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Quality evaluation of mozzarella cheese prepared from blends of Cow and Buffalo milk

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Abstract

Experienced pizza makers will say that the best mozzarella stretches long, melts evenly, and browns without burning—but they seldom agree on which milk delivers all three. This research compared mozzarella cheese manufactured from cow milk (100%), buffalo milk (100%), and two blends (cow: buffalo 70:30 and 50:50) at the Department of Animal Products Technology, University of Agriculture, Faisalabad, Punjab, during August-November 2023. Cheese was prepared by the pasta filata method, and quality was assessed through proximate composition, stretchability, meltability, free oil formation, colour, texture profile analysis, and sensory evaluation. Buffalo-milk mozzarella had the highest fat (24.7%), protein (25.1%), and stretchability (52 cm at 70 °C) but tended toward excessive chewiness. The 50:50 blend offered the best compromise: good stretch (44 cm), moderate fat (23.1%), acceptable browning, and the highest sensory score (7.9/9). The 70:30 (cow: buffalo) blend behaved more like cow-milk cheese, with limited stretch and lower yield. These findings suggest that a 50:50 blend can produce mozzarella with stretch and yield advantages of buffalo milk while retaining the softer body and lighter colour that consumers associate with cow-milk cheese.

Keywords: Mozzarella cheese, milk blends, quality evaluation, cheese technology, dairy processing, stretchability, pasta filata, texture profile, cow milk, buffalo milk

Introduction

Experts in cheese technology have long debated whether cow or buffalo milk makes superior mozzarella ^[1]. Cow milk yields a softer, paler cheese that melts readily on pizza, while buffalo milk—with its higher fat and casein—produces a denser, stretchier product with greater yield per litre ^[2]. In Pakistan, both species contribute roughly equally to total milk production (26.4 and 42.8 million tonnes in 2022-23), yet most mozzarella sold domestically is made from buffalo milk alone, partly because imported pizza recipes assume cow-milk properties ^[3].

Blending the two milks in defined ratios could combine the functional merits of each: buffalo's casein network for stretch and yield with cow's softer texture and better browning ^[4]. A few earlier reports tested blends at 80:20 or 60:40, but data from the Pakistani context—where Sahiwal cattle and Nili-Ravi buffaloes produce milk of variable composition—are missing ^[5]. This research evaluated four milk sources for mozzarella manufacture and identified the blend ratio that best balances functional, compositional, and sensory quality.

Material and Methods

Material

Fresh cow milk (Sahiwal-Friesian cross, 4.2% fat, 3.3% protein) and buffalo milk (Nili-Ravi, 7.1% fat, 4.4% protein) were collected from the university dairy farm, Faisalabad, Punjab, during August-November 2023. Direct-vat-set mesophilic starter culture (*Streptococcus thermophilus* + *Lactobacillus delbrueckii* subsp. *bulgaricus*) and microbial rennet (*Mucor miehei*) were sourced from Chr. Hansen (Lahore). Calcium chloride (food-grade) was used at 0.02% ^[6].

Methods

Four treatments were prepared: T₁ = 100% cow, T₂ = cow: buffalo 70:30, T₃ = cow: buffalo 50:50, T₄ = 100% buffalo.

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Milk was standardised to the natural fat:casein ratio of each blend, pasteurised (63 °C, 30 min), cooled to 37 °C, inoculated with 1.5% starter, and held until pH 5.2-5.3 was reached (~45 min). Rennet was added; the curd was cut after 30 min, cooked at 42 °C, and drained at pH 5.2. Curd was stretched in hot water (78 °C) until smooth and elastic, moulded into 250 g balls, and brined (20% NaCl, 4 °C, 2 h). Cheese was vacuum-packed and stored at 4 °C. Proximate composition (AOAC), yield, stretchability (fork test at 60-80 °C), meltability (Schreiber disc method), free oil (modified Gerber), colour (HunterLab), and texture profile analysis (TA.XT Plus, Stable Micro Systems) were measured at day 7. Sensory evaluation used a 9-point hedonic scale with 12 trained panellists [7]. Three independent batches were prepared per treatment. Data were analysed by ANOVA and Tukey's HSD ($p < 0.05$) using R v 4.3.1.

Results

Cheese yield increased linearly with buffalo milk proportion: from 12.4% (T₁) to 14.2% (T₄), reflecting the higher total solids of buffalo milk. Moisture moved in the opposite direction, being highest in cow-milk cheese (46.2%) and lowest in buffalo (43.8%).

Table 1: Proximate composition, yield, and functional properties of mozzarella cheese

Parameter	T ₁ (Cow)	T ₂ (70:30)	T ₃ (50:50)	T ₄ (Buffalo)
Moisture (%)	46.2 ^a	45.4 ^{ab}	44.8 ^{bc}	43.8 ^c
Fat (%)	21.3 ^c	22.4 ^{bc}	23.1 ^b	24.7 ^a
Protein (%)	23.8 ^b	24.1 ^b	24.6 ^{ab}	25.1 ^a
Yield (%)	12.4 ^c	12.9 ^{bc}	13.4 ^b	14.2 ^a
Stretch (cm, 70°C)	31 ^c	38 ^b	44 ^{ab}	52 ^a
Meltability (%)	68.4 ^a	62.3 ^b	58.7 ^{bc}	54.1 ^c

Values with different superscripts in the same row differ at $p < 0.05$.

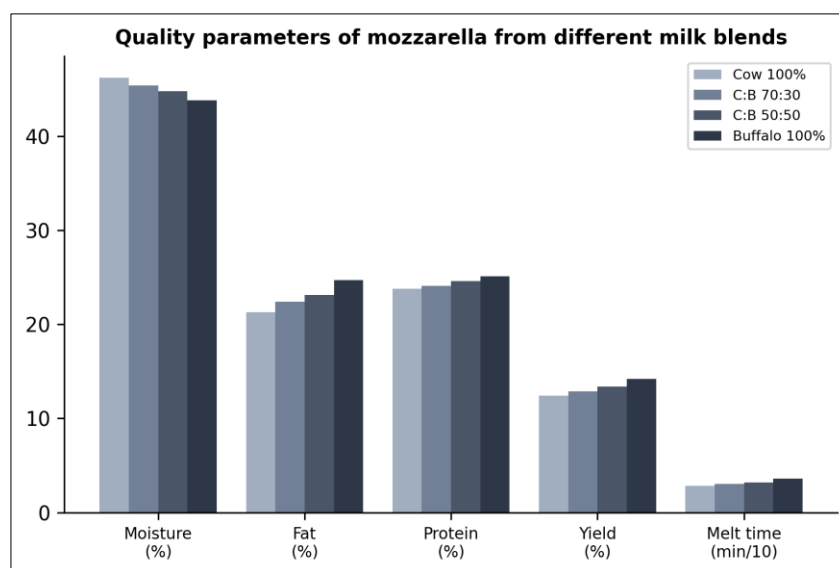


Fig 1: Quality parameters of mozzarella cheese from different milk blends

Table 2: Sensory scores (9-point hedonic scale) of mozzarella cheese at day 7

Attribute	T ₁ (Cow)	T ₂ (70:30)	T ₃ (50:50)	T ₄ (Buffalo)
Colour	7.8	7.4	7.2	6.6
Flavour	7.2	7.4	7.6	7.3
Texture	6.8	7.2	7.8	7.4
Stretch	6.4	7.0	7.6	8.1
Overall	7.1	7.3	7.9	7.4

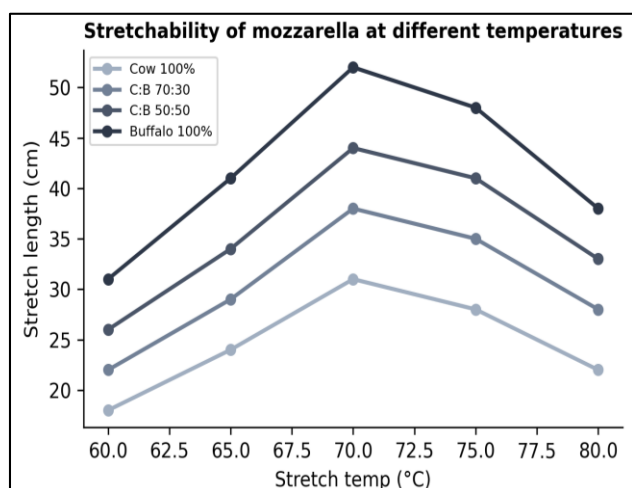


Fig 2: Stretchability of mozzarella cheese at different temperatures

Comprehensive Interpretation

The 50:50 blend (T₃) achieved the best overall sensory score (7.9) by combining adequate stretchability (44 cm), good texture, and moderate colour. Pure buffalo cheese had the longest stretch but was penalised for dark colour and excessive chewiness. Pure cow cheese melted well but lacked stretch.

Discussion

The superior stretchability of buffalo mozzarella arises from its higher casein content and the stronger calcium-paracasein matrix formed during pasta filata stretching—a relationship well described by Kindstedt *et al.* [1]. The 50:50 blend preserved most of this advantage while reducing chewiness, likely because the smaller fat globules of cow milk disrupt the continuous protein matrix and soften the body [4].

Meltability showed the reverse trend: cow-milk cheese melted furthest because its lower casein concentration and higher moisture create a weaker gel that flows more readily upon heating^[8]. From a pizza-performance standpoint, the 50:50 blend hit the sweet spot between stretch and melt—a balance that pure-milk cheeses could not achieve individually.

The yield advantage of buffalo milk (14.2% vs 12.4% for cow) translates directly into manufacturing economics. Even the 50:50 blend yielded 8% more cheese than pure cow milk, which could justify the slightly higher procurement cost of buffalo milk in regions where both species are available^[9].

Conclusion

This research set out to compare mozzarella cheese prepared from cow milk, buffalo milk, and their blends at two ratios. The 50:50 cow: buffalo blend delivered the best functional-sensory compromise: adequate stretchability (44 cm at 70 °C), good meltability (58.7%), and the highest overall sensory score (7.9/9), along with an 8% yield advantage over pure cow-milk mozzarella. Pure buffalo cheese excelled in stretch and yield but was too chewy and dark for broad consumer appeal. These results recommend a 50:50 blend as a practical formulation for mozzarella manufacturers in Pakistan's north-eastern dairy belt. Future work should assess the blend's performance on commercial pizza ovens, monitor functional changes during 30-day cold storage, and conduct a cost-benefit analysis at the dairy-plant scale.

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