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COMPOSITIONAL ANALYSIS OF MARKET MILK IN THIMPHU & PARO DISTRICTS

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ABSTRACT: Milk available in the market is not subject to systematic regulations or monitoring for control of quality. The compositional quality of milk is not maintained due to lack of regulations leading to adulteration of milk and supply of poor-quality milk to consumers. The study on compositional quality of milk available in the market of Thimphu and Paro revealed deviation and variation in all milk components from expected constituents as well as consistent adulteration with water. Milk available in the market of Thimphu and Paro is found to be of poor quality with unfair trade practices and deception of consumers through sale of inferior quality milk. Besides, the study also found that the Lactoscan MCCW has a higher precision than Portable milk analyzer for detecting added water in milk as adulterant. The Centre will continue to undertake studies on milk composition throughout the country and will also undertake to identify the source of adulteration (producers – middlemen – retail outlets) for corrective action to be taken for improving the quality of milk and formulation of standards for milk.

Keywords: Adulteration; equipment specificity; milk composition; raw milk.

1. INTRODUCTION

Milk is defined as the secretion from the lacteal glands of one or more cows and serves as a source of essential nutrients. The composition of milk varies according to species, breed, age, diet etc. Normal cow milk is generally composed of fat within the 3 – 6% variation, protein content of about 3.5%, lactose of 4.8% and minerals/salts/vitamins in the range of 0.7 – 0.8% (Fox 2011). These components are known as the solids component and comprises of about 13.4% of the milk content with the remaining 86.6% being the water content of milk on average.

Additionally, normal milk has a titratable acidity of 0.14 - 0.16%, pH of 6.5 – 6.7, specific gravity of 1.030 - 1.035, and freezing point of -0.512 to -0.550 ºC (McCarthy 2002). The depression of freezing point is used as the basis for the detection of milk adulterated with water (Henno et al. 2008). Wangdi et al (2014) in his study recorded an overall mean composition of milk in the country as being constituted of 4.99% fat, 3.25% protein, 5.48% lactose and 0.67% salts. The study also recorded the density of milk as 1.028 kg/liter and a freezing point of -0.571ºC. Similarly, the milk composition obtained from the farm of National Dairy Research and Development Centre (NDRDC), Yusipang was 4.7% fat, 3.4% protein, 4.6% lactose, 0.7% salts and a freezing point of -0.550.

Dairy farmers groups of Thimphu, Paro and Haa market their milk and milk products in their respective areas as well as in Thimphu that has a higher buying potential for dairy products. Most of the milk and milk products from Paro and Haa are also available in Thimphu through the various dairy outlets set up in the capital city. All of the milk available is raw milk directly sourced from the dairy farmers groups and sold unprocessed in plastic bottles. The price for 1 liter milk is sold at the market rate of Nu. 60 – 65 per liter in the outlets. The outlets procure the milk from the dairy groups in bulk and packaging is done at the respective outlets in either new or re-used mineral water bottles. Some outlets sell the milk directly from the bulk containers in containers bought by the customers. A common feature in the supply of milk from the dairy groups is the use of middlemen for transportation and sale of milk from the point of production to the marketing outlets.

As there is no systematic regulation or monitoring mechanism in place for the sale of raw liquid milk, the compositional quality of milk is not maintained for the consumers with variations in compositional quality and adulteration with water being common practice. The use of water as an adulterant to increase the volume of milk

sold can pose a risk to human health through the use of contaminated and unclean water leading to the rapid deterioration of milk quality as well as the reduction of milk solids (Handford et al. 2016).

No study to determine the compositional quality of raw milk available in the market has been carried out and this study aims to address the lack of information and quantitative data. Through this study, initial information on the compositional quality of milk will be made available for future reference and corrective measures to be implemented in case of adulteration.

2. MATERIALS AND METHODS

The study is carried out to investigate the compositional quality of raw milk and incidences of water adulteration in milk available through the various milk sales outlets in Thimphu and Paro town areas. About 20 random samples each were collected from four different milk outlets (T1, T2, T3 and T4) in Thimphu and two different outlets (P1 and P2) in Paro for compositional analysis. Physical examination of all samples was made for appearance, odor, color and packaging material used. Compositional analysis of the samples was carried out using ultrasonic milk analyzer, Lactoscan MCCW, Milktronics Ltd. (Bulgaria) and the portable milk analyzer Master Eco used in various Milk Collection Centers and Milk Processing Units. All samples were measured in triplicate for fat, protein, lactose, salts, density, SNF and added water. The milk composition obtained from the farm of the NDRDC, Yusipang was used as reference for analysis.

3. RESULTS AND DISCUSSIONS

3.1 Physical appearance

Majority of the samples had acceptable appearance, odor and color. All samples from one outlet in Paro had the distinctive odor of areca nut and an odor of unknown origin in one instance. The origin of the areca nut odor was from the storage of bottled milk in the same refrigerator as the areca nut and also due to simultaneous handling of the products. One sample from the same outlet was also found to be tainted due to improper washing of the reused bottle as it was reported in the study of Shaikh et al. (2013).

All the samples procured were packaged in plastic mineral water containers. The packaging material used in four of the six outlets were predominantly recycled mineral water bottles with one outlet also using plastic fruit juice bottles. Two outlets in Thimphu claimed to be using fresh new bottles for packaging the milk.

Samples from outlets in Thimphu analyzed with the Lactoscan MCCW showed fat content ranging from 3.17 – 4.89%, protein ranging from 1.99 – 2.72%, lactose 2.99 – 4.00% and SNF content of 5.44 – 7.51% (Figure 1).

On average all samples were adulterated with water ranging from 10.09 – 35.52% added water (Figure 1).

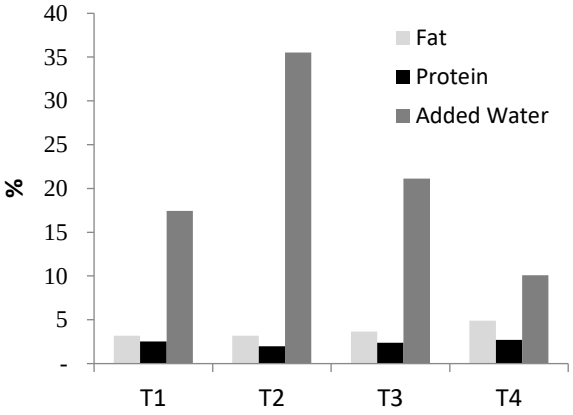


Figure 1: Composition of milk for Thimphu outlets analyzed using Lactoscan MCCW

The freezing point of the samples was detected in the range of -0.335ºC to -0.468ºC.

The same samples were also analyzed using the portable Master Eco available in most MCCs and MPUs.

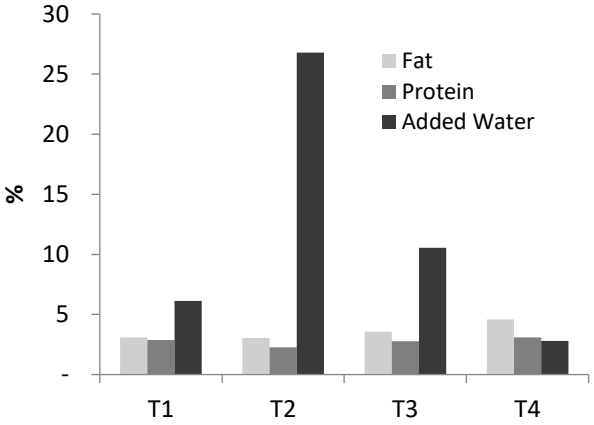


Figure 2: Milk composition for Thimphu outlets analyzed using portable milk analyzer Master Eco

Results obtained from the samples showed fat range from 3.03 – 4.60%, protein 2.26 – 3.10%, lactose 3.06 – 4.10% and SNF 6.15 – 8.56%. Samples were also found to be adulterated with water ranging from 2.80 – 26.79% added water and freezing point range of -0.350ºC to -0.488ºC (Figure 2).

Similarly, samples from outlets in Paro analyzed with the Lactoscan MCCW showed a fat content in the range of 3.61 – 4.06%, protein content of 2.69 – 2.83%, lactose 4.04 – 4.25% and SNF content of 7.35 – 7.72% (Figure 3).

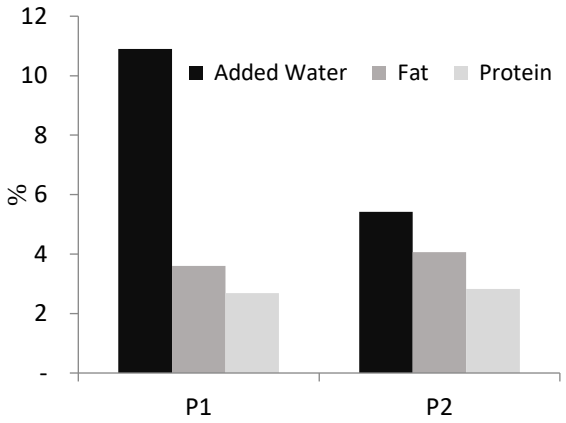
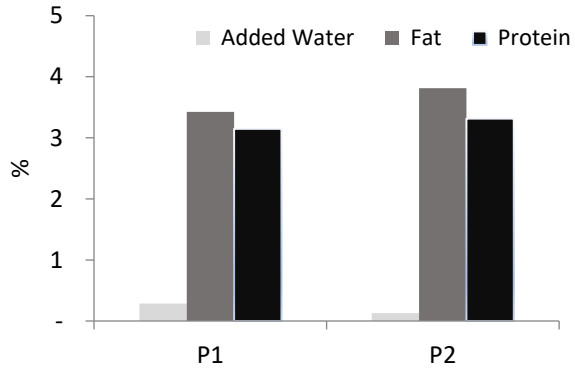


Figure 3: Composition of milk for Paro outlets analyzed using Lactoscan MCCW

Adulteration with water was found to range between 5.42 – 10.90% added water with freezing point range of -0.464ºC to -0.491ºC (Figure 3).

The samples were also analyzed using the portable Master Eco with results of fat content ranging from 3.42 – 3.81%, protein content 3.15 – 3.31, lactose from 4.23 – 4.42 and SNF content of 8.35 – 8.82% (Figure 4).



The samples analyzed with the portable milk analyzer detected adulteration with water at a range of only 0.13 – 0.29% added water while the freezing point

Figure 4: Milk composition for Paro outlets analyzed using portable milk analyzer Master Eco

was found to be in the range of -0.495ºC to -0.523ºC.

3.2 Milk fat content

Milk analyzed using the Lactoscan MCCW produced fat content of milk in Thimphu in the range of 3.17 – 4.89% and 3.61 – 4.06% in Paro. Analysis with the Portable Milk Analyzer produced a range of 3.03 – 4.60% fat for Thimphu market milk. However, some samples produced milk fat measurement below the 3% level which is considerably lower than the reference milk fat content of 4.7%. It is expected that as majority of cows present in the Thimphu and Paro region constitutes a mixture of Jersey Cross and local cattle, both of which are known to produce high fat milk, the fat content should have been higher than the average of 3.72%. It is possible that either the producers or retail outlets are practicing skimming of milk for the sale of cream or manufacture of butter in addition to adulteration with water.

3.3 Protein content of milk

The protein content analyzed using the Lactoscan MCCW for Thimphu and Paro was found in the range of 1.99 – 2.72% and 2.69 – 2.83% respectively. Analysis with the portable milk analyzer produced results in the range of 2.26 – 3.10% for Thimphu and 3.15 – 3.31% for Paro. Overall, majority of the samples analyzed had low protein content in comparison to the reference value of 3.4% which could be attributed to the adulteration of milk with water. The significance of feed intake also needs to be taken into consideration for the low overall protein content of milk.

3.4 Lactose content of milk

The lactose content was analyzed in the range of 2.99 – 4.00% for Thimphu market milk and 4.04 – 4.25% for Paro market milk with the Lactoscan MCCW. The portable milk analyzer produced results in the range of 3.06 – 4.10% in Thimphu milk and 4.23 – 4.42% in Paro milk. The lactose content is generally considered to be the least variable milk component but variation in lactose content is evident in samples analyzed and is also lower than the reference value of 4.6%. This variation could be attributed to the adulteration of milk with water.

3.5 Freezing Point of milk

The freezing point of the samples was also analyzed with the two machines with large variations found through the analysis. Market milk in Thimphu was found to have freezing point in the range of -0.335 to -0.468ºC while Paro market milk had -0.464 to -0.491ºC using the Lactoscan MCCW. Analysis with the portable milk analyzer produced a freezing point of -0.350 to -0.488ºC for Thimphu and -0.495 to -0.523ºC for Paro. Paro milk had a freezing point closer to the freezing point of the reference value but variation in freezing point exists in milk samples from both districts. The depression of freezing point is used as a measure of adulteration of milk with water (Henno et al. 2008), and with the variation that exists in the samples, adulteration with water is a common occurrence in market milk available in Thimphu and Paro.

3.6 Added Water in milk

The Lactoscan MCCW and the portable milk analyzer also measures the amount of water added as an adulterant

in milk. The Lactoscan MCCW showed an added water range of 10.09 – 35.52% water addition in Thimphu market milk and 5.42 – 10.09% added water for Paro market milk. The portable milk analyzer showed a lower added water content in milk with a range of 2.80 – 26.79% added water for Thimphu market milk and 0.13 – 0.29% added water for Paro market milk.

3.7 Lactoscan MCCW and Portable Milk Analyzer

An ANOVA analysis was made between the equipment with findings revealing significant difference for measured parameters of lactose, protein, freezing point, density, and added water. No significant difference was observed for the measurement of fat content. Further investigation into the discrepancy on the amount of added water between the equipment was carried out with the results indicating that the portable milk analyzer does not detect added water up to 10%. The Lactoscan MCCW has a higher precision for detecting added water but the equipment is more expensive to procure and is suitable for laboratory purposes and not for field use.

4. CONCLUSIONS

Milk available in the markets of Thimphu and Paro was found to show variation in all milk components and also found to be consistently adulterated with water. This adulteration with water is the primary cause in the variations of milk components from the normal expected milk composition leading to inferior quality milk. Adulteration with water further reduces the nutritional value of milk in addition to introducing microbes through use of poor-quality water as an adulterant. Unfair trade practices and deception of consumer through the sale of adulterated milk at high prices is also an area of major concern as consumers should receive good quality milk. Further study is required to identify whether the source of adulteration arises from the producers, the middlemen or the retail outlets so that corrective action can be taken and the market quality of milk improved. Additionally, the use of recycled mineral water containers and in particular fruit juice containers or other bottles needs to be discouraged as these are also potential sources of contamination.

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