



Original Article

Assessment of Fresh Milk Quality Through Quality Parameters

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ABSTRACT

Raw milk manipulation is one of the major food frauds to gain financial benefits that can be identified through basic analysis. **Objective:** To analyse fresh milk quality parameters not only to define that milk is of poor quality but also to give some sort of clue that milk is adulterated. **Methods:** In this regard, a total of 110 (47 cows and 63 buffalo) raw milk samples were collected along with control samples through recommended methods and their routine physical & chemical quality parameters were analyzed. **Results:** The analysis of physical & chemical quality parameters showed 52/110 (47.3%) unsatisfactory samples with significantly decreased levels of major quality parameters like milk fat (94.2%), total solids (90.4%) and specific gravity (75.0%). It also showed an addition of water while other parameters were comparatively less decreased. There was compensation of water with thorough addition of other adulterants. The analysis also showed 58 (52.7%) samples were found satisfactory with 41/58 (70.7%) samples having normal quality parameters showing natural raw milk or precisely prepared adulterated milk while 17/58 (29.3%) samples had exceptionally raised quality parameters as fat 16/17 (94.1%) samples, total solids 14/17 (82.4%) and specific gravity 12/17 (70.6%) of samples showed the addition of water as well as other adulterants. **Conclusions:** The assessment of the quality of fresh milk through physical and chemical parameters not only described the poor quality of fresh milk but also gave some clues regarding the addition of different sorts of adulterants (>76.6%).

INTRODUCTION

The availability of a variety of nutrients renders raw milk the ideal meal for both newborns and adulterants. As it contains nearly all nutrients, including protein, carbs, fats, vitamins, and minerals, it is also regarded as a complete meal [1]. It comes from the udders of a healthy cow, buffalo, goat, or sheep and is a natural, pure, and clean secretion. Both raw (fresh) milk and pasteurized milk are options [2]. Organoleptic tests, fat percentage, SNF (solid-not fat) percentage, protein content, freezing point, pH, conductivity, total solids, and lactose are typical characteristics examined to assess milk quality [3]. The dietary and genetic state of animals, the environment, and the lactation stage all have an impact on the composition of milk, the typical milk composition includes water 87.00%, lactose 4.00% to 5.00%, protein 3.00%, lipids 3.00% to 4.00%, minerals 0.80%, and vitamins 0.10% [4]. Cow milk is

produced at a rate of 80 to 83 % worldwide, but only about 42% in South Asia. The percentage of buffalo milk consumed globally is 13%, but it is approximately 24% in developing nations and other animals like goat, sheep, and camel milk all make up the remaining percentage [5]. Milk production in developing nations reached 747 million tons in 2013. The amount of milk produced globally has increased to 906 million tons, with Asia contributing 378 million tons and Pakistan contributing 57,722 thousand tons. Nearly 80% of milk is produced in rural areas, 15% in pre-urban areas, and 5% in entirely urban areas [6]. In Pakistan, there are currently more than 67.00 million cattle, buffalo, 89.00 million sheep, 0.20 million camels, and other animals. Nilli/Ravi buffaloes, Sahiwal cows, Kajli sheep, and Beetle goats are just a few examples of the high-yielding genetic dairy animals that Pakistan is blessed with. The

year-round production of milk due to heat stress and a lack of fodder, milk production is significantly decreased throughout the summer [7]. Unfortunately, all across the world, milk is easily tampered with. There may be a mismatch between supply and demand, milk is perishable, the consumer has limited purchasing power, or there aren't enough detection tests [1]. Adulterants are defined as articles that are not of natural origin, substance, or quality but are asserted to contain a foreign substance that may lower the quality of the product, as well as articles that have been combined, coated, or treated with substances that are illegal or whose quality or purity do not meet the required criteria, as well as articles that contain poisonous or other elements that are harmful to human health [2]. The issue of adulteration is even greater in emerging and underdeveloped nations due to a lack of efficient monitoring and appropriate law enforcement. As milk fraud claims that traditional detection processes are useless and milk adulteration detection systems must be exceedingly specialized and rapid, the nature of the adulterants in milk affects the sort of technology used to analyze [8]. For financial gain or to mask the negative effects of unhygienic processing, storage, shipping, and marketing conditions, adulterants are added to milk. To balance the qualitative features of milk, dishonest milk producers dilute milk, remove essential components like cream and fat, and add inexpensive additives [9]. Through a middleman known locally as a "dhodhie," milk is delivered. This milk is watered to make more of it. Starch, flour, urea, cane sugar, vegetable oil, and other chemical adulterants are added to preserve their composition [7]. Water, sodium carbonate, sodium bicarbonate, caustic soda, formalin, urea, detergents, ammonium sulphate, boric acid, benzoic acid, salicylic acid, hydrogen peroxide, starch, sugars, and melamine, as well as skimmed milk powder, reconstituted milk, rice flour, vegetable oil, animal fat, and whey powder are among the various adulterants that alter the quality of milk [10, 3]. Urea is added to milk to increase the non-protein nitrogen content and SNF (solid not fat), Melamine is added to milk to increase the protein content, formalin, hydrogen peroxide, salicylic acid, and benzoic acid are used to extend the shelf life of the milk, and vegetable oil is used to preserve milk fat for financial gain [11, 12]. Value-added milk is created by combining synthetic or semi-synthetic milk with natural milk. Synthetic or semi-synthetic milk comprises vegetable oil as a source of milk fat, urea as a nitrogen component and detergent to make it foamy with a certain specific gravity [13]. The addition of water in the milk (fresh milk) to increase the volume of milk and then compensation for this increased volume of water through the addition of different adulterants to maintain the quality parameters of fresh natural milk are the tactics of milk

fraudulent nowadays and this study will help common people to have a clue regarding such milk frauds through analysis of simple physical and chemical quality parameters.

METHODS

Collection of fresh milk either cow or buffalo fresh milk along with data were the point of prime importance to know the analysis of quality parameters found in fresh milk. A total of 110 fresh milk samples were analyzed through the analysis of their quality parameters. 46 out of 110 were collected along with control samples from various sources of milk suppliers like milk collectors, milkmen as milk distributors or milk retailers, middle man as dhodhie (common name) and end users. 64 samples were received from the same sources at the reception of the Nutrition Division, NIH. 47 of 110 samples were of cow origin while 63 samples were of buffalo origin. The control sample was a self-collected fresh milk sample of healthy buffalo origin having a lactation period of 2–4 months. These samples were analyzed as per the following quality parameters through recommended methods; Sample Collection: Milk samples were collected through the recommended method through an authorized agent free from infectious disease in the presence of concerned parties in a dry clean container, preserved in cold chain container (2–8°C) with proper labeling [14]. Stability Study: A stability study was conducted to determine the shelf life of collected fresh milk samples at 2–8°C for 0 to 5 days based on the quantity and duration of utilization of fresh milk at the domestic level. The fall in the concentration of certain important parameters after four days was very negligible like fat decreases from 5.0% to 4.98 (0.40%), SNF decreases from 8.03% to 7.97% (0.65%) & total solid decreases from 13.03% to 12.95% (0.61%). It means that fresh milk samples remained stable for 4 days at 2–8°C. Sample Preparation & Analysis: 250 – 500 ml sample in the form of homogenous milk sample at 20°C through the recommended method before analysis. Physical & Chemical Parameters: Natural fresh milk was white without any distinctive odor, palatable in taste and had no soapiness while rubbing on the palm. Milk was analyzed and stated as satisfactory or unsatisfactory on these physical findings. pH: Milk was slightly acidic with pH 6.4 – 6.8 which was carried out by a calibrated pH Meter. Density/Specific Gravity: Density/Specific Gravity was between 1.025 and 1.035 [15, 13]. It was carried out by lactometer reading as a free-floating principal-based activity concerning water for comparison. Moisture / Water Content: Gravimetric method (calculation based), it was calculated in percentage by subtracting total solid weight from the weight of 100ml of fresh milk sample. Ash: Gravimetric method to know the total solid through getting weights of

the empty dish, a dish with 10ml of milk sample then kept in the furnace at 550°C for drying milk sample and again weighing and calculating with the help of following formula;

$$\text{Ash Content} = \frac{\text{Weight of dried sample}}{\text{Weight of milk sample}} \times 100$$

Total Solid: Gravimetric method to know the total solid through getting weights of the empty dish, a dish with 10ml of milk sample then incubated for drying milk sample and again weighing and calculating with the help of following formula;

$$\text{Total Solid} = \frac{\text{final reading (dried sample)} - \text{initial reading (empty dish)}}{\text{final reading (before drying)} - \text{initial reading (empty dish)}} \times 100$$

Fat: Ether extraction method and Gerber Method with the help of Gerber's tube to treat milk sample with concentrated sulfuric acid for precipitation of protein and getting interface by amyl alcohol and segregation by centrifugation to get fat layer and taking reading. **SNF:** Solid not fat (SNF) was obtained by subtracting fat contents from total solid. **Lactose:** Gravimetric method, lacto scan readings or picric acid method to get red picramic acid due to the presence of lactose in milk samples [16]. **Protein:** Kjeldhal method for protein nitrogen content in which milk sample was treated/digested with strong acid to release nitrogen content which was determined in titration. The nitrogen contents were converted to a concentration of protein by applying a multiplying factor [17, 16]. **Calories:** Calories were calculated by multiplying factors concerning the contents of protein, carbohydrate and fats in 100 ml.

RESULTS

Table 1 shows that 52(47.3%) out of 110 samples were found unsatisfactory as per the complete analysis of milk quality parameters. 32 out of 52 samples were of buffalo origin while 20 out of 52 were of cow origin milk samples which were found as unsatisfactory. The increased rate of the unsatisfactory sample shows the level of change in milk quality through milk adulteration mostly through the addition of water that lowers the values of quality parameters like fat, total solid, SNF etc.

Table 1: Fresh Milk Quality Status

Satisfactory		Unsatisfactory		Total
Cow	Buffalo	Cow	Buffalo	
27(24.5)	31(28.2)	20(18.2)	32(29.1)	110(100)
58(52.7)		52(47.3)		110(100)

Table 2 shows that significantly decreased levels of major quality parameters, Fat content (94.2%), total solids (90.4%) and specific gravity (75.0%) were the main parameters and were significantly decreased. The quality parameters which define the quality of milk were remarkably decreased, not only stating that milk is of substandard quality but also giving a clue that milk volume was increased by adding water to the milk which decreases the specific gravity of the milk products. The addition of

water was also the cause of decreased values of total solid and fat content. The fewer numbers of milk samples with decreased values of SNF, protein and lactose rather than fat, totally solid and specific gravity also showed that the substandard milk samples were not only due to the addition of water but other adulterants were also used to compensate for the decreased values of quality parameters.

Table 2: Fresh Milk Quality Status – Unsatisfactory

Significantly Decreased Levels						Total
Sp. G	T. S	SNF	Fat	Protein	lactose	
39(75)	47(90.4)	25(48.1)	49(94.2)	20(38.5)	25(48.1)	52(100)

Table 3 shows the standard of satisfactory milk samples as 41(70.7%) out of 58 samples with normal quality parameters while 17(29.3%) out of 58 samples had normal quality parameters with significantly raised quality parameters. These exceptionally raised normal values of the milk samples had shown that good quality milk may also give a clue regarding milk adulteration and different adulterants compensate for the decreased values of milk quality parameters due to the addition of water.

Table 3: Fresh Milk Quality Status – Satisfactory

Marginal Satisfactory	Exceptional Satisfactory	Total
41(70.7)	17(29.3)	58(100)

Table 4 shows the standard of exceptionally satisfactory milk samples with exceptionally raised quality parameters as fat 16(94.1%) out of 17 samples, total solid 14(82.4%) out of 17 samples and specific gravity 12(70.6%) out of 17 samples. These exceptionally raised values of quality parameters may also be natural but synthetically adulterated samples can also have exceptionally raised quality parameters.

Table 4: Fresh Milk Quality Status – Exceptional Satisfactory

Significantly Increased Levels						Total
Sp. G	T. S	SNF	Fat	Protein	lactose	
12(70.6)	14(82.4)	10(58.8)	16(94.1)	04(23.5)	06(35.3)	17(100)

DISCUSSION

To understand the criteria of composition or quality and the etiology of milk's poor quality, numerous investigations have been carried out. It has been explained that an average milk composition consists of water 87%, lactose 4-5%, protein 3%, lipids 3-4%, minerals 0.8%, and vitamins 0.1% to discover changes in milk quality [4]. The summer months have a severe negative impact on these quality parameter values. As a result of heat stress, a lack of fodder, and other factors, milk production is significantly decreased during the summer. Due to its scarcity, milk was regrettably very readily falsified [7]. Possible causes included a gap between supply and demand, the perishable nature of milk, limited customer purchasing power, and a lack of appropriate detection tests [1]. It was done either

for personal or professional gain or to boost their profit from the sale of milk by diluting it, removing important components like cream and fat, and adding inexpensive additives to balance the milk's quality characteristics. According to the Punjab Food Authority of Pakistan, only 27 out of 52 milk samples were judged to be fit for consumption, indicating a decline in milk quality [9]. In another investigation, 18 out of 25 milk samples taken from Peshawar, a significant Pakistani city, were determined to be unsafe. According to recent studies, Pakistan sold over 80% contaminated milk [18]. The samples from an educational canteen contained up to 93.00% adulterants like water, urea, formalin, and hydrogen peroxide [19]. The most common adulterants in milk included the inclusion of vegetable protein, milk from various species, the addition of whey, and watering [20]. These practices were referred to as economically motivated adulteration. Milk adulteration has been widely reported in developing nations like Pakistan, Brazil, India, and China [12]. Through a middleman known locally as a "dhodhie," milk is delivered. This milk was watered to make more of it. Starch, flour, urea, cane sugar, vegetable oil, and other chemical adulterants were added to preserve their composition [7]. To raise these quality indicators, these adulterants were introduced to milk, dishonestly raising the milk's quality. To boost solid-not-fat (SNF), for instance, cane sugar, starch, sulfate salts, urea, and common salts were added. The maximum allowed concentration of urea, a naturally occurring component of raw milk, was 70 mg/100 ml. To boost the non-protein nitrogen content, commercial urea was added to milk [10, 3]. Urea was added to milk to increase the non-protein nitrogen content and SNF (solid not fat), melamine was added to milk to increase the protein content, formalin, hydrogen peroxide, salicylic acid, and benzoic acid were used to extend the shelf life of the milk, and vegetable oil is used to preserve milk fat for financial gain [11, 12]. Synthetic or semi-synthetic milk is a type of adulterated milk that is combined with genuine milk to generate value-added milk. It incorporates vegetable oil as a source of milk fat, urea as a nitrogen component, and detergent to make it foamy with a certain specific gravity [13]. The analysis of quality parameters of milk samples showed that findings of quality parameters helped in the discrimination of satisfactory and unsatisfactory milk samples through provided compositional permissible limits. This study also helped in the understanding of the prevalence of adulterated samples either due to the addition of water to meet supply demand gap/financial benefit and then compensation of removed fat by addition of different sorts of adulterants to hide the effects of added water and removed constituents. There were 47.30% unsatisfactory samples and marked decreased levels of fat

and total solid confirmed the addition of water/removal of fat. The exceptionally raised levels of quality parameters and 55.20% numbers of such samples showed compensation of removed constituents with adulterants. The aggregated adulteration possibility was 76.36% on the part of milk quality while the increased level of somatic cell count (83.64%) showed unsafe milk due to the addition of filthy water and other factors. These findings were also supported by above mentioned other studies.

CONCLUSIONS

The assessment of the quality of fresh milk through physical and chemical parameters not only describes the quality of fresh milk but also gives some clue regarding the addition of different sorts of adulterants (>76.6%) and this study exposes the tactics of milk fraudulent through analysis of simple physical and chemical quality parameters.

Authors Contribution

Conceptualization: TI

Methodology: FHW

Formal analysis: MHSW

Writing review and editing: SH

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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