Oxytocin may be found in cows and buffalo. oxytocin is a hormone that regulates milk production and expulsion. Oxytocin usage is still widespread throughout Indian towns, and its use should be regulated. Dairy farm. Farmers may readily obtain oxytocin injections from pharmacies without a veterinarian's prescription. However, the Indian government has outlawed the usage of oxytocin injections on Prevention of Cruelty to Animals Act and Food and Drug Adulteration Prevention Act, 1960.

A little bit of the hormone is released into the milk when cows or buffalos are given an oxytocin injection. In addition, milk is oxytocin-contaminated in men. The following adverse effects of this hormone may occur in men, women, and developing children: • heart diseases, such as cardiac arrhythmia, high or low blood pressure, etc. lowers blood pressure, premature ventricular contraction, etc.

- Kidney ailments.
- Losing an eye.
- Memory loss.{7}

3.1.1. Effect of human health

- Hormone imbalance: The hormone has the potential to upset the hormonal balance in both sexes.
- Cardiovascular problems: It can cause heart conditions like cardiac arrhythmia, as well as high or low blood pressure.
- Kidney issues: Drinking adulterated milk can lead to kidney diseases.
- Effects on the brain and development: Research indicates that it can result in memory loss and, in youngsters, can cause early puberty, gynecomastia (breast enlargement in boys), hearing loss, and visual issues.
- Reproductive health: It might raise the chance of miscarriage in pregnant women. Additionally, it may result in maternal hemorrhage following childbirth and in newborns, it may result in birth abnormalities or weakened immunity.

3.1.2. Impacts on animal

- Reduced lifespan: Regular oxytocin use in dairy animals might shorten their lifespan.
- Reproductive system damage: It may harm the reproductive system of buffaloes and cattle.
- Additional problems: Over time, it may result in slowed growth and a drop in total milk output {8}

3.2. Milk testing and purity

3.2.1. Starch Detection

To make milk thicker and harder to detect added water, starch, cereal flours, or arrowroot are used. The starch-iodide test reveals its presence. In a test tube, 3 mL of well-mixed sample is collected. It is heated to a boil over flame, then brought to room temperature. A drop of iodine solution at 1% concentration is then added and combined. The presence of starch is indicated by the look of blue hue, which vanishes upon boiling and returns upon cooling.

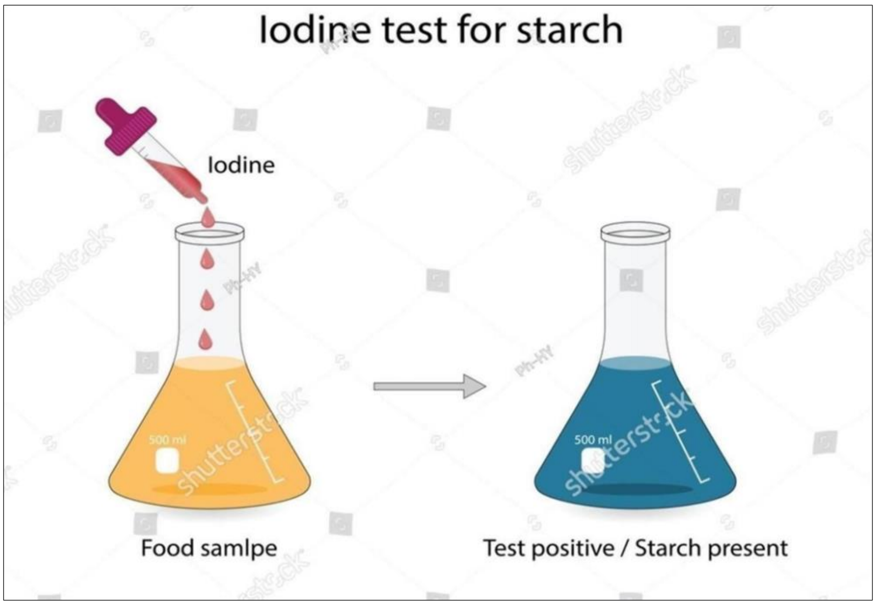

Figure 1 Iodine Test

3.3. Finding Artificial Milk

In a test tube, combine 5 ml of milk with 0.2 ml of urease (at a concentration of 20 mg/ml). Mix thoroughly, then add 0.1 ml of BTB. The presence of artificial milk is indicated by the dark blue hue of the solution (0.5%). The procedures for detecting urea and artificial milk are identical; the The only distinction is the presence of a dark blue hue in synthetic milk.

3.4. Milk Detergent Detection

Place 5 ml in a test tube and add 0.1 ml of a 0.5% Bromocresol Purple (BCP) solution. The presence of detergent is indicated by the violet color. Only a trace of violet can be seen in unadulterated, genuine milk

3.4.1. Urea

Add half teaspoon of soybean or arhar powder in a Put a teaspoon of milk in a test tube and stir it up. By giving the test tube, a good shake. Dip a red litmus paper changes color from red to after half a minute. Urea in milk is indicated by the color blue

3.5. Melamine Detection

Prior to the melamine incident, food legislation had not established a limit for melamine, which is not a food component or an allowed addition. In 2008, there were reports of contamination in China. {9}

3.5.1. Lactometer test

Milk is frequently adulterated by farmers, milk traders, transporters, and stores in order to boost their earnings. Although it is a prevalent issue, it can be quickly remedied. The density of milk was measured using a lactometer, which is a tool used for this purpose. The density of pure milk ranges from 1.026 to 1.032 grams per milliliter, depending on the specific gravity. The density is altered by the inclusion of water or other ingredients. The addition of solids greatly raises the density, whereas water lowers it. The milk has been tampered with if the density falls outside the usual range. The alcohol test is more accurate than the COB test.

3.6. Lactometer trial

Farmers, milk traders, transporters and retailers frequently add adding water and other ingredients to milk to enhance its earnings. It's a typical issue, but it can be solved quickly. The lactometer is an instrument used for testing. in order to determine the density of milk. Milk that is unadulterated has a density. (specific gravity) ranging from 1.026 to 1.032 grams per milliliter. Water or other compounds may be added to alter the density. The density is decreased when water is added, whereas The density increases significantly when solids are added. If The milk has an abnormal density, which indicates that it is is contaminated. Alcohol tests are more receptive over the COB test

Figure 2 Lactometer

3.6.1. Procedure

Make sure the milk is approximately 20°C first. Hot milk should be allowed to cool at room temperature. for a minimum of 30 minutes. Warm the milk to 40°C if it was refrigerated below 10°C, then lower it to 20°C. Mix. the milk sample, and gently pour around 200 ml into a measuring cylinder. Slowly immerse the lactometer in the milk and leave it. The milk will now settle a little bit before coming to a halt. Just above the milk, read the lactometer reading. milk's surface. Lactometers are used to determine the chemical makeup of milk, including total solids percentage (% TS) and solids non-fat (SNF). The Butyrometer test (also known as the Gerber butterfat test) can be used in conjunction with the findings.[10]

3.7. Spectroscopy

Figure 3 Spectroscopy

Near-infrared spectroscopy, a molecular absorption/reflection spectrometry, is a comparatively quick technique that is employed in QC/QA and process analysis. NIR spectroscopy combined with two statistical techniques was used: first, discriminant PLS, and second, SIMCA in an try to identify water and whey as contaminants in milk. They discovered that the DPLS approach produced superior results. better categorization outcomes than the SIMCA technique. As previously stated The four wavelength ranges and three pretreatments were discussed earlier. the spectral techniques used in the creation of the PLS model for the Water detection was assessed. The quantitative analysis was conducted using the following method: the PLS model, which was developed using milk whey analysis pretreated spectra in the combination regions of MSC With an error limit of 0.244% (g/v), the wavelength ranges of 1100–1850 nm and 2048–2500 nm were shown to produce outstanding results.

Derivative is an additional spectroscopic technique. The existence of may also be determined using spectroscopy. when in milk and milk powders (Meisel 1995). By improving the resolution of small spectral signals, this approach was successful. has characteristics in the typical UV spectrum that allows for separation separate signals from the aromatic amino acids. The tryptophan/tyrosine ratio was determined to be approximately 0.59. because whey proteins have a value of 0.19 and caseins have a value of 0.19, this was taken advantage of Peng and Puhan's (1999) method for identifying whey in milk.The approach was somewhat altered by Miralles et al. (2000). Meisel (1995) employed the fourth-derivative UV spectroscopy technique to evaluate the quality of various kinds of. milk. All milk samples underwent skimming to prevent interference. The skim milk was diluted using the measurement. guanidine-HCl buffer. This study was able to identify UHT milk adulteration greater than 5% regardless of the raw milk's bacterial counts and storage period. In every instance, adulteration was observed at levels over 5%. UV spectra of milk and reference samples were included in these investigations. against a buffer-like guanidine-HCl buffer, they were recorded. calculating the fourth derivative using a spectrophotometer.

3.8. Sandwich ELISA technique

The enzyme-linked immune-sorbent assay approach comprises the identification of the complex between the target protein and specific monoclonal or polyclonal antibodies, which allows for both. the quantitative and qualitative identification of that protein. The distinct casein fractions, peptide, and whey proteins ELISA can be used to identify pieces of caseins. The sandwich ELISA approach has been successfully linked to the identifying GMP as a sign of contamination in raw materials Using polyclonal and anti-milk with liquid cheese whey GMP antibodies (Chavez et al. 2012). The assay measures GMP in The TCA- treated sample was identified via conjugation with first with rabbit anti-GMP antibodies, then with biotinylated (A molecule such as protein or nucleic acid has had biotin covalently attached to it.) secondary antibodies. Delayed rabbit antiGMP antibodies. This entire complex was then was found by generating a colored substance, which was caused by a substrate response to HRP-avidin(horseradish perox-idase and avidin) The technique may be used to with which to identify the presence of 0.047% cheese whey in milk. with a quantification limit of 0.14% (v/v) and no cross- interaction with other ingredients in raw milk or food. The system Having a high degree of reproducibility, the tem was discovered to be reproducible precision .[11]

Figure 4 ELISA kit

4. Conclusion

Milk adulteration has become a serious public health issue affecting the quality, safety, and nutritional value of one of the most essential food items in daily life. The addition of substances such as water, detergents, starch, urea, formalin, and synthetic milk components not only reduces milk's nutritive value but also poses severe health hazards to the community. Regular consumption of adulterated milk can lead to gastrointestinal disorders, kidney damage, food poisoning, and even long-term diseases. Testing the purity of milk using simple chemical and physical evaluation methods—such as lactometer tests, clot-on-boiling tests, and detection of specific adulterants—helps identify contamination and ensures consumer safety. Awareness among consumers, strict quality control, regular monitoring, and enforcement of food safety laws are essential to prevent adulteration practices.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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