Adulteration and Assessment of Raw Milk Quality in and Nearby Areas of Palampur Himachal Pradesh, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Original Research Article

ABSTRACT

Milk is one of the essential food for human intake, especially for growing children, which contains various proteins, fats, carbohydrates, vitamins and minerals. However, milk is prone to adulteration, minimizing its quality and safety even as it has numerous benefits to consumers. Present research monitored the physicochemical quality and the level of adulteration observed for the milk samples which were directly retrieved from the consumer's door. The study established that there was variations in different studied parameters in 120 collected raw milk samples where CLR

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(27.16±5.15), fat (4.07±1.53), SNF (7.94±1.70), Total solid (12.00%), Protein (2.92±0.58%), Lactose (4.38±0.82), Minerals (0.65±0.12) were assessed. As for the intentionally added substances formalin, starch, cellulose, maltose and boric acid were not present, while ammonium sulphate (9.10%), urea (6.66%), neutralizers (2.50%), detergent (10%), sodium chloride (30%), skim milk powder (1.66%), sugar (2.50%), glucose (3.33%), hydrogen peroxide (45.83%) and pond water were found in different percentages. The investigation was carried out on the problem of adulteration faced and awareness regarding the quality of milk and its variations which was needed for better quality check system. The investigation made awareness amongst the society about the health dangers linked with the contaminated milk advancements in dairy equipment's and farming techniques can also enhance the milk quality. Testing helped to measure the nutritional contents of milk including fats, vitamins and minerals. Study provided information about factors affecting milk quality and better storage conditions.

1. INTRODUCTION

India is the world's largest milk producer with the production of 187.7 million tonnes in 2018 to 2019 (Department of animal husbandry and dairying, 2019). India contributes 17 percent of the world's milk production because it produces 90 percent of the world's buffalo milk and is the second largest producer of milk in the world with 54 million tonnes [1]. India is the highest producer of milk and is number one in the world accounting for 26 percent [2]. Milk producing states in India include Punjab, Maharashtra, Uttar Pradesh, Madhya Pradesh, Haryana and Karnataka [1]. Uttar Pradesh is the largest milk producing state in India [3].

Milk is nutritious food that is readily absorbed and digested. It is composed of nutrients necessary for proper body development and maintenance [4]. Every age group uses milk, which is the greatest and least expensive food source. It is an excellent diet for pregnant women and their unborn children as it has a significant amount of lipids, proteins, vitamins that develops muscle, lactose and many other nutrients [5]. It is a special substance that is secreted by mammary gland in mammals and the most popular food item in Indian people's diet is milk and milk products [6]. The constituents of milk are same in all animals, but the quantity varies according to the species, genetics and environmental variables [7]. Milk composition includes 87.00 percent water, 4-5 percent lactose, 3 percent proteins, 3-4 percent lipids, 0.80 percent minerals and 0.10 percent vitamins [8]. Adulteration is the process of reducing the quality of product by adding some other inferior substance in it due to which actual quality of milk loses [9]. Adulteration can occur accidentally or on purpose. Accidental contamination which typically resulted from carelessness, ignorance or lack of facilities can also cause adulteration [10]. Different adulterants in milk are water, urea, formalin, ammonium sulphate, hydrogen peroxide, detergents, melamine, neutralizer, starch and synthetic milk [4].

Adulterated milk is dangerous for health as it may contain various toxic chemicals and deprived of nutrients required for proper growth and development of human body [11]. Adulterants can result in a wide range of acute signs and symptoms such as dermatitis, blood in urine, auto immune disease, asthma, headaches, sinus infections, nausea [12].

The previous study on milk adulteration in Kangra district (Palampur) was in 2017 and since then no study has been conducted on this subject. To fill the research gap of seven years, this study was reconducted to assess the quality of raw milk in and around Palampur. The main purpose of the study was to ensure that milk does not contain any harmful substances that could affect the consumers' health and to protect them against frauds.

2. MATERIALS AND METHODS

Study area and sample collection: The study was conducted during period of February to April 2024 at Sri Sai University Palampur. Total 120 raw milk samples were collected at consumer door from nearby areas of Palampur. Milk was collected in separate storage bottles which were sterilized before collection. All the raw milk samples were observed for testing.

Kit used for testing milk samples: Kit1- HiMedia K088A, Kit 2- K088B.

This kit contained reagent for detection of 17 adulterants and gave the consumers, the right to check the quality of milk consumed immediately,

anywhere and anytime without sending the samples to the laboratory. The purpose was to ensure the quality of milk for consumers. The tests were performed as per instruction given in the kit manual.

The ultrasonic milk analyzer was used to measure and record milk fat, SNF, protein, lactose, water, temperature, freezing point, density, minerals content, while the adulteration tests were done using the Hi-media adulteration testing kit (Manufacturer-EKO Milk, India) protocol as per the instruction given in the kit manual. The tests were performed for the detection of presence and absence of alizarin, formalin, urea, detergent, sugar, starch, glucose, hydrogen peroxide, cellulose, maltose, protein, boric acid and pond water.

Statistical Analysis: All the data of this research was statistically analyzed using Microsoft office excel 365.

3. RESULTS

In this study, total 120 raw milk samples were analyzed to assess the physicochemical quality of market milk that was collected at the consumer door. Significant differences were found in the collected milk samples. Among the different raw milk samples, the average CLR (27.16±5.15), Fat% (4.07±1.53), Solid Not Fat% (7.94±1.70), Total Solid% (12.00±0), Protein (2.92±0.58), Lactose (4.38±0.82), Minerals (0.65±0.12) and Freezing Point (0.514±0.12) (Table 1).

Table 1. Quality of market milk collected at consumer door

Particular	Range	Average	S.D.
CLR	11.6-33.8	27.16	5.15
Fat %	1.0-9.6	4.07	1.53
Solid Not Fat %	3.5-9.9	7.94	1.70
Total Solid %	4.5-18.6	12.00	-
Protein	0.5-3.6	2.92	0.58
Lactose	1.9-5.6	4.38	0.82
Minerals	0.3-0.8	0.65	0.12
Freezing Point	0.219-0.643	0.514	0.12

Table 2. Market milk analysis reports for fat and solid not fat (SNF)

Particulars	<3.5 % Fat	>3.5 % Fat	<8.5 % SNF	>8.5 % SNF
Fat	51 (42.5 %)	69 (57.5 %)	-	-
SNF	-	-	57 (47.5 %)	33 (52.5 %)

Table 3. Parameters and samples studied

Parameters	Samples Studied		
Alizarin	**Alkaline**	**Normal**	**Acidic**
	16.60%	79.16%	4.16%
	Present		**Absent**
Formalin	_		100%
Urea	6.66%		93.33%
Starch	_		100%
Neutralizer	2.50%		97.5%
Detergent	10%		90%
NaCl	30%		70%
SKM Powder	1.66%		98.33%
Sugar	2.50%		97.50%
Glucose	3.33%		96.66%
Hydrogen Peroxide	45.83%		54.16%
Cellulose	_		100%
Maltose	_		100%
Ammonium Sulphate	9.10%		90.83%
Boric acid	_		100%
Protein	_		100%
Pond water	25.83%		74.16%

Table 4. Analysis of market milk samples for level of adulteration

Particulars	Positive Samples	Correlations
Formalin, Starch, Cellulose, Maltose, Boric acid,	Nil	-
Ammonium Sulphate	11 (9.10%)	Pond water (07), Hydrogen Peroxide (08), NaCl (04), Sugar (01), Detergent (02), SKM (01), Neutralizer (01)
Alizarin	Alkaline (20), Normal (95), Acidic (5)	-
Urea	08 (6.66%)	NaCl (05), Hydrogen Peroxide (03), Sugar (01)
Neutralizer	03 (2.5%)	NaCl (01), SKM (01), Hydrogen Peroxide (02), Detergent (02), Glucose (02), Ammonium Sulphate (01)
Detergent / Shampoo	10 (8.33%)	NaCl (05), Hydrogen Peroxide (08), Ammonium Sulphate (01), Glucose (02)
NaCl	15 (12.5%)	Detergent (05), Hydrogen Peroxide (30), Pond water (22), Ammonium Sulphate (06), Sugar (01), Urea (03), SKM (03), Neutralizer (01)
Skim milk powder	02 (1.66%)	NaCl (02), Hydrogen Peroxide (02), Neutralizer (01), Ammonium Sulphate (01)
Sugar	03 (2.5%)	Hydrogen Peroxide (02), NaCl (01), Urea (01), Pond water (01)
Glucose	03(2.5%)	Hydrogen Peroxide (03), Detergent (03), Neutralizer (01)
Hydrogen Peroxide	54 (45%)	NaCl (30), Detergent (08), Pond water (32), Ammonium Sulphate (08), Sugar (02), Neutralizer (02), SKM (02), Urea (03), Glucose (03)
Pond water/Nitrate	33 (27.5%)	Hydrogen Peroxide (31), NaCl (21), Ammonium Sulphate (07), Sugar (01)

Similarly, the market milk analysis was carried out for fat and solid not fat. The market milk samples contain average Fat <3.5 percent Fat was (42.5%) and >3.5 percent Fat was (57.5%), SNF<8.5 percent SNF was (47.5%) and >8.5 percent SNF (52.5%) (Table 2).

Out of 120 raw milk samples, the most common contaminants were hydrogen peroxide (45%) and pond water (27.5%), indicating significant adulteration. Sodium chloride was also notably present in (12.5%) of the samples (Table 3). Other contaminants included detergent (8.33%), ammonium sulphate (9.10%), urea (6.66%), while the neutralizer, sugar, glucose and SKM were less prevalent. This suggested a range of adulterants affecting milk quality with hydrogen peroxide and pond water being the most prevalent. The correlation among different parameters of the milk samples was shown in (Table 4).

4. DISCUSSION

Milk is a healthy nutritious dairy product and is consumed by majority of world population. Increased demand, increased competition in the dairy industry and economic benefits derived some producers to adulterate milk. Adulterated milk is a worldwide issue and a social problem [13]. A total of seventeen tests were carried out in our study to determine the degree of milk adulteration from samples for formalin, starch, cellulose, maltose and boric acid which were found to be present in our study. In concordant to present investigation Mane et al. [14] found that milk samples were invariably adulterated by unscrupulous milk agents. In addition, another study was carried out to check milk adulteration where the most harmful addition found in the milk was benzoic acid and sugar [1].

The intention of the farmers for addition of adulterants was to increase profits boosting

volume and shelf life and to acquire more money. Despite this, there were not any worse effects on the public health. Similar to present investigation Abbas et al. [15] found formalin, starch and carbonates as adulterant. In addition to present investigation Kumar et al. (2015) found starch, sucrose and skim milk powder as adulterant. Formalin, hydrogen peroxide and detergents were also the adulterants found in milk. These chemicals were used as cheap preservatives which increase the shelf life of milk. It has been further observed by Panahzadeh et al. [16] that milk used for human consumption can be adulterated with cheaper materials or hazardous chemicals. Furthermore, in the study by Kazeminia et al. [17] where the effect of seasonal variations was studied revealed that the average pH, freezing point, solid-not-fat, and protein content were insignificantly higher in warm seasons, while the average acidity, lactose, and fat content were insignificantly higher in cold seasons. Thus, it has been revealed that further more analysis is a need of an hour where awareness among the consumers regarding malpractices and negligence in milk production is essential.

5. CONCLUSION

It was observed that a high percentage of milk samples were adulterated. Thus, the adulteration of extraneous water, urea, neutralizer, sugar, NaCl, hydrogen peroxide, ammonium sulphate and glucose were found to modify the physicochemical characteristics of raw milk and to have significant negative impact on milk quality. There has to be greater public awareness of the malpractices or negligence in milk production as it is a concerning issue for the consumers in the area.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc.) and text-to-image generators have been used during the writing or editing of this manuscript.

ACKNOWLEDGEMENT

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/123924