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Review

## Assessment of raw milk and skimmed milk through analytical parameters



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	<b>Abstract</b>
Published on: 30 Dec 2024	<p>Milk, a cornerstone of global nutrition, plays a vital role in human diets due to its rich nutritional profile. Quality assurance of milk, whether raw or skimmed, is critical for ensuring public health and meeting regulatory standards. This review provides a detailed examination of the key parameters for assessing milk quality, focusing on physical, chemical, microbiological, and nutritional aspects. Advanced analytical techniques and their relevance in modern dairy science are discussed, emphasizing their application in detecting adulteration, ensuring safety, and meeting consumer demands. Through an in-depth exploration of each parameter, this article underscores the importance of milk quality assessment in the dairy industry.</p>
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## INTRODUCTION

Raw milk provides a multitude of nutrients, making it the perfect food for infants and adults. [1] It is also considered a complete meal because it includes almost all the nutrients, such as protein, carbohydrates, fats, vitamins, and minerals. A healthy cow, buffalo, goat, or sheep's udders produce this natural, pure, and clean secretion. Pasteurized milk and raw (fresh) milk are also available [2]. Typical features evaluated to evaluate milk quality include conductivity, total solids, protein content, freezing point, pH, fat percentage, SNF (solid not fat) percentage, organoleptic tests, and lactose [3]. The composition of milk is influenced by the environment, the genetic and dietary status of the animals, and the stage of lactation. Generally, milk contains 87.00% water, 4.00% to 5.00% lactose, 3.00% protein, lipids, 3.00% to 4.00% minerals, and 0.10% vitamins [4]. Around 42% of cow milk is produced in South Asia, compared to 80–83% globally. While buffalo milk accounts for 13% of global

milk consumption, it accounts for about 24% in poor countries, with the remainder coming from goat, sheep, and camel milk [5].

747 million tons of milk were produced in developing countries in 2013. With Asia accounting for 378 million tons and Pakistan for 57,722 thousand tons, the total amount of milk produced worldwide has risen to 906 million tons. Pre-urban areas produce 15% of milk, fully urban areas produce 5%, and rural areas generate about 80% of milk [6]. Presently, there are over 67,000,000 cattle, buffalo, 89,000,000,000 sheep, 0.20,000,000 camels, and other animals in Pakistan. Pakistan is endowed with high-yielding genetic dairy animals, such as Beetle goats, Kajli sheep, Sahiwal cows, and Nilli/Ravi buffaloes. Because of heat stress and a shortage of food, milk production is drastically reduced during the summer months [7].

The type of technology used to analyze milk is influenced by the type of adulterants present, as milk fraud asserts that conventional detection methods are ineffective and that systems for detecting milk adulteration need to be extremely specialized and quick [8]. Adulterants are introduced to milk for profit or to cover up the harmful consequences of unsanitary production, storage, shipping, and marketing conditions. Dishonest milk producers dilute milk, eliminate necessary ingredients like cream and fat, and add cheap additions to balance the milk's qualitative qualities [9].

Formalin, hydrogen peroxide, salicylic acid, and benzoic acid are used to prolong the shelf life of milk, urea is added to milk to increase its nonprotein nitrogen content and SNF (solid not fat), melamine is added to milk to increase its protein content, and vegetable oil is used to preserve milk fat for financial gain [10,11].

### **The Importance of Milk Quality Assessment**

Milk is an essential dietary component for billions of people worldwide, offering a unique combination of macronutrients, vitamins, and minerals. As a perishable commodity, milk is highly susceptible to contamination, adulteration, and spoilage, making rigorous quality assessment imperative. Raw milk, often consumed directly or used as a base for other dairy products, contains natural fats, proteins, and minerals but is prone to microbial contamination. Skimmed milk, with its reduced fat content, caters to health-conscious consumers and dietary restrictions. The composition and safety of these milk types are critical, especially with the growing demand for high-quality dairy products globally. This article delves into the core parameters used to evaluate raw and skimmed milk, offering a framework for understanding the scientific, nutritional, and technological factors that influence milk quality.

### **Physical parameters of milk quality**

Physical parameters are the first line of assessment for milk quality, providing quick insights into its condition. These characteristics include color, odor, consistency, specific gravity, and freezing point.

#### **Color**

Raw milk has a creamy white color due to its fat and protein content. The yellowish tinge in cow's milk, for instance, is attributed to carotene, while goat's milk appears whiter due to the lack of carotenoids. Skimmed milk, after fat removal, has a lighter appearance. Variations in milk color can indicate contamination, dilution, or oxidation of fat.

#### **Odor**

Fresh milk has a mild and pleasant smell. Any deviation, such as sourness or off-odors, suggests microbial activity, spoilage, or contamination with foreign substances like detergents or chemicals. Sensory evaluation, while subjective, remains a valuable tool in quality checks.

#### **Consistency**

The viscosity of milk reflects its fat and solids content. Raw milk is slightly viscous, while skimmed milk, with reduced fat, has a thinner consistency. Instruments like viscometers are often used to measure this parameter accurately.

#### **Specific Gravity**

This parameter determines the density of milk compared to water. Specific gravity for raw milk ranges from 1.028 to 1.035, while skimmed milk, due to fat removal, shows slightly higher values (1.035–1.040). Lactometers are commonly used for this analysis.

#### **Freezing Point**

Milk's freezing point, typically around  $-0.55^{\circ}\text{C}$ , is a reliable indicator of water adulteration. Deviations from this standard suggest dilution or alteration, necessitating further testing.

### **Chemical parameters: a comprehensive breakdown**

Chemical analysis offers a detailed composition profile, including fat, protein, lactose, pH, acidity, and mineral content.

#### **Fat Content**

Fat is a major determinant of milk quality and calorific value. Raw milk contains 3.5–4.5% fat, whereas skimmed milk has less than 0.5%. Fat globules in milk contribute to its texture, flavor, and nutritional value. The Gerber or Babcock methods are widely used for fat determination.

#### **Protein Content**

Proteins in milk, such as casein and whey, are critical for nutritional and functional properties. Raw and skimmed milk both contain 3.0–3.5% protein. High-performance liquid chromatography (HPLC) is often used for precise protein quantification.

#### **Lactose Content**

Lactose, a disaccharide sugar, accounts for 4.7–5.0% of milk's composition. Its concentration remains consistent in raw and skimmed milk. Enzymatic methods and spectroscopy are utilized for lactose analysis.

#### **pH and Acidity**

The pH of fresh milk ranges from 6.6 to 6.8. A lower pH indicates fermentation or spoilage due to lactic acid production. Acidity, expressed as percentage lactic acid, should be within 0.14–0.16%. Both parameters are crucial for assessing milk freshness.

#### **Minerals and Vitamins**

Milk is a rich source of calcium, potassium, magnesium, and fat-soluble vitamins like A and D. Skimmed milk often undergoes fortification to replenish vitamins lost during fat removal. Atomic absorption spectroscopy is employed for mineral analysis.

### **Microbiological parameters: ensuring safety and hygiene**

Microbial analysis evaluates the safety and hygiene of milk. Raw milk, due to its exposure to external contaminants, poses a higher microbial risk compared to pasteurized or skimmed milk.

#### **Total Plate Count (TPC)**

TPC measures the overall microbial load in milk. Counts exceeding regulatory limits (e.g.,  $10^5$  CFU/mL) indicate poor hygiene or extended storage.

#### **Coliform Count**

Coliform bacteria, indicative of fecal contamination, should be minimal ( $<10$  CFU/mL in pasteurized milk). Their presence highlights the need for improved sanitation during milking and processing.

#### **Pathogen Detection**

Tests for harmful pathogens like *E. coli*, *Listeria monocytogenes*, *Salmonella*, and *Staphylococcus aureus* are critical. Polymerase chain reaction (PCR) methods provide rapid and accurate pathogen identification.

### **Advanced Analytical Techniques in Milk Testing**

Technological advancements have revolutionized milk quality analysis. Key techniques include:

#### **Infrared Spectroscopy**

Infrared methods offer rapid, non-destructive analysis of milk components, including fat, protein, and lactose.

#### **Chromatography**

HPLC and gas chromatography (GC) are used to detect vitamins, amino acids, and adulterants with high precision.

#### **Microscopy**

Microscopy helps analyze fat globule size and distribution, differentiating between raw and skimmed milk.

### **Somatic Cell Count (SCC)**

SCC reflects udder health, with high counts indicating mastitis. Automated counters are used for quick assessments.

### **Adulteration Testing: Safeguarding Consumer Trust**

Milk adulteration, a growing concern, involves adding substances like water, starch, urea, or detergents. Analytical tests such as freezing point depression, chemical assays, and spectroscopic methods are critical for detecting these adulterants.

### **Nutritional Assessment: Highlighting the Health Benefits**

Both raw and skimmed milk offer unique nutritional profiles. While raw milk provides higher caloric value due to fat, skimmed milk supports low-fat diets. Vitamins A and D, often lost during fat removal, are replenished through fortification in skimmed milk.

### **Summary**

#### *Milk Contamination Sources:*

Raw milk contamination arises from environmental factors, the animal itself, or handling and equipment. Key bacterial groups include psychrophilic and psychrotolerant bacteria that grow at low temperatures, and spore-forming bacteria that resist processing.

#### *Adulteration Practices:*

Water dilution is the most common form of adulteration, reducing the fat and solid-not-fat (SNF) content. Urea, melamine, and preservatives like formalin and hydrogen peroxide are also added, compromising safety and quality.

#### *Analytical Findings:*

Out of 110 milk samples tested, 47.3% were deemed unsatisfactory due to adulteration. Buffalo milk samples were more frequently adulterated than cow milk samples.

#### *Recommended Approach:*

The use of total bacterial count as a single microbiological indicator for raw milk quality. A farm-to-shelf quality assurance system integrating data-driven and risk-based tools.

## **CONCLUSION**

The analytical assessment of raw and skimmed milk is fundamental to ensuring quality, safety, and consumer satisfaction. By leveraging advanced analytical techniques and adhering to stringent regulatory standards, the dairy industry can meet the evolving demands of consumers while safeguarding public health.

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