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Comparison of a Few Raw and Pasteurized Milk Samples from Minor Milch Animals in the Palpa Area

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Abstract

Milk is a whitish liquid that mammals secrete and is a vital source of sustenance for a newborn baby. Milk contains vitamins, minerals, proteins, lipids, milk sugar, and other nutrients. After 28th days of pregnancy, the physico-chemical characteristics of raw milk (RaM) and pasteurized milk (PaM) from some female milch animals, such as goats, cows, buffalo, and humans, in the Palpa area were compared. The pH, water content, fat, milk sugar, and chloride levels of the RaM and PaM samples from goats (GM), cows (CM), buffaloes (BM), and humans (HM) varied, according to the documented parametric analysis. Standard United States Department of Agriculture (USDA) requirements were met by all tested physico-chemical parameters, with PaM exhibiting better qualities than RaM. Water content is decreased but other parameters are increased when RaM is pasteurized to obtain PaM. Infants respond better to PaM samples than RaM samples. The community will be able to properly use pasteurised milk instead of raw milk thanks to this study.

Key Words: *milch animals, parametric analysis, pasteurized milk, raw milk.*

Introduction

Milk is a whitish liquid and an essential source of nutrients for newborn mammals, supporting their growth and serving as a dietary component for adults. It is secreted by female mammary glands, including sweat and sebaceous glands, providing a complete nutritional supply for neonates (Bruckmaier & Zinn, 2023). In addition to being a rich source of protein and energy necessary for human development and parental care (Grenov & Michaelsen, 2018), milk contains antibodies that protect young mammals from infections (Galili, 2020). Approximately 150 million animal species, including cows, buffalo, goats, sheep, camels, horses, yaks, donkeys, reindeer, moose, elk, musk ox, pigs, and humans, produce milk. While the fundamental composition of milk remains consistent across mammalian species, its physical properties vary significantly (Kanetkar *et al*., 2023).

Goat milk (GM), also referred to as the "poor man's cow," is an essential source of human nutrition by providing animal origin protein, especially for smallholder farmers and newborns (Lund & Ahmad, 2021). Among the essential elements of GM include proteins, lipids, lactose, minerals, vitamins, and more (Antunes *et al*., 2022). Because of its alkalinity, buffering ability,

and digestibility, it is widely accepted as a nutritional component. Additionally, cow milk (CM) offers enough minerals or Human milk contains substantially lower quantities of these minerals, with only one-fourth as much calcium and one-sixth as much phosphate (Dagnaw *et al*., 2016). CM has a pale yellow hue due to β-carotene and is characterized by its lower fat content, making it lighter, easily digestible, and a rich source of calcium (Zalewska *et al*., 2025). Buffalo milk (BM), on the other hand, is a favoured protein source over cow's milk since it is notably pure white because it lacks carotene and contains a high amount of casein (Garau *et al*., 2021). According to Ahmad *et al*. (2013), BM includes vital nutrients such water, protein, fat, lactose, minerals like Ca, Mg, P, K, Na, S, Fe, Cu, Zn etc., and vitamins such as B-complex, A, C, niacin, pantothenic acid, biotin, and folic acid. Human milk (HM) is especially suitable for baby feeding since it contains all of the vital components needed for growth until weaning (Szyller *et al*., 2024). With changes throughout breastfeeding, macronutrient and micronutrient of HM makeup sets it apart from other kinds of milk (Ballard & Morrow, 2013). Water, protein, fat, lactose, minerals like calcium, chlorine, magnesium, phosphorus, potassium, sodium, sulphur, iron, copper, etc., oil and water soluble vitamins are nutrients present in human milk (Ren *et al*., 2024). Because of its high lactose content, HM is notably sweeter and thinner, and it contains more than 200 healthy ingredients that support cognitive development (Chiurazzi *et al*., 2021).

Currently, there is no comparison between raw milk (RaM) from milch animals and pasteurized milk (PaM) during the first month of pregnancy, as far as the authors are aware. Therefore, the purpose of this research is to compare RaM and PaM from goats, cows, buffalo, and human in the Palpa area. Different physico-chemical characteristics of RaM and PaM obtained from common female milch animals (GM, CM, BM, and HM) were compared in this study. This study will open the door to determining the optimal conditions for using raw or pasteurized milk. Also, PaM will be suggested better to use for infants.

Materials and Method

The research was carried out in Chhahara village of Rainadevi, located 27 km from Tansen, where three types of RaM samples (GM, BM, and HM) were collected within one-month post-pregnancy (28 days). The region experiences a moderate to warm climate, with temperatures varying between 8°C in winter and 28°C in summer. Also, CM sample was collected from Damkada, 12 km from Tansen, where temperatures range from 30°C in summer to 7°C in winter. RaM samples were stored in sterile carboys and transported in an ice container to maintain freshness for analysis. The collected RaM samples for three different times were first evaluated for physical characteristics using sensory analysis, and then their boiling point was determined using thermometric analysis. Within 12 hours at 18°C, chemical characteristics such as water content, pH, lactose, fat, and chloride levels were examined. In order to compare RaM and PaM, these parameters were reevaluated within 36 hours of pasteurization employing standardized protocols. The pH was measured using a digital pH meter (Hanna, USA) in accordance with AOAC (2000) recommendations. A lactometer's reliable reading in a measuring cylinder was used to calculate the water content. The fat column was measured straight from the butyrometer, and the fat content was determined using a volumetric approach that involved centrifugation and chemical treatment (Panta & Gautam, 2023).

Fehling's solution (FSSAI 01.111:2022) method was used to determine the percentage of milk sugar in the RaM and PaM samples. After boiling the Fehling-A and Fehling-B solutions, methylene blue indicator was added, and the mixture was titrated with a standard lactose solution until a bright red colour developed and the burette readings were recorded as 'p' mL. The titre volume was recorded as 'q' mL after milk samples (RaM or PaM) were treated with acetic acid, diluted, and filtered prior to a second titration with Fehling's solution. Using the following formula, the percentage of milk sugar was determined (Sharma *et al.*, 2013):

$$\% \text{ Milk Sugar} = \frac{p \times 5}{q}$$

The chloride content in RaM and PaM samples was estimated using Volhard method (Sharma *et al.*, 2013). A mixture of silver nitrate and concentrated nitric acid was heated until reddish fumes appeared, then cooled before adding ferric alum indicator. The solution was titrated with potassium thiocyanate until a stable orange-red color appeared, and the burette reading was recorded as 'x' mL. Similarly, a 10 mL milk sample was mixed with $AgNO_3$ and HNO_3, digested, and titrated with KSCN until the orange-red color persisted for few seconds, with the burette reading noted as 'y' mL. The chloride content was calculated using the formula (Sanders, 1939):

$$\% \text{ chloride content} = [x\text{-}y] \times 0.01773$$

Results and Discussion

The raw samples of female milch animals like GM, CM, BM, and HM after collected in sterile carboys in ice container were subjected to sensory evaluation with boiling point determination as tabulated in Table 1.

Table 1: *Physical parameterization of RaM samples employing Sensory evaluation method*

RaM Samples	Physical Evaluation
GM	Buttery Yellow; 355 K
CM	Pale Yellow; 364 K
BM	Creamy White; 361 K
HM	Bluish Yellow; 356 K

The colours of RaM samples ranged widely from bluish yellow to white and could be distinguished using sensory approaches, but their tastes and odours were somewhat different and had features that were difficult to define. This indicates that although GM and HM samples had a strong milky smell, they tasted significantly sweeter than CM and GM samples. While HM samples have a yellowish blue colour due to the presence of carotene, and CM sample has a pale yellow colour due to β-carotene, the precursor of vitamin A, BM sample has a white colour due to the presence of more casein and less carotene. Also, GM had a boiling temperature of only 355 K, while CM, BM, and HM had boiling points of 364 K, 361 K, and 356 K, respectively.

After milking some milch animals, including goats, cows, buffaloes, and humans, after 28 days of pregnancy, and after pasteurizing these samples, chemical parameters such as water content, milk sugar, fat, chlorides, and other minerals or proteins were examined for milk samples in addition to their physical characteristics. The percentage composition of several chemical parameters found in raw and pasteurized samples taken from goats within a month of giving birth is depicted in **Fig. 1**, a bar diagram. This showed that in RaM samples, the GM comprises 8.68% minerals and proteins with acceptable milk sugar, fat, chlorides, and water according to standards. However, following pasteurization, the percentages of water, milk sugar, fat, and chloride fall while the percentages of minerals and proteins increase from 8.68% to 13.19%. Less than 5% milk sugar is present that is good according to USDA standards. Therefore, it can be said that milk from goat (GM) can be easily digested more readily than cow and buffalo milk (Kapadiya *et al.*, 2016).

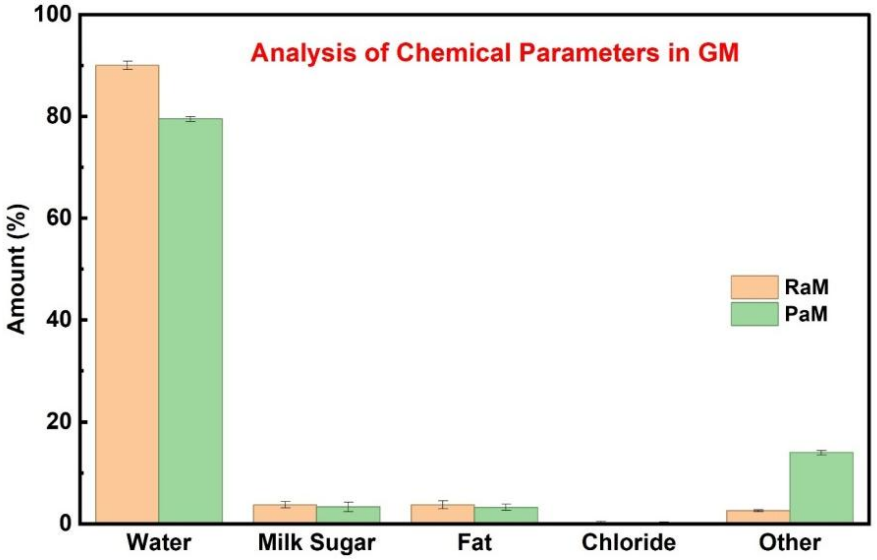

Figure 1: Bar diagram with error bars showing different percentages of chemical parameters present in RaM and PaM obtained from Goat within one-month post-pregnancy.

Fig. 2 shows the percentage composition of various chemical parameters found in raw and pasteurized milk samples that were taken from cows within a month of giving birth. This result showed that in RaM samples, the CM contained 2.56% minerals and proteins, with accepted milk sugar, fat, chlorides, and water. However, following pasteurization, the percentages of water, milk sugar, fat, and chloride similarly decrease, but the percentages of minerals and proteins increase from 2.56% to 13.96%. The trends of decrease in the concentration of milk sugar, fat, and chlorides from raw sample to pasteurized sample as reported in previous reports (Melini *et al.*, 2017). USDA guidelines specify that cow milk (CM-RaM) samples have less than 3.30% fat, while PaM samples satisfy the standards better than RaM, indicating that it is preferable to have PaM in milk from cows after 28 days of pregnancy in the investigated regions.

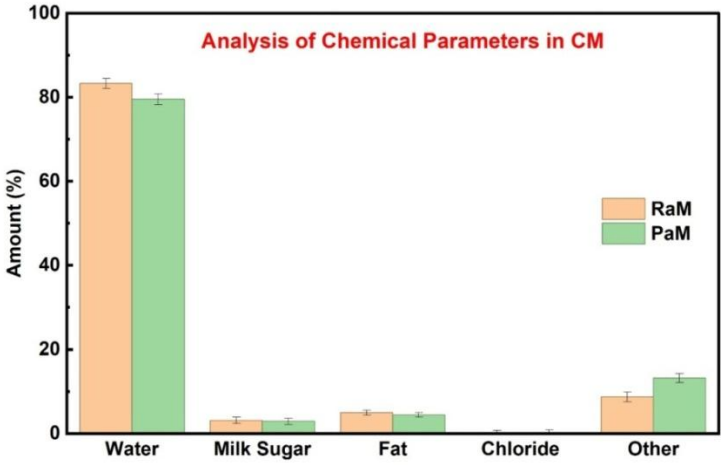

Figure 2: Bar diagram with error bars showing different percentages of chemical parameters present in RaM and PaM obtained from Cow within one-month post-pregnancy.

Similarly, raw and pasteurized samples of same milk obtained from Buffalo within one month of post-pregnancy was analyzed for chemical parameterization and illustrated in the bar diagram as shown in **Fig. 3**. The percentage compositional analysis of samples contains 90 % water along with milk sugar, Fat, and chlorides as essential for nutrient milks, and about 0.04 % minerals and proteins in RaM samples. But percentages of water, milk sugar, fat and chloride is decreased after pasteurization with increased in percentages of minerals and proteins from 0.04 % to 2.6 % or more. Lesser than 4.4% milk sugar. Also, higher amount of fat among investigated samples (GM, CM, BM, and HM) but BM samples are good according to USDA standards, as previous literatures (Abdelazim, & El-Shibiny, 2011). Buffalo milk is nutritious for infants and have no side effects on human health due to fats and milk sugar content. Also, pasteurized samples are better than raw samples, as described elsewhere (Amar & Farid, 2024).

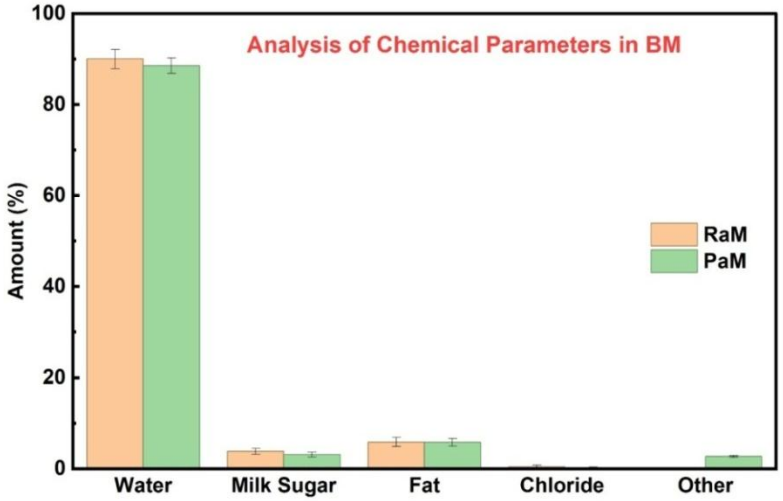

Figure 3: Bar diagram with error bars showing different percentages of chemical parameters present in RaM and PaM obtained from Buffalo within one-month post-pregnancy.

Fig. 4 is the bar diagram for illustrating the percentage composition of different chemical parameters present in raw and pasteurized samples obtained from Humans within one month of post-pregnancy. This revealed that the HM contains about 4 % minerals and proteins along with accepted ranges of water, milk sugar, Fat, and chlorides in RaM samples. But percentages of water, milk sugar, fat and chloride is decreased after pasteurization with increased in percentages of minerals and proteins from 3.96 % to 18.26 %. These results revealed that fresh human milk samples (RaM-HM) at the 28th days of lactation are better than fresh goat milk (RaM-GM) and buffalo milk (RaM-BM) due to lesser than 3.4 % fat which is required for USDA standards of good quality milk (Pietrzak-Fiećko, R., & Kamelska-Sadowska, 2020).

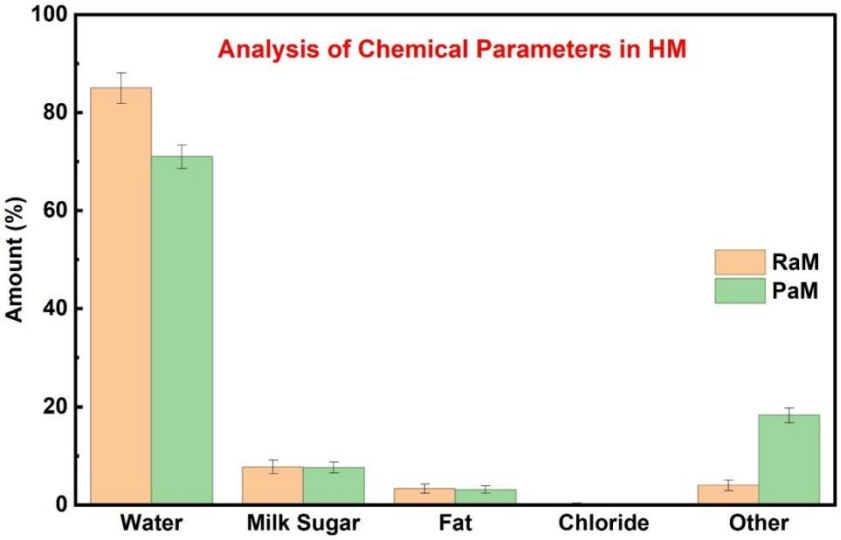

Figure 4: Bar diagram with error bars showing different percentages of chemical parameters present in RaM and PaM obtained from Human within one-month post-pregnancy.

Using the digital pH meter presented in **Fig. 5**, the pH values of the collected fresh RaM samples and samples after pasteurization (PaM) were ascertained. All of the samples under investigation fall within the ideal pH range for nutrient-dense milk, which is slightly acidic to slightly alkaline. It is well known that the ideal pH is around 6.7, as indicated elsewhere (Yang *et al.*, 2023). The pH values also show similar trends of decreasing its values from RaM to PaM samples of all investigated milch animals (Elbagerma *et al.*, 2014). The pH of milk samples from goat, cow, buffalo, and human species should be 6.3, 6.4, 6.7, and 7.1, respectively, according to USDA standards. This showed that PaM samples are practically superior to all RaM samples, and that RaM samples from cow (CM) and goat (GM) are within the range even in RaM samples. As a result, even somewhat acidic samples of milch animals taken within a month of pregnancy are acceptable. According to USDA, the alkaline pH value of HM samples is substantially greater than that of GM, CM, and BM samples, which is effectively utilized to balance the body's acidity. However, the pH value of the BM-

sample used in this study is somehow lower (>2.5) than the predicted standard value, which could be because of the buffalo's lactation time and the climatic condition of geographical place from sample was taken, as previous literatures (Panta & Gautam, 2023).

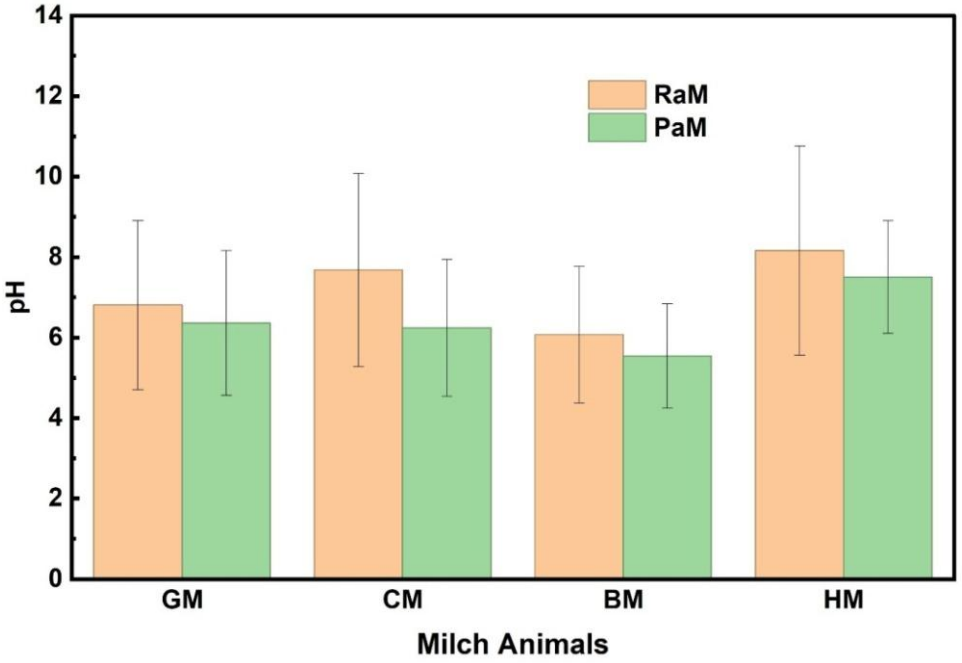

Figure 5: Bar diagram with error bars showing pH values of RaM and PaM obtained from milch animals (GM/CM/BM/HM) within one-month post-pregnancy.

These all data revealed that pasteurized milk samples are better to consumed than milk at raw condition since, all parameters are in balanced condition after pasteurized condition.

Conclusion

The physical and chemical properties of raw milk (RaM) collected from minor milch animals, including goats, cows, buffaloes, and humans, in the Palpa region after 28 days of pregnancy were analyzed. Additionally, these RaM samples were pasteurized (PaM), and their characteristics were assessed. The evaluated parameters, such as milk sugar, water content, chloride levels, minerals, and proteins, aligned with USDA standards. Variations in RaM composition were observed among different species, influenced by climatic and geographical factors. All milk samples exhibited slightly acidic pH, while PaM samples had pH levels suitable for infants. Overall, both RaM and PaM samples from goats, cows, buffaloes, and humans met USDA standards. While buffalo and cow milk were easily digestible, human milk provided higher immune benefits for infants, and goat milk was found to be the most nutritious. Furthermore, pasteurized milk samples were deemed superior to raw milk samples.

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Authors' Contributions

The experiments were planned by SP, SS, and MG; SP prepared the samples, conducted the experiments, and analyzed the data; MG, and SS reviewed the data and results summarization; SP and SS produced the paper draft; and MG made the final revisions. The final manuscript was read and approved by all authors.

Conflict of Interest

The authors claim that they have no competing interests.

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