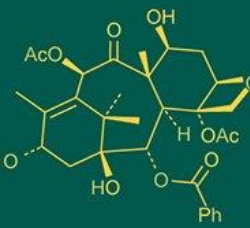
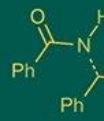


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Effect of milk type and pressing pressure on the physicochemical composition of *Chhurpi*: A traditional Himalayan hard dairy product

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Abstract

Chhurpi is a traditional Himalayan hard dairy product known for its high protein content, prolonged shelf life, and nutritional significance. The present study was undertaken to evaluate the effect of milk type and pressing pressure on the physicochemical composition of *chhurpi*. The product was prepared from cow milk, buffalo milk, and a 1:1 blend of cow and buffalo milk and subjected to four pressing pressure levels (8, 9, 10, and 11 kg/cm²). A market sample of yak milk *chhurpi* was used as a reference control. The prepared samples were analyzed for moisture, fat, protein, ash, carbohydrate, and lactose contents. The results indicated that both milk type and pressing pressure significantly influenced the composition of *chhurpi*. Moisture content ranged from 13.49 to 15.20%, while protein content varied from 63.50 to 65.80%. Higher pressing pressures enhanced whey expulsion, resulting in lower moisture and lactose contents and increased concentrations of protein and ash. Buffalo milk *chhurpi* exhibited comparatively lower moisture and higher protein and mineral contents than cow milk *chhurpi*, owing to its higher total solids and casein content. *Chhurpi* prepared from mixed milk showed intermediate characteristics. Significant interaction effects between milk type and pressing pressure were observed for moisture, protein, and lactose contents, indicating that the response to pressure depended on milk composition. The findings demonstrate that optimization of milk type and pressing pressure is essential for improving product quality, compositional uniformity, and processing efficiency. The study provides valuable scientific information for the standardization and commercial-scale production of *chhurpi* while maintaining its traditional identity and nutritional attributes.

Keywords: *Chhurpi*, dairy product, milk type, pressing pressure, physicochemical composition

Introduction

Indigenous dairy products constitute an integral part of the traditional food systems, cultural heritage, and nutritional security of the Himalayan region. Among these products, *chhurpi* is a traditional fermented and dried dairy product widely consumed in India, Nepal, Bhutan, and Tibet. The product is characterized by its low moisture content, firm texture, and remarkable storage stability under ambient conditions, which contribute to its extended shelf life. Traditionally consumed by local communities in mountainous regions, *chhurpi* has recently gained international attention owing to its high protein content and increasing demand as a natural dog chew product in global markets (Tamang, 2010; Pradhan & Tamang, 2011) [8, 7].

The physicochemical and textural properties of *chhurpi* are significantly influenced by the composition of the milk used during its manufacture. Milk from different species varies in fat, protein, and total solids content, which directly affects coagulation behavior, curd formation, moisture retention, and whey expulsion. Buffalo milk, owing to its higher concentrations of fat and protein compared to cow milk, generally produces a firmer curd with distinct drainage characteristics, thereby influencing the pressing behavior and final quality attributes of *chhurpi* (Fox & McSweeney, 2017) [1]. When cow milk, buffalo milk, or their blends are used for *chhurpi* production, differences in curd structure necessitate precise control of pressing parameters to achieve uniform product quality. However, the traditional manufacturing process largely relies on manual pressing methods, resulting in variability in moisture content, texture, and overall product consistency.

Nutritionally, *chhurpi* is a rich source of high-quality protein, calcium, phosphorus, and essential micronutrients, making it a valuable dietary component for communities residing in high-altitude regions. Recognizing the nutritional, cultural, and economic importance of traditional dairy products, the National Commission on Agriculture (1976) emphasized the need for the development of suitable technologies for their standardized and commercial-scale production. Therefore, the optimization and standardization of processing operations, particularly pressing conditions for different milk types, are essential to improve product consistency, enhance processing efficiency, and support the commercial development of *chhurpi* while preserving its traditional identity.

Materials and Methods

Cow milk and buffalo milk for *chhurpi* making was procured from local dairy farm of Dandi, Naini, Prayagraj. The chemicals for *chhurpi* analysis were procured from HiMedia, Mumbai, India. The experimental study was conducted to evaluate the effect of different milk types and pressing pressures on the quality characteristics of *chhurpi*. A total of twelve treatments were formulated, based on milk type and applied pressing pressure.

The treatments were designated as follows:

- T₁ = Cow milk *chhurpi* + 8 kg/cm² pressure
- T₂ = Buffalo milk *chhurpi* + 8 kg/cm² pressure
- T₃ = 50% cow milk + 50% buffalo milk *chhurpi* + 8 kg/cm² pressure
- T₄ = Cow milk *chhurpi* + 9 kg/cm² pressure
- T₅ = Buffalo milk *chhurpi* + 9 kg/cm² pressure
- T₆ = 50% cow milk + 50% buffalo milk *chhurpi* + 9 kg/cm² pressure
- T₇ = Cow milk *chhurpi* + 10 kg/cm² pressure
- T₈ = Buffalo milk *chhurpi* + 10 kg/cm² pressure
- T₉ = 50% cow milk + 50% buffalo milk *chhurpi* + 10 kg/cm² pressure
- T₁₀ = Cow milk *chhurpi* + 11 kg/cm² pressure
- T₁₁ = Buffalo milk *chhurpi* + 11 kg/cm² pressure
- T₁₂ = 50% cow milk + 50% buffalo milk *chhurpi* + 11 kg/cm² pressure

Thus, the experiment comprised three types of milk (cow milk, buffalo milk, and 1:1 cow-buffalo milk blend) subjected to four levels of pressing pressure (8, 9, 10, and 11 kg/cm²).

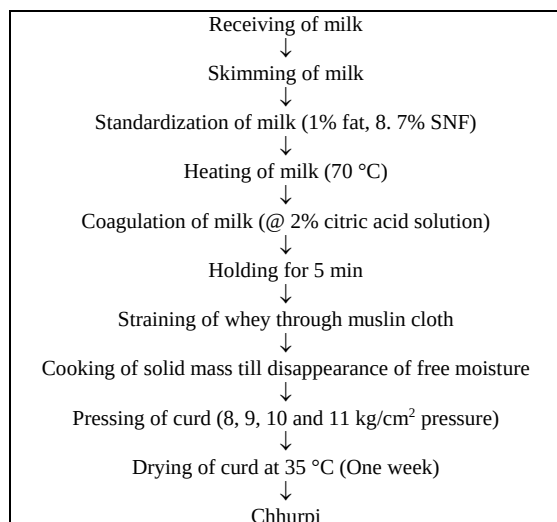


Fig 1: Flow diagram of *chhurpi*

Milk was first received and subjected to skimming to remove cream, followed by standardization to obtain a composition of approximately 1% fat and 8.9% solids-not-fat (SNF). Standardization ensures uniform raw material quality and consistency in the final product. The standardized milk was heated to 70 °C, which helps improve microbial safety and facilitates subsequent coagulation. Coagulation was achieved by adding 2% citric acid solution, resulting in the precipitation of milk proteins and the formation of curd. The coagulated mass was then held for 5 min to allow complete curd formation and whey separation. The whey was removed by straining the coagulum through a muslin cloth. The resulting curd mass was subsequently cooked until free moisture disappears, producing a compact protein-rich mass with reduced water content. This cooking step enhances the firmness and shelf stability of the product. The cooked curd was then subjected to pressing at different pressure levels (8, 9, 10 and 11 kg/cm²) to expel additional moisture and develop the characteristic dense texture of *chhurpi*. Pressing pressure significantly influences the moisture content, hardness, and overall quality of the final product. After pressing, the curd blocks are dried at 35 °C for one week in hot air oven. Controlled drying further reduces moisture content, increases product hardness, and contributes to the extended shelf life of *chhurpi*. The final dried product obtained was *chhurpi*, a traditional high-protein dairy product known for its firm texture, nutritional value, and excellent storage stability under ambient conditions.

The physico-chemical properties of *Chhurpi* were analyzed using standard analytical procedures as described below:

- **Moisture (%) of *chhurpi*:** Determined as per Food Safety and Standards Authority of India (FSSAI, 2015) [2] standard method.
- **Fat (%):** Estimated according to FSSAI (2015) [2] prescribed procedure.
- **Protein (%):** Determined by standard Kjeldahl method as per FSSAI (2016) [3].
- **Ash (%):** Determined following FSSAI (2016) [3] method.
- **Total Carbohydrate (%):** Calculated by difference method.
- **Lactose (%):** Determined as per FSSAI (2016) [3] guidelines.

Results and Discussion

All the physicochemical composition of *chhurpi* obtained during the study is represented in Table 1.

Table 1: Physicochemical composition of *chhurpi*

Treatment	Moisture	Fat	Protein	Ash	Carbohydrate	Lactose
T ₁	14.30	7.30	64.80	6.32	7.28	3.20
T ₂	13.80	7.10	65.30	6.47	7.33	3.05
T ₃	13.59	7.00	65.60	6.61	7.20	2.90
T ₄	13.49	6.90	65.80	6.80	7.01	2.75
T ₅	15.20	7.00	63.50	6.12	8.18	3.50
T ₆	14.40	6.80	64.20	6.24	8.36	3.35
T ₇	14.10	6.70	64.60	6.38	8.22	3.10
T ₈	13.90	6.60	65.00	6.53	7.97	2.90
T ₉	14.80	7.10	64.00	6.21	7.89	3.35
T ₁₀	14.10	6.90	64.60	6.34	8.06	3.20
T ₁₁	13.90	6.80	64.90	6.49	7.91	3.00
T ₁₂	13.70	6.70	65.20	6.66	7.74	2.82

The present investigation demonstrated that both milk type and pressing pressure significantly influenced the physicochemical composition of *chhurpi*. Variations in moisture, protein, fat, ash, carbohydrate, lactose, and titratable acidity among the treatments were primarily associated with differences in milk composition and the extent of moisture removal during pressing and drying. Similar observations have been reported for traditional hard cheeses and *chhurpi*, where the compositional characteristics of the raw milk and processing conditions play a critical role in determining product quality (Fox & McSweeney, 2017; Panda *et al.*, 2016) [1, 5].

Moisture Content of *chhurpi*

The moisture content was higher in cow milk than buffalo milk and mix milk. Moisture content in *chhurpi* of buffalo milk was 14.3%, 13.8%, 13.59% and 13.49% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. Moisture content in *chhurpi* of cow milk was 15.2%, 14.4%, 14.1% and 13.9% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively while moisture content in *chhurpi* of mix milk (50% cow milk and 50% buffalo milk) was 14.80%, 14.10%, 13.9% and 13.7% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. Buffalo milk *chhurpi* generally has lower moisture content compared to cow milk *chhurpi* due to higher fat, solid and protein (casein) content, resulting in a drier, firmer texture. The similar results were noted in case of cheese made from cow milk and buffalo milk by Bittante *et al.*, 2022; Sonwane *et al.*, 2024 [8, 10].

A full factorial experimental design was employed to evaluate the effects of milk type and pressing pressure on the moisture content of *chhurpi*, and the data were analyzed using SPSS through two-way ANOVA. The ANOVA results showed that milk type had a highly significant effect on moisture content ($p < 0.001$). Pressing pressure also exhibited a statistically significant effect ($p < 0.001$), confirming that mechanical compression significantly influences whey expulsion and moisture distribution within the curd structure. The interaction effect between milk type and pressure was also highly significant ($p < 0.001$).

Fat content of *chhurpi*

Fat content of *chhurpi* was higher in buffalo than cow milk and mix milk. Fat content in *chhurpi* of buffalo milk was 7.3%, 7.1%, 7.0% and 6.9% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. Fat content in *chhurpi* of cow milk was 7.0%, 6.8%, 6.7% and 6.6% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively while fat content in *chhurpi* of mix milk (50% cow milk and 50% buffalo milk) was 7.1%, 6.9%, 6.8% and 6.7% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. Fat percentage in *chhurpi* was reported 4.01% to 7.7% by Bhat *et al.*, 2022; Panda *et al.*, 2016; Pal *et al.*, 1996) [11, 5, 12].

ANOVA results indicated that milk type and pressure had a highly significant effect on fat content ($p < 0.001$) while the interaction effect between milk type and pressure was found to be non-significant ($p > 0.05$).

Protein content of *chhurpi*

Protein content in *chhurpi* of buffalo milk was 64.8%, 65.3%, 65.6% and 65.8% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. Protein content in

chhurpi of cow milk was 63.5%, 64.2%, 64.6% and 65.0% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively while protein content in *chhurpi* of mix milk (50% cow milk and 50% buffalo milk) was 64.0%, 64.6%, 64.9% and 65.2% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. The protein content of *chhurpi* samples in the present study ranged from 63.5% to 65.8%, indicating that *chhurpi* is a highly protein-rich dairy product. The values obtained in this study are comparable with those reported in earlier studies. Panda *et al.* (2016) [5] reported that the protein content of *chhurpi* ranged between 60-63%, while Shrestha (2015) [13] reported approximately 68.5% protein on a dry basis. The slight variation between the present results and the literature values may be attributed to differences in milk composition, processing techniques, pressing conditions, and moisture content of the final product.

ANOVA results indicated that milk type and pressure had a highly significant effect on protein content ($p < 0.001$). The interaction effect between milk type and pressure was found to be significant ($p < 0.05$).

Ash Content of *chhurpi*

Ash content in *chhurpi* of buffalo milk was 6.32%, 6.47%, 6.61% and 6.8% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. Ash content in *chhurpi* of mix milk (50% cow milk and 50% buffalo milk) was 6.21%, 6.34%, 6.49% and 6.66% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively while ash content in *chhurpi* of cow milk was 6.12%, 6.24%, 6.38% and 6.53% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. The ash content of *chhurpi* samples in the present study ranged from 6.12% to 6.80%, indicating a relatively high mineral content typical of hard dairy products. The values obtained are comparable with previously reported studies. Ash content in *chhurpi* was cited in the range of 5.9-6.3% in other literature (Panta *et al.*, 2023; Panda *et al.*, 2016) [6, 5], which are very close to the results observed in the present investigation. The slightly higher ash values observed in the present study may be attributed to differences in milk composition, mineral concentration in the casein matrix, and the extent of moisture removal during pressing and drying.

ANOVA results indicated that milk type and pressure had a highly significant effect on ash content ($p < 0.001$) while the interaction effect between milk type and pressure was found to be non-significant ($p > 0.05$).

Carbohydrate content of *chhurpi*

Total carbohydrate content in *chhurpi* of buffalo milk was 7.28%, 7.33%, 7.2% and 7.01% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. Total carbohydrate content in *chhurpi* of mix milk (50% cow milk and 50% buffalo milk) was 7.89%, 8.06%, 7.91% and 7.74% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively while carbohydrate content in *chhurpi* of cow milk was 8.18%, 8.36%, 8.22% and 7.97% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. The carbohydrate content of *chhurpi* samples in the present study ranged from 7.01% to 8.18% across different treatment combinations. These values fall within the range reported in previous studies. Raigar *et al.* (NHMS report) reported that the carbohydrate content in yak milk hard cheese ranged between 4-15%.

ANOVA results indicated that milk type and pressure had a highly significant effect on total carbohydrate content ($p < 0.001$) while the interaction effect between milk type and pressure was found to be non-significant ($p > 0.05$).

Lactose content of *chhurpi*

Lactose content in *chhurpi* of buffalo milk was 3.2%, 3.05%, 2.9% and 2.75% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. Lactose content in *chhurpi* of mix milk (50% cow milk and 50% buffalo milk) was 3.35%, 3.2%, 3.00% and 2.82% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively while lactose content in *chhurpi* of cow milk was 3.5%, 3.35%, 3.1% and 2.9% with pressure 8 kg/cm², 9 kg/cm², 10 kg/cm² and 11 kg/cm², respectively. The lactose content of *chhurpi* samples in the present study was found that increasing the pressure lactose content decreases. Lactose content in cow milk *chhurpi* is higher than buffalo milk *chhurpi*. These values are comparable with those reported in previous studies. Shrestha *et al.* (2015) [13] reported that the lactose content of *chhurpi* prepared from buttermilk was 3.18%. Similarly, Hossain (1994) [4] reported that the lactose content in *dudh chhurpi* ranged between 3.14% and 3.22%. The lactose values obtained in the present investigation fall within a similar range, indicating comparable retention of milk sugar in the final product.

The ANOVA results showed that milk type had a highly significant effect on lactose content ($p < 0.001$). Pressing pressure also exhibited a statistically significant effect ($p < 0.001$), confirming that mechanical compression significantly influences whey expulsion and moisture distribution within the curd structure. The interaction effect between milk type and pressure was also highly significant ($p < 0.001$).

Overall, the findings demonstrate that optimization of milk type and pressing pressure is essential for controlling the physicochemical composition and quality characteristics of *chhurpi*. Among the factors studied, milk type exerted the greatest influence on product composition, whereas pressing pressure played a crucial role in regulating moisture removal, concentration of milk solids, texture development, and shelf stability. These results are in agreement with previous studies on *chhurpi* and hard cheese manufacture, which emphasize the importance of milk composition and processing conditions in determining the quality and nutritional attributes of the final product (Fox & McSweeney, 2017; Panda *et al.*, 2016; Shrestha, 2015) [1, 5, 13].

Conclusion

The present study demonstrated that both milk type and pressing pressure significantly affect the physicochemical composition of *chhurpi*. Buffalo milk *chhurpi* exhibited comparatively lower moisture and higher protein and ash contents than cow milk *chhurpi*, while *chhurpi* prepared from a cow-buffalo milk blend showed intermediate characteristics. Increasing pressing pressure enhanced whey expulsion, resulting in reduced moisture and lactose contents and a corresponding concentration of protein and mineral constituents. Significant interactions between milk type and pressing pressure for moisture, protein, and lactose contents indicated that the response to pressing varied according to the compositional properties of the milk used. Overall, milk composition was the primary determinant of

the nutritional profile of *chhurpi*, whereas pressing pressure played a critical role in moisture regulation and product concentration. These findings highlight the importance of optimizing processing conditions to achieve consistent product quality, improved nutritional value, and enhanced shelf stability, thereby supporting the standardization and commercial production of this traditional Himalayan dairy product.

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