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Comparative Study Of Packed And Unpacked Milk For Common Adulteration Using Various Detection Techniques

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Abstract: Milk adulteration poses a significant global public health threat, particularly in regions with limited regulatory frameworks.[1,2] This study presents a comparative analysis of packed and unpacked milk samples to identify common adulterants and evaluate detection methodologies. Using a series of rapid qualitative tests, various edible adulterants (starch, glucose, and common salt) and hazardous chemicals (urea, detergents, and artificial coloring agents) were analyzed. The findings indicate that adulteration is prevalent in both packed and unpacked milk, with potential health implications, including gastrointestinal, renal, and cardiovascular disorders.[3] This research underscores the critical need for consumer education, stringent regulatory enforcement, and the adoption of simple yet effective detection techniques to safeguard the quality and safety of milk.

Index Terms – Milk,Adulteration,Chemicals

I. INTRODUCTION

Milk, a nutrient-dense secretion from mammals, is a dietary staple and a vital source of nutrition for all age groups.[2] It provides a balanced profile of macronutrients (proteins, fats, and carbohydrates) and essential micronutrients (calcium, magnesium, and vitamins) crucial for growth and health maintenance. Despite its nutritional significance, milk has become increasingly vulnerable to contamination and adulteration.[1] Rapid urbanization, coupled with high demand and insufficient supply, has created an environment conducive to unethical practices within the milk industry.[2] In developing nations with weak regulatory oversight, vendors and processors often resort to diluting milk or introducing foreign substances to increase volume, enhance appearance, or extend shelf life.[3]

A wide array of adulterants is used, ranging from common, low-cost fillers to hazardous chemicals.[1,2] Common adulterants include starch, sodium carbonate, and formalin, which are used to mimic milk's physical properties or prevent spoilage.[1] More dangerous substances such as urea, detergents, and artificial coloring agents are also employed, posing severe risks to human health.[2,3] The consumption of adulterated milk can lead to a spectrum of health issues, including gastrointestinal disorders, kidney damage, eye irritation, heart complications, and endocrine disruption.[2,3] These health risks are particularly acute for vulnerable populations such as infants, children, and the elderly. Beyond health concerns, milk adulteration erodes public trust in the food supply chain and undermines national food security.[1,2]

Addressing this problem requires a multifaceted approach, including the implementation of stringent regulatory policies, enhanced enforcement mechanisms, and standardized testing protocols.[1,2] Public awareness campaigns are also essential to empower consumers.[1] Furthermore, scientific innovation in the form of low-cost, rapid, and reliable detection techniques can play a transformative role in identifying adulterants at both the consumer and industry levels.[3] The objective of this study is to perform a comparative analysis of adulteration in packed and unpacked milk samples using a range of qualitative detection methods.

II. RESEARCH METHODOLOGY

Milk Samples:
Fresh packed & unpacked market milk was collected in sterile containers and analyzed within 24 hours of collection.

Glassware & Equipment:
The study utilized standard laboratory glassware and equipment, including 10 mL test tubes, 1 and 5 mL graduated pipettes, watch glasses, a water bath, a boiling water bath, test tube holders, a thermometer, beakers, glass rods, and turmeric paper strips.

Reagents and Chemicals:
All reagents were of analytical grade and prepared freshly before use. These included concentrated hydrochloric acid (HCl), concentrated sulfuric acid (H_2SO_4), resorcinol (0.1 g), modified Barfoed's reagent, phosphomolybdic acid reagent, 0.1 N silver nitrate solution, 10% potassium chromate solution, 1% iodine solution, potassium iodide–starch reagent, and ferric chloride (trace for formalin test and 0.5% solution for benzoic/salicylic acid test).

Analytical Procedures:
Milk samples were subjected to a series of qualitative tests for common adulterants based on standard protocols with minor modifications.[1],[2],[4]

• **Detection of Added Sugar:** Five mL of milk were mixed with 1 mL of concentrated HCl and 0.1 g of resorcinol.[4] The mixture was heated in a water bath for 5 minutes. A red color indicated the presence of added sugar.

• **Detection of Starch:** Three mL of milk were boiled, cooled, and treated with one drop of 1% iodine solution. The formation of a blue color confirmed starch adulteration.

• **Detection of Glucose:** One mL of milk was combined with 1 mL of modified Barfoed's reagent and heated for 3 minutes in a boiling water bath. After rapid cooling, 1 mL of phosphomolybdic acid reagent was added. A deep blue color confirmed the presence of glucose.

• **Detection of Common Salt:** Five mL of milk were treated with 1 mL of 0.1 N silver nitrate, mixed, and then 0.5 mL of 10% potassium chromate solution was added. A yellow color indicated added salt, while a brick-red color indicated its absence.

• **Detection of Formalin:** Ten mL of milk were carefully overlaid with 5 mL of concentrated H_2SO_4 containing a trace of ferric chloride. A violet or blue ring at the interface indicated formalin.[5]

• **Detection of Benzoic Acid and Salicylic Acid:** Five mL of milk were acidified with concentrated H_2SO_4 and 0.5% ferric chloride solution was added dropwise. A buff color confirmed benzoic acid, and a violet color indicated salicylic acid.[3],[6]

• **Detection of Borax and Boric Acid:** Five mL of milk were mixed with 1 mL of concentrated HCl. A turmeric paper strip was immersed in the mixture, removed, and dried at 100 °C. A red coloration of the paper confirmed the presence of borax or boric acid.

• **Detection of Coloring Matter (Azo Dye):** A few drops of HCl were added directly to a milk sample. A pink color upon acidification indicated the presence of azo dyes.

III. RESULTS AND DISCUSSION

Table 1: Adulterant Detection in Milk Samples

Adulterant	Unpacked Milk	Packed Milk
Glucose	–	+
Starch	–	–
Common Salt	+	–
Hydrogen Peroxide	–	–
Urea	–	–
Benzoic Acid & Salicylic Acid	+	–
Borax	–	–
Detergent	–	–
Coloring Agent	–	–

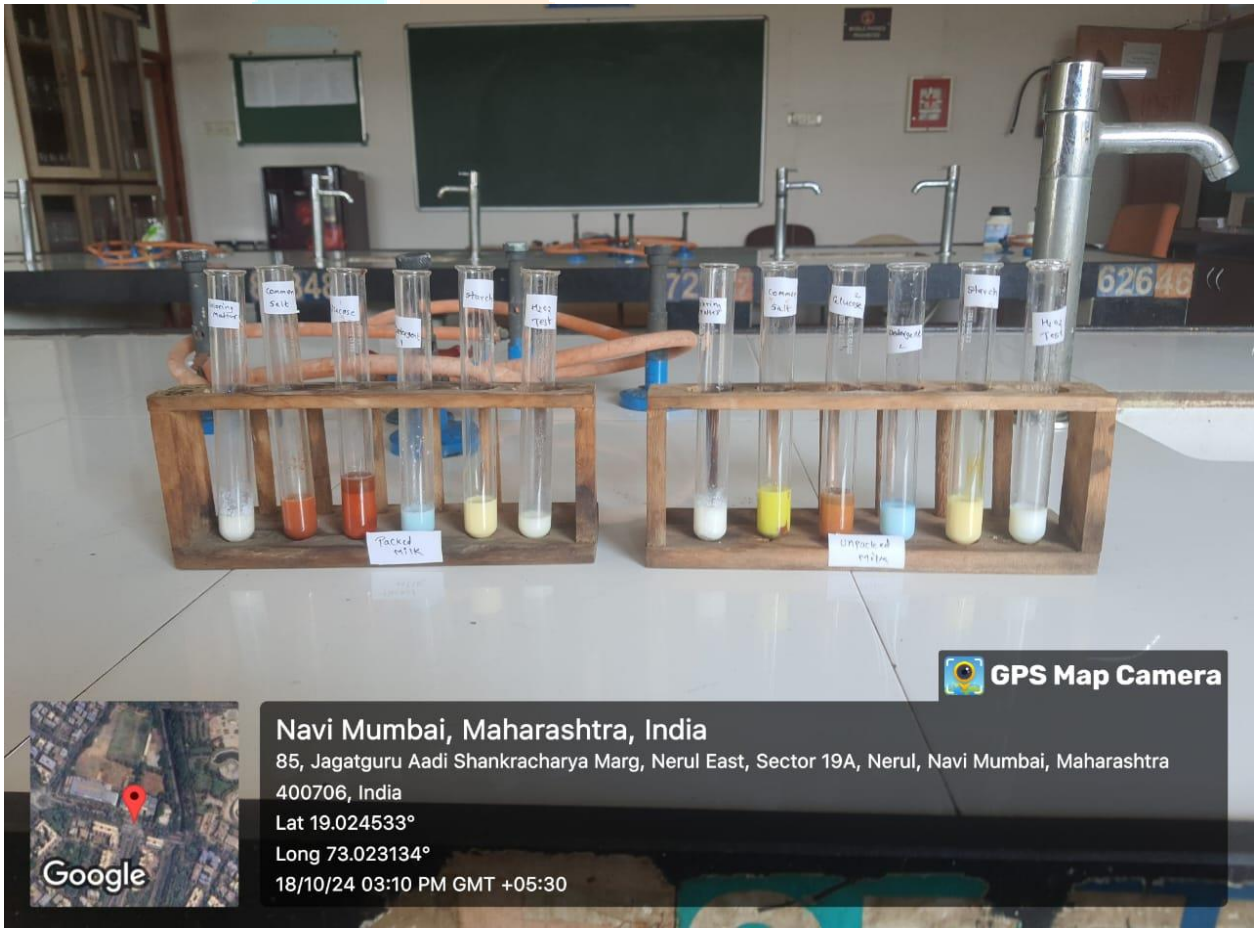

Figure 1. Qualitative detection of adulterants in packed and unpacked milk samples.

Glucose: Glucose was detected exclusively in the packed milk sample. This finding suggests that it may have been added during industrial processing, likely to enhance taste or to mask a lower milk-fat content.[1,2]

Common Salt: Common salt was found only in the unpacked milk sample. Its presence is likely a common practice by local vendors to increase the density and perceived richness of the milk, particularly after dilution with water.[2]

Benzoic Acid & Salicylic Acid: These preservatives were detected only in the unpacked milk. Their use is indicative of a lack of refrigeration and a need to extend shelf life through informal, unregulated means.[3],[6]

Other Adulterants: Starch, hydrogen peroxide, urea, borax, detergent, and coloring agents were not detected in either milk sample.

Comparison: The comparative analysis reveals that unpacked milk is more susceptible to a wider range of adulterants, particularly those used to alter its physical properties (salt) or extend its shelf life without refrigeration (benzoic and salicylic acids). Conversely, packed milk, while not free from adulteration, showed a narrower range of contaminants, likely due to a more controlled industrial processing environment subject to some form of quality control and regulation.[1],[2]

Health and Safety Implications: The presence of benzoic and salicylic acids in unpacked milk poses significant long-term health risks, including potential gastrointestinal issues and allergic reactions.[3],[6] The widespread use of such unregulated preservatives highlights a serious public health concern, particularly for vulnerable consumers who rely on milk as a primary source of nutrition.

Need for Consumer Awareness and Regulatory Oversight: This study underscores the urgent need for a multi-pronged approach to combat milk adulteration. This includes: (1) increased consumer education regarding the risks of adulterated milk and the importance of using safe sources; (2) the development and widespread availability of simple, affordable detection kits for consumer use; and (3) stricter enforcement of food safety standards by regulatory authorities to monitor both production and distribution channels.[1],[2]

Conclusion

Milk is a cornerstone of human nutrition, but its quality is significantly compromised by adulteration. This study demonstrates that both packed and unpacked milk can contain adulterants, posing a serious threat to public health. While packed milk showed fewer types of adulteration, unpacked milk was found to contain hazardous preservatives. Ensuring milk safety requires a collaborative effort among government agencies, scientific institutions, and consumers. Strengthening food safety regulations, promoting advanced detection technologies, and fostering public awareness are critical steps toward maintaining the integrity, quality, and safety of the milk supply.[1],[2],[3]

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