

PHYSICO-CHEMICAL PARAMETERIZATION AND COMPARISON OF SOME MILKS

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Abstract

Milk is a source of Lactose, Proteins, Fats, Vitamins, minerals, etc. This work was carried out to estimate and compare the physicochemical parameters of fresh milk and boiled milk of Human (woman), Cow, Buffalo and Goat of Palpa after one month of their pregnancy time in December, 2018 and to compare these parameters with their standard values. These were analyzed using standard literature methods. It has been determined that Fresh Human milk has 8.16 pH, 7.7 % Lactose, 3.30 % Fat, 85 % Water, and 0.036mg Chloride, Fresh Cow milk has 6.68 pH, 3.7 % Lactose, 3.71 % Fat, 90 % Water, and 0.035mg Chloride, Fresh Buffalo milk has 6.07 pH, 3.8 % Lactose, 5.84 % Fat, 90 % Water, and 0.037 mg Chloride and Fresh Goat Milk has 6.81 pH, 3.1 % Lactose, 4.93 % Fat, 83.25 % Water, and 0.036 mg Chloride but 7.50 pH, 7.6 % Lactose, 3.11 % Fat, 71 % Water and 0.03249 mg Chloride in Human milk, 6.24 pH, 3.3 % Lactose, 3.21 % Fat, 79.5 % Water, and 0.03427 mg Chloride in Cow milk, 5.54 pH, 3.1 % Lactose, 5.74 % Fat, 88.5 % Water, and 0.01831 mg Chloride in Buffalo milk and 6.36 pH, 2.9 % Lactose, 4.37 % Fat, 79.5 % Water, and 0.04136 mg Chloride in Goat milk after boiling at 50°C respectively. All determined parameters of collected milk samples meet the standard requirements and boiled milk is found to be better than fresh milk.

Keywords: parameterization, raw milk, nutrients, antibodies, minerals, vitamins

Introduction

A source of essential nutrients for the neonate of all mammalian species for the growth of children and the nourishment of adults is called Milk. It is the secretion of mammary glands like sebaceous glands, sweat glands, etc. which is the complete food for young mammals (Mahmood, 2010). Milk provides energy and protein both for the growth of human beings or for parental care purposes (Sarwar et al., 2002) and it also contains antibodies that protect the young mammal against infection (Bylund, 1995). There are near 150 million milk producers such as Cow, Buffalo, Goat, Sheep, Camel, Horse, Yak, Donkey, Reindeer, Sow, Moose, Elk, Musk ox, human beings, etc. All of the female mammals can secrete milk, the composition somewhat similar but there are considerable differences to their physical nature.

Buffalo Milk is pure white because it contains no carotene and it has a high concentration of casein, the protein which is preferred more than cow's milk (Bilal et al., 2006). In general, buffalo Milk contains water, pH, protein, fat, lactose, Vitamins like Vitamin A, Vitamin B₁, Vitamin B₂, Vitamin B₆, Vitamin B₁₂, Vitamin C, Niacin, Pantothenic acid, Biotin, and Folic acid, and Minerals like Calcium, Chlorine, Magnesium, Phosphorus, Potassium, Sodium, Citrate, Sulphur, Iron, Copper and Zinc are considered as the most valuable nutrients (Sharma et

al.,2013). Cow milk has characteristics pale yellow color due to the presence of β -carotene (Hodgson, 1979). Cow's milk contains water, pH, protein, fat, lactose, Vitamins such as Vitamin A, Vitamin D, Vitamin E, Vitamin K, Vitamin B₁, Vitamin B₂, Niacin, Pantothenic acid, Vitamin B₁₂, Folic acid, and Biotin and Minerals like Calcium, Chlorine, Magnesium, Phosphorus, Potassium, Sodium, Citrate, Sulphur, Iron, Copper, and Zinc (Requena et al., 2018; Sharma et al.,2013). Due to the low content of fat in this milk, it is lighter and easily digestible and also considers an excellent source of calcium (Requena et al., 2018). The production of goat milk is a useful strategy to tackle the problem of nutrition, especially among the infant and smallholder farmers, and has been referred to as the "poor man's cow" (Haenlein, 2004). Goat milk contains water, pH, protein, fat, lactose, Vitamins like Vitamin A, Vitamin B₃, Vitamin B₅, Vitamin B₂, Vitamin D, Vitamin B₁, and Folic acid, and Minerals such as Calcium, Phosphorus, Magnesium, Potassium, Chlorine, Sodium, and Sulphur essential constituents (Sharma et al., 2013). Due to its better digestibility, alkalinity, and buffering capacity, it is considered the valuable nutrient-rich primary source for mankind (Park, 1994; Haycraft, 1994). Human milk is believed to provide all the nutrients and essential minerals and trace elements or micronutrients that are required for the normal term infant growth, until weaning (Bates and Prentice,1994).The composition of human milk is water, pH, protein, fat 4.4, lactose 6.9, Vitamins like Vitamin C, Vitamin E, Vitamin K, Vitamin B₁, Vitamin B₂, Vitamin B₆, Vitamin B₁₂, Niacin, Pantothenic acid, Biotin and Folic acid and minerals such as Calcium, Chlorine, Magnesium, Phosphorus, Potassium, Sodium, Citrate, Sulphur, Iron, Copper, and Zinc (Sharma et al., 2013). Human milk is markedly different from other milk, both in terms of macronutrient and micronutrient, and varies throughout lactation. It is thinner and sweeter than other milk since it contains 200 known beneficial elements and helps in cognitive development (Osborn et al., 2017).

It is important to investigate and compare the milk composition of buffalo, cow, goat, and human being in Nepal since such comparisons are limited. A better understanding of the mineral composition of milk would play a key role in solving the malnutrition problem in Nepal. This study has highlighted the composition of four different milk samples and their effects which are important in our daily activities. The main objective of this research is to estimate and compare the physical parameters (color, odor, taste, boiling point etc.) and chemical parameters (water, fat, lactose, protein, pH etc.) of fresh milk and boiled milk of Human (woman), Cow, Buffalo and Goat collected in Damkada and Chhahara of Palpa and to compare these Physicochemical parameters with their United States Department of Agriculture (USDA) standard values.

Materials and Methods

Collection of Milk samples

Chhahara village of Rainadevi which is 27 km away from Tansen was selected as a study area due to the availability of three samples of milk after 1 month of their pregnancy time where its temperature is moderate to warm with 28°C (maximum) during summer and 8°C (minimum) in the winter ; while cow milk was collected from Damkada which is 12 km away from Tansen where the temperature is 30°C (maximum) during summer and 7°C (minimum). Milk samples were collected in sterile bottles from four species viz buffalo, goat, cow, and human (women) after 1 month of their pregnancy time in December, 2018 (Pouss and Magh, 2015). Fresh or raw

Milk samples were collected in an especially made ice tank until reaching the laboratory. Physical parameters such as color, odor, and taste were determined by sensory method where as boiling point by thermometric method and chemical parameters (pH, water, locatose content, fat, chloride content) were analyzed within 12 hours at room temperature about 18°C using documented standard methods. Also, all these parameters were measured within 36 hours after boiling all these fresh milk samples. and a comparative result was made.

Determination of pH

A digital pH meter (Hanna instrument) was used to determine the pH according to the method of Association of Official Analytical Chemists(AOAC, 2000). First of all, the pH meter was warmed for about 30 minutes to eliminate the asymmetric potential of the pH meter, and then, it was calibrated with buffer solutions of pH7 and pH4 using glass electrodes. The pH of each fresh milk at 18°C and after boiling at 50°C sample was then recorded by dipping the glass electrode for about 3 minutes of constant reading.

Determination of Lactose Content

Lactose content was determined by using Fehling's solution method(Sharma et al., 2013). Mixture of 5mL Fehling-A and 5mL Fehling-B was boiled for two minutes and 3-4 drops of methylene blue indicator was added without removing from flame. The mixture in the conical flask was titrated with standard lactose solution (5 g of lactose has been taken in the 1 L volumetric flask in freshly boiled and cooled distilled water and then it was stored in a cool place) when blue colors disappeared and bright red color had been observed, the burette reading was noted as V₁. Again, 10mL of milk samples with 30–40 mL of distilled water was warmed at 40 – 50°C. Then, 1.5 mL of 10% acetic acid was added immediately, diluted up to 100 mL with distilled water, and then been kept undisturbed for 30 min. Then content of the volumetric flask was filtered through What man filter paper grade 42. The titration mixture was then titrated with milk filtrate where the blue color of the solution disappeared and bright brick red color had been observed, the burette reading was noted as V₂. Lactose percentage in milk was calculated by using the following formula.

$$\% \text{ Lactose content in milk} = 5 \times \frac{V_1}{V_2}$$

Where, V₁ = volume in ml of standard lactose solution taken to reduce 10 mL of Fehling's solution and V₂ = volume in mL, of prepared milk filtrate taken to reduce 10 mL of Fehling's solution.

Determination of Chloride Content

The chloride content in milk was determined by Volhard's Argentometric titration method (Sharma et al., 2013). The mixture of 10 mL of AgNO₃ solution and 10 mL of conc. HNO₃ was digested until the reddish fumes were evolved, cooled and 1mL of saturated iron alum as indicator (the filtrate by dissolving Ferric alum crystal in 10% HNO₃ with boiling and the excess

of alum was then followed with cooling) was added, then it was titrated with KSCN (97.18 g of KSCN in 1000 mL distilled water) till the appearance of orange-red color that persists for 10 sec, the burette reading was noted as B. Then, 10mL of milk sample was mixed with 10mL of AgNO_3 and 10 mL of conc. HNO_3 and was digested until the reddish-brown fumes were evolved. Then it was titrated against KSCN by adding 1 mL of indicator till the persistence of orange-red color for 10 sec, the burette reading was noted as A. The chloride content was then calculated by the following formula:

Percentage by weight of chloride content = $0.01773(B-A)$

where B = volume in mL of the standard KSCN solution required by the blank,

and A = volume in mL of standard KSCN solution required by the sample.

Determination of Water Content

Water was detected by using a lactometer. First of all, some milk was taken on a measuring cylinder in which the diameter of the cylinder is about 1 inch greater than the diameter of lactometer and the lactometer had been placed in it, the bulb going on first after that the lactometer bulb floats and reading on lactometer when it becomes stationary indicates the amount of water content on milk.

Determination of Fat content

A volumetric method in which fat is separated from milk by centrifugal force where sulphuric acid is used to dissolve the protein that forms the membrane around the fat and amyl alcohol is added to improve separation of fat from other solids. First, the stem side opening of the butyrometer was closed with a good quality of acid-resistant silicon stopper. Then, 10mL sulphuric acid, 10.75 mL milk sample and 1mL iso-amyl alcohol was added continuously in the butyrometer whose neck side was closed with a lock stopper. The content was mixed and centrifuge at about 1200 rpm. After 5 min, clear fat as the straw yellow color column was observed and reading was directly noted on the stem.

Results and Discussion

Analysis of Physical Properties

The color of milk samples had quite different ranges from bluish yellow to white and could be identified by sensory methods while odor and taste were slightly different and characteristics but couldn't be specified properly. This means human milk and goat milk had an intense smell of milk but the taste of buffalo milk and human milk were much sweeter than cow milk and goat milk. The white color of buffalo milk was due to the presence of a greater amount of casein and lack of carotene whereas, the yellowish blue color of human milk was due to the presence of carotene and the pale-yellow color of cow milk was due to β -carotene which is the precursor of vitamin A. The boiling point of goat milk was only 82°C where as; cow milk was 91°C and buffalo milk was 88°C but human women) milk was 83°C .

Analysis of Chemical Properties

The pH value of collected fresh milk and boiled milk which was determined with the digital pH meter and standard pH values as requirements were shown as in Figure 1. Figure 1 indicates that all collected milk samples lie between slightly acidic to slightly alkaline which is the optimum pH range for nutritious milk. It is known that about 6.7pH is considered the best. Among four collected samples of fresh milk, only two (cow milk and goat milk) are in the range of standard value so they are suitable for use even they are acidic and the pH of all boiled same samples is decreasing than that of fresh milk.

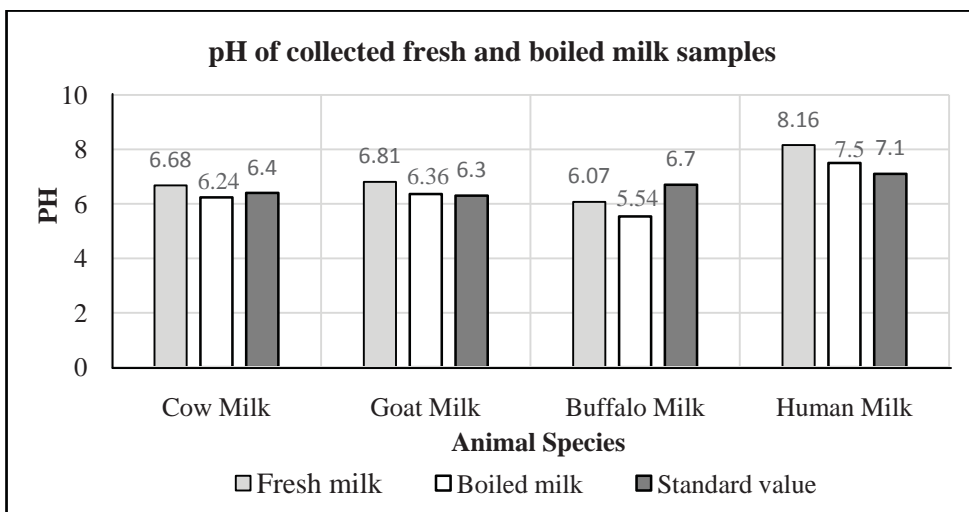


Figure 1: Bar diagram showing comparative pH values of Fresh milk, Boiled milk and standard values of different species.

These data revealed that the pH value of human milk is significantly higher than cow milk, goat milk, and buffalo milk and human milk is alkaline which is essentially used to balance acidity in the body according to United States Department of Agriculture (USDA). But the pH value of the buffalo milk sample under this study is lower than the expected standard value by 2.7 may be due to the lactation period of buffalo and the climatic condition of Chhahara of Rainadevi.

The percentage of lactose present in the collected samples of fresh milk and boiled milk were as in figure 2. The results illustrated that there is a higher content of lactose in human milk than that of other collected fresh milk samples. Goat milk, Cow milk, and Buffalo milk are considered as good in fresh conditions by United States Department of Agriculture (USDA) since they have less than 5 % Lactose content. All samples have decreased amounts of lactose in boiled conditions. Thus, all samples are good and nutritious as food since all have a percentage of Lactose is lesser than 5 %. Thus, it can be concluded that goat milk is easily digested to all than cow milk and buffalo milk.

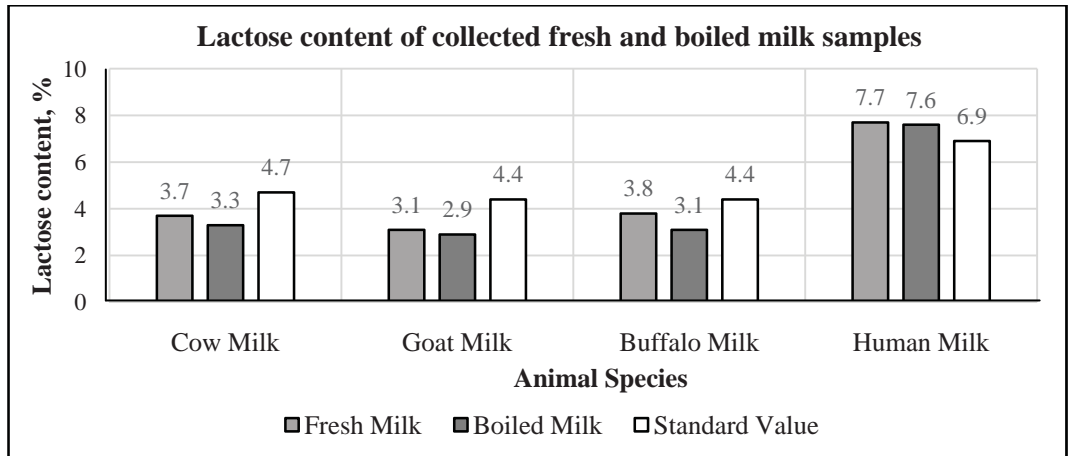


Figure 2: Bar diagram showing comparative Lactose content of Fresh milk, Boiled milk and standard values of different species.

The chloride content of all collected fresh and boiled milk samples were shown in figure 3. It is concluded that almost the same chloride content is present in cow milk, goat milk, and human milk but buffalo milk has a slightly greater value of chloride content. All fresh milk is nutritious milk because collected fresh milk samples have chloride content less than 80 mg/100 mL. After boiling fresh milk, chloride content is decreased than fresh milk, and therefore, they are better in use.

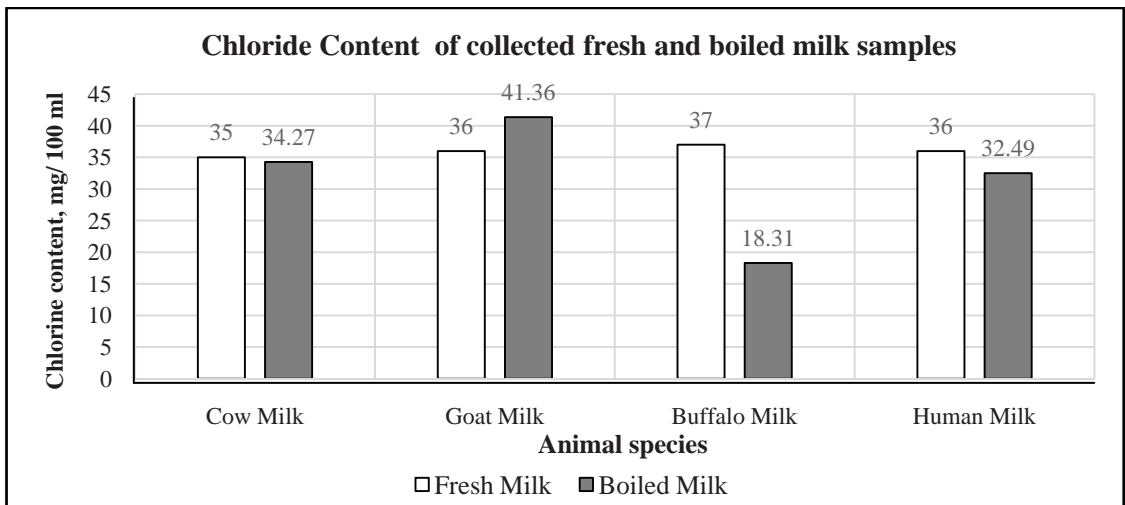


Figure 3: Bar diagram showing comparative chloride content of Fresh milk and Boiled milk of different species.

The percentage of Fat content present in the collected fresh and boiled milk samples were as in figure 4.

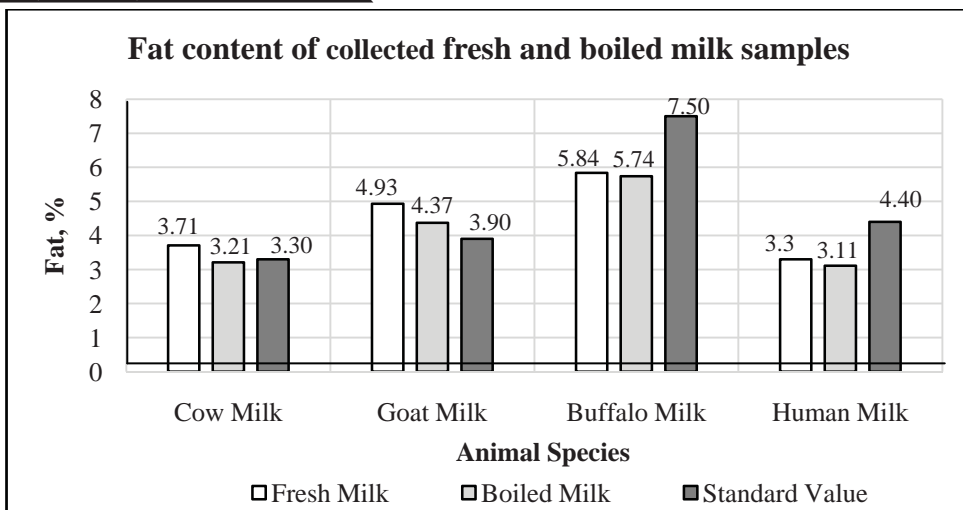


Figure 4: Bar diagram showing comparative values of Fat content of Fresh milk, Boiled milk and standard values of different species.

Fresh cow milk and human milk are better than fresh goat milk and buffalo milk due to lesser than 3.4 % fat which is required for United States Department of Agriculture (USDA) standards of good quality milk. All boiled milk has decreased amount of fat than fresh milk and is suitable also.

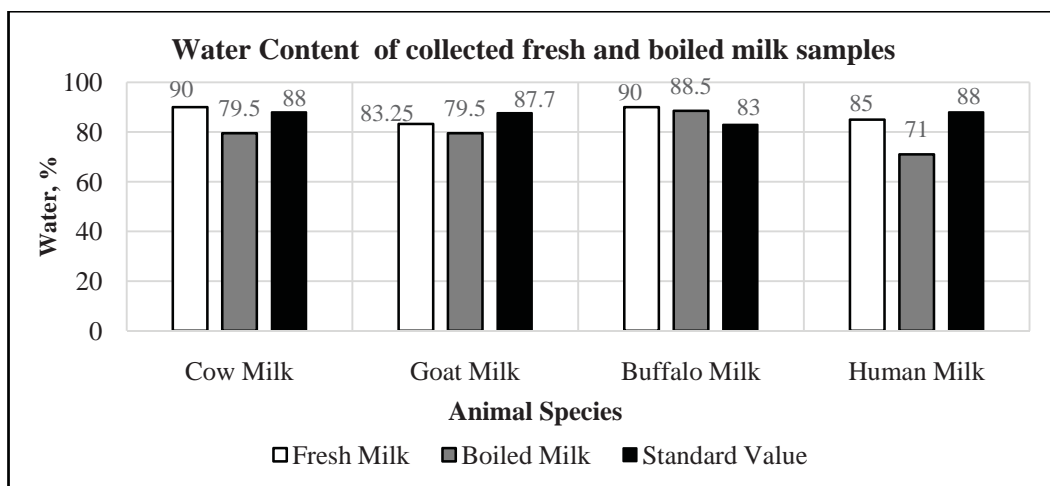


Figure 5: Bar diagram showing comparative percentage water content of Fresh milk, Boiled milk and standard values of different species.

The percentage of water content present in the collected samples of fresh milk of cow, goat, buffalo, and human and these milks after boiling were as in figure 4. All collected milk samples have water in the range of standard requirements in both conditions. The high percentage of water content in cow milk and buffalo milk indicates the presence of fewer amounts of total solids and fat content in fresh milk.

Conclusion

Mammals as cows, goats, buffalo, and human beings produce milk, but their composition varies widely according to the climate where they live, lactation period, the food they feed on, and so on. From the viewpoint of human nutrition, human milk has several unique properties that make it the most preferred milk as compared to the milk of other milk. Also, all milk samples seem to be good in boiled conditions than in fresh conditions. Following conclusions are drawn as: -

- Cow milk meets the standard requirement of pH values, lactose content, chloride content, percentage fat, and water content so cow milk is considered as suitable milk for our health nutrition and easily can be digested.
- Goat milk also meets with the standard requirement of pH values, lactose content, chlorine content, and water content but the fat content is higher than 3.4 %. So, due to the higher percentage of fat in goat milk, it is difficult to digest than cow milk. Goat milk is beneficial and nutritious since, it contains a high percentage of Proteins, Vitamins, and Minerals.
- Buffalo milk has a very low pH value, less than 5% lactose content, higher value of chlorine content than others but it is less than 80mg/100mL, fat content is greater than 3.4%, and water content is in a suitable range. So, due to low pH, it is sour and has greater fat content, which causes difficulty in digesting.
- Human milk is alkaline, the lactose content is higher than others, chlorine content is in the range, fat is less than 3.4% and water content is in a definite range. So, Human milk is considered the best milk since it contains the highest percentage of Minerals, Vitamins, and Proteins, and also, Human milk has high immune power for the infant.

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