The Pharma Innovation

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Physicochemical & Sensory evaluation for optimization of rabri made through milk flake formation system

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Abstract
Rabri is partially concentrated and sweetened milk product containing several layers of clotted cream (Malai). Traditionally, it is prepared by simmering of whole milk for a prolonged period and adding sugar after attaining the desired concentrations. In the present study, rabri is produced through milk flake formation system and their physicochemical & sensorial properties were studied. Fixed parameters were steam pressure (1.5 kg/cm2), scraper speed (130 rpm) and milk flow rate (400 l/h). The developed system was evaluated, and the variable parameters were the type of milk (buffalo milk and cow milk) and initial total solids of concentrated milk (18, 22, 26 and 30%). The responses for this study were color properties (L*, a*, b*), whitening index and sensory evaluation (flavor, color & texture). It was observed that there was a significant resemblance ($p>0.05$) in flavor, color, and texture. Buffalo milk at 26% total solids (T.S.) was found as an optimized parameter based on numerical optimization.

Keywords: Rabri, whitening index, flavor, color, texture

Introduction

Milk is treated as a complete food, and India is the largest milk producing nation in the world. with a current annual production of 198.4 MT (NDDB, 2019-2020). An estimated 50% to 55% of milk produced in India is converted into a variety of traditional value-added milk products such as heat desiccated products, cultured products, fat rich products, acid heat coagulated products, and milk-based puddings (Mahesh Kumar, 2013) [7]. In India, the unorganized dairy sector and village households utilize a large quantity of milk. Around 70% of the total produced milk is coming from marginal or small-scale milk producers (Sain *et al*., 2020) [13]. Many traditional dairy products, particularly khoa-based sweets like burfi, peda, pantoa, gulabjamun etc., Channa and channa-based sweets like Rasogolla, Rasmallai etc. and Paneer, kheer, Dahi has enormous market presence and tremendous consumer base in India and overseas as well. The clotted cream called Malai scrapped off from the edge of pan and immersed in thick sweetened milk and stored till marketing (Prasad, 1997) [10].

Rabri is a traditional dairy product, possesses viscous body containing several layers of clotted cream. It has a pleasant caramelized sweet flavor (Rajorhia, 1991) [11]. Rabri is in demand during festivals and other celebrations, especially in the northern and eastern parts of India (Aneja *et al*. 2002) [1]. According to Pal, 2000 [9], Rabri is prepared by heating fresh whole milk at simmering temperature in shallow pan. The surface of milk is intermittently fanned to permit formation of thin clotted cream layers which are moved to cooler parts of vessel (Pal, 2000) [9].

Wide varieties of Indian milk products have undergone needed technological changes, resulting in the development of equipment for the same (Aneja, 1992) [15]. Still, there is a need to develop equipment for commercial production for many popular traditional Indian dairy products. One such product is rabri.

Rabri prepared by traditional method is unhygienic, non-uniform in quality, has low keeping quality and involves labour and energy intensive method of production (Chauhan at el; 2014) [2]. For the preparation of rabri, small quantities of whole milk are maintained nearest to the boiling point in fairly large-sized evaporating pans as the milk evaporates slowly, skin forms on the surface. This skin is carefully removed by a flat-edged scraper and stuck on the cooler edges of the pan so as to get partially desiccated (Srinivasan and Anantakrishan, 1964). For large-scale production of Rabri, vacuum concentration of milk followed by blending it with required quantities of sugar and malai was attempted by Gayen and Pal (1991) [16].

Chopde *et al*. (2016) [3] developed an in-line system for the production of rabri by integrating

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scraped surface heat exchanger with conical process vat. Optimized the process parameters of a three-stage scraped surface heat exchanger for continuous rabri production. In our previous study (Kumawat et al., 2022) [6], we designed and fabricated milk flake formation system for production of rabri.

In the present study, we have evaluated physicochemical and sensory properties for optimization of rabri manufacturing through previously fabricated milk flake formation system.

Materials and Method
Physicochemical Properties
Color properties
The color of concentrated milk was measured by taking multiple readings and then calculating the average value, using a Color Desk D1. The data was presented in the terms of lightness (L*) ranging from zero (black) to 100 (white), redness (a*) ranging from +60 (red) to -60 (green) and yellowness (b*) ranging from +60 (yellow) to -60 (blue) in values of the international color system (CIE system). Digital images were processed in Color Desk software based on Scilab 5.4 and average CIE L*, a* and b* were measured.

Whitening index
The whitening index of flakes was measured using Color Desk D1 software. Hirschler, R. (2012) suggested whitening index as follows:

$$W.I. = L* - 3b*$$

Sensory evaluation
Sensorial assessment of the rabri samples was carried out by an expert panel of minimum five judges to judge the samples on a 9- point hedonic scale (9= like extremely; 1=dislike extremely) at room temperature.

Experimental procedure
Trials were planned according to the experimental design shown in table 1.

Table 1: Experimental design

Process Parameters		Levels	Measured parameters (Responses)
Variable parameters	Type of milk	Buffalo milk	1. Color (L*)
		Cow milk	2. Color (a*)
	Milk T.S.	18%	3. Color (b*)
		22%	4. Whitening index
		26%	5. Color (Hedonic Scale)
		30%	6. Flavor (Hedonic Scale)
Fixed parameters	Scraper speed	RPM-130	7. Texture (Hedonic Scale)
	Steam pressure	1.5	
	Milk flow rate	400 l/h	

Optimization of process parameters

Design Expert 10 statistical analysis software was used for the optimization of process parameters. The software prepared the factorial experimental design, and after trials, data were analyzed. Only significant parameters were considered during the optimization process. The criteria for process optimization are shown in Table 2.

Table 2: Criteria for process optimization

Parameters	Goal	Lower Limit	Upper Limit	Importance
Color (L*)	In Range	74.80	85.20	3
Color (a*)	In Range	-10.30	-5.93	3
Color (b*)	In Range	12.05	15.52	3
Whitening Index	In Range	29.63	46.41	3
Color (Hedonic Scale)	Maximize	06.92	8.00	3
Flavor (Hedonic Scale)	Maximize	6.50	8.50	3
Texture (Hedonic Scale)	Maximize	7.08	8.33	3

Results & Discussion

In the present study physicochemical and sensorial properties of rabri produced through milk flake formation system was evaluated. The main objective of this investigation was to optimize rabri through physicochemical and sensory properties evaluation.

Performance evaluation of milk flakes formation system

Performance of milk flakes formation system was evaluated at different types of milk (Buffalo milk and cow milk) and feed total solids content (18, 22, 26, and 30 %). Following responses were measured during performance evaluation of the developed system.

Color properties (CIEL*a*b*)

Color properties of final product obtained from milk flakes formation system was taken by using Color Desk D1 instrument. Color of concentrated milk shows the intensity of heat treatment as index of maillard reaction. The average values of color (L*, a*, b*) are presented graphically in Fig. 1, 2, 3. The color value L* is significantly ($p<0.05$) increased with buffalo milk it may be due to buffalo milk having naturally whiter than cow milk due to absence of carotene content (Fig. 1). The color value a* changed significantly ($p<0.05$) with type of milk and feed T.S (Fig. 2). Higher value of a* indicates that it is having more browning it may be due to higher residence time. Color value b* also increased significantly ($p<0.05$) with cow milk and feed T.S (Fig. 3). The higher value of b* indicates the yellowness in the product. It may be due to cow milk having slight yellow color.
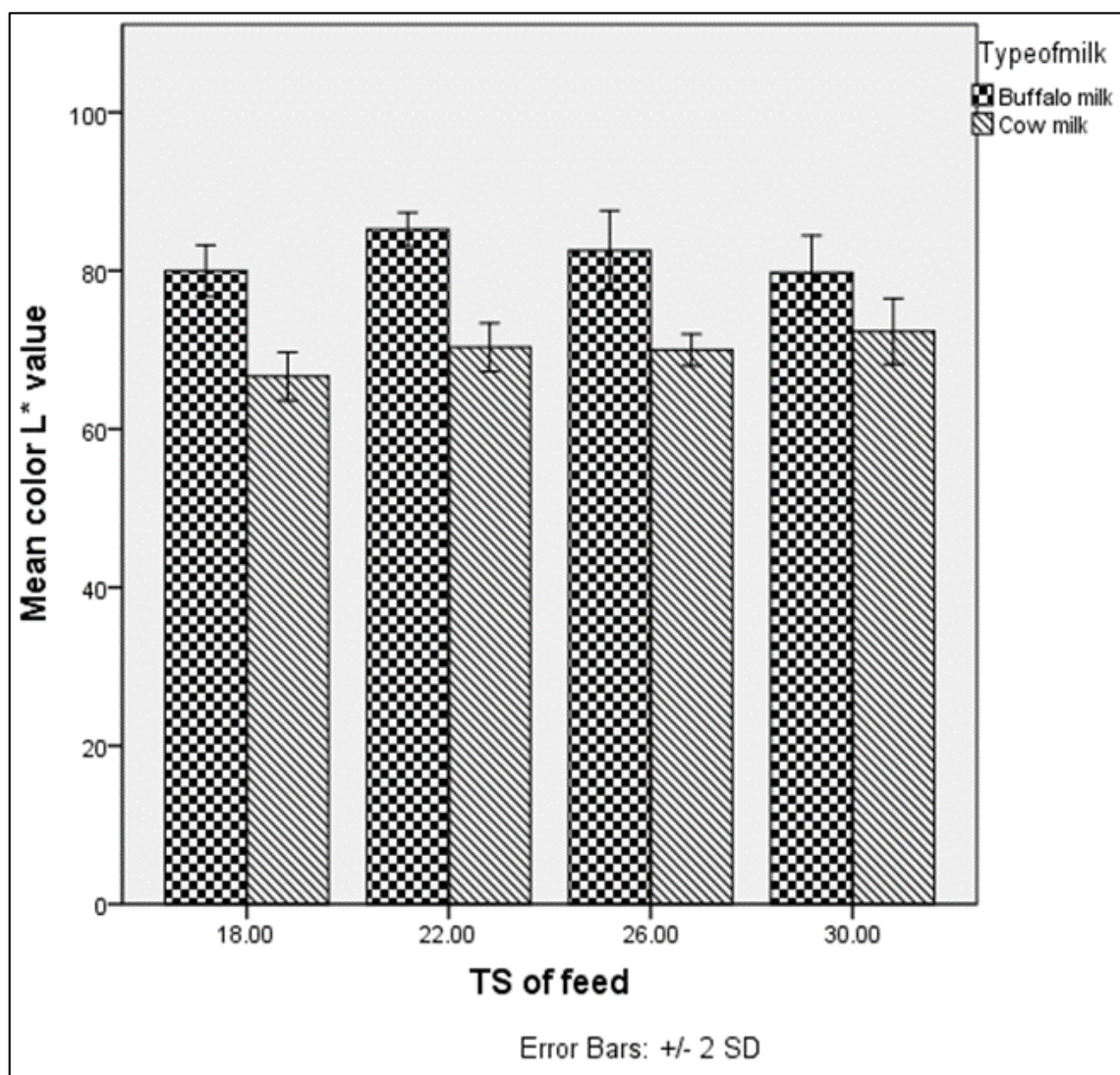

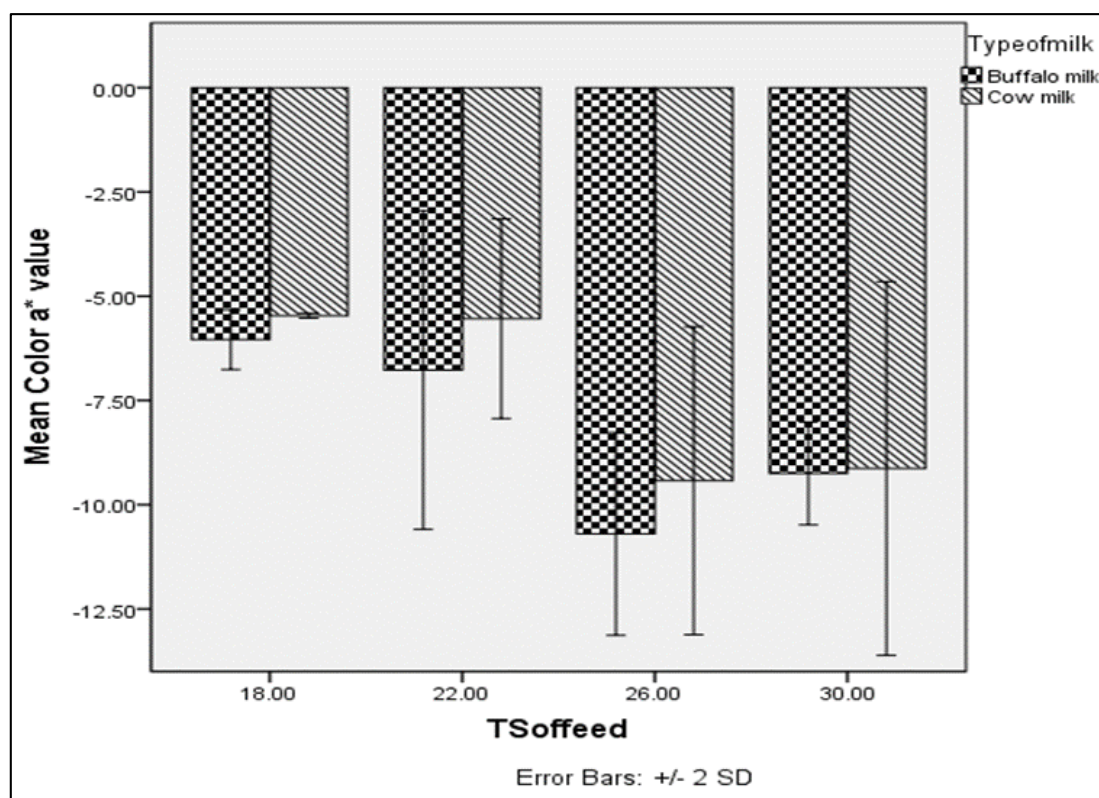**Fig 1:** Effect of type of milk and T.S. of feed on mean color L* value

Fig 2: Effect of type of milk and T.S. of feed on color a *value
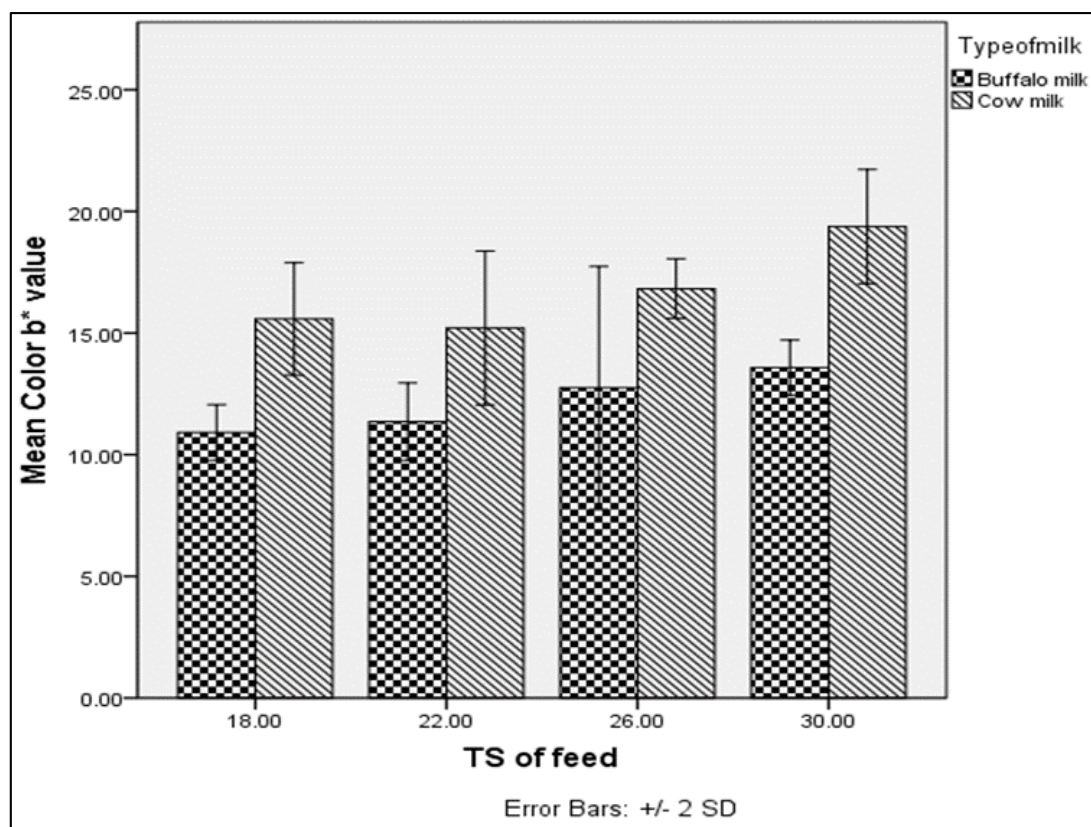

Fig 3: Effect of type of milk and T.S. of feed on color b* value

Whiteness index

The whitening index was significantly ($p<0.05$) affected with type of milk and feed T.S (Fig. 4). The value obtained of whitening index was maximum for buffalo milk it may be due to absence of carotene content in the buffalo milk. The maximum value of whitening index was 51.14 and 43.17 for the buffalo and cow milk respectively.
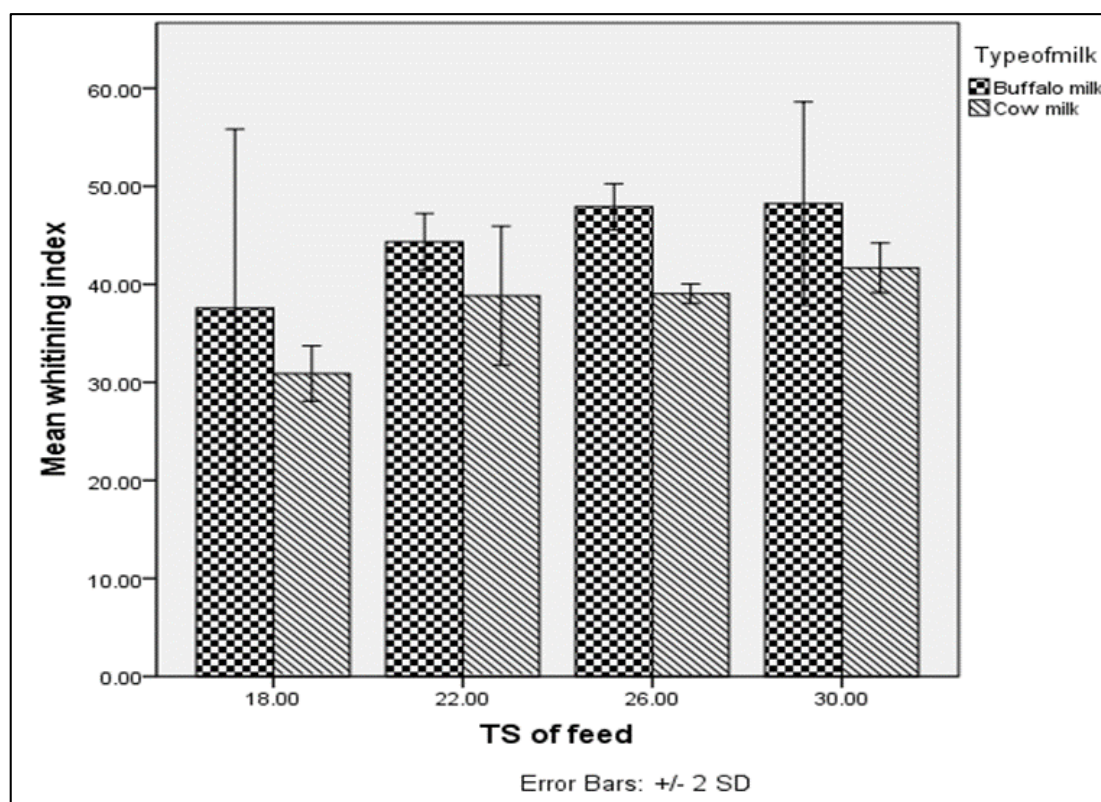
Fig 4: Effect of type of milk and T.S. of feed on whitening index value

Sensory evaluation

In case of sensory evaluation by panel using 9-point hedonic scale, it was observed that there was a significant resemblance ($p > 0.05$) in color (Fig. 5), texture (Fig. 6) and flavor (Fig. 7). The panel scores specifies that there is no significant variation in quality of rabri by means of sensory evaluation (Color, texture and flavor). As a result, concept of milk flakes formation system does not have detrimental influence on quality of product.
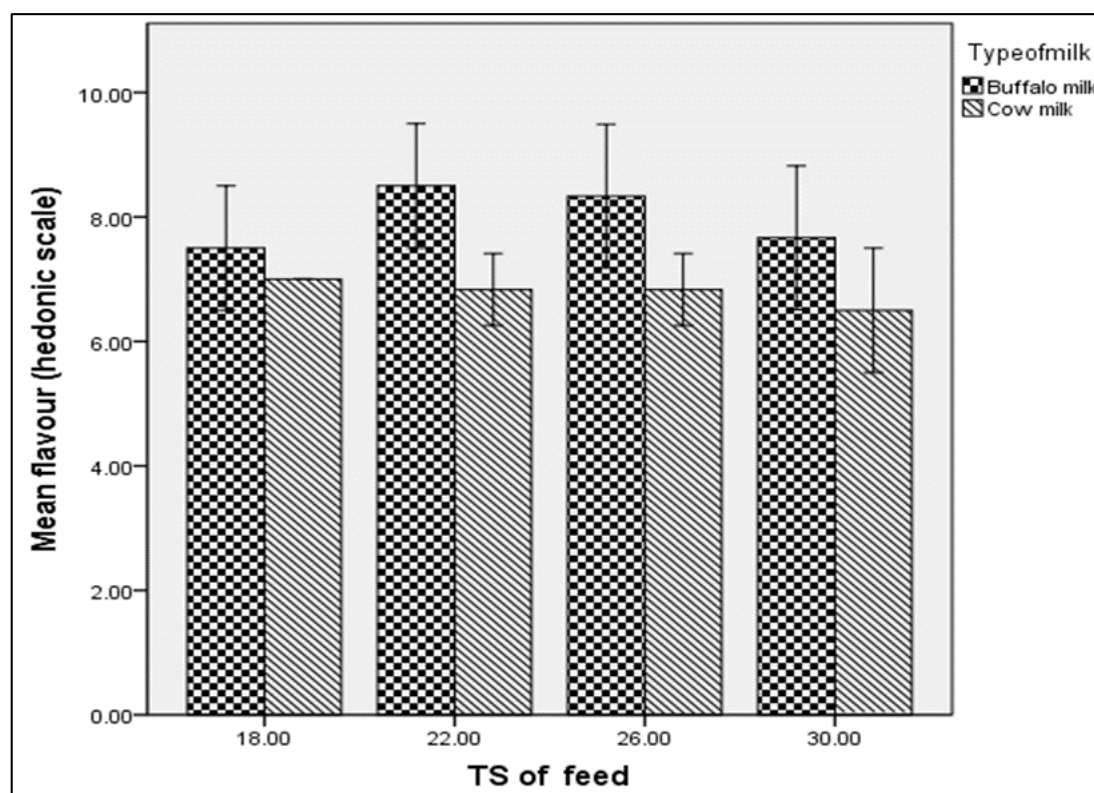

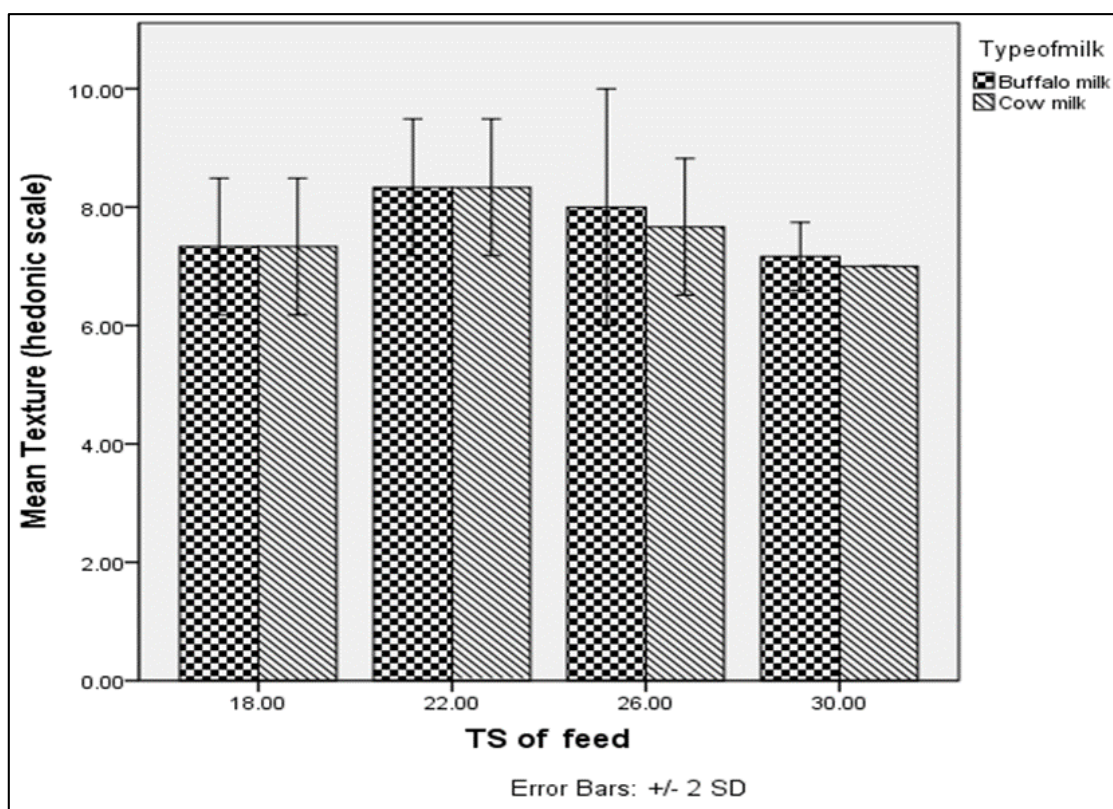**Fig 5:** Effect of type of milk and T.S. of feed on color

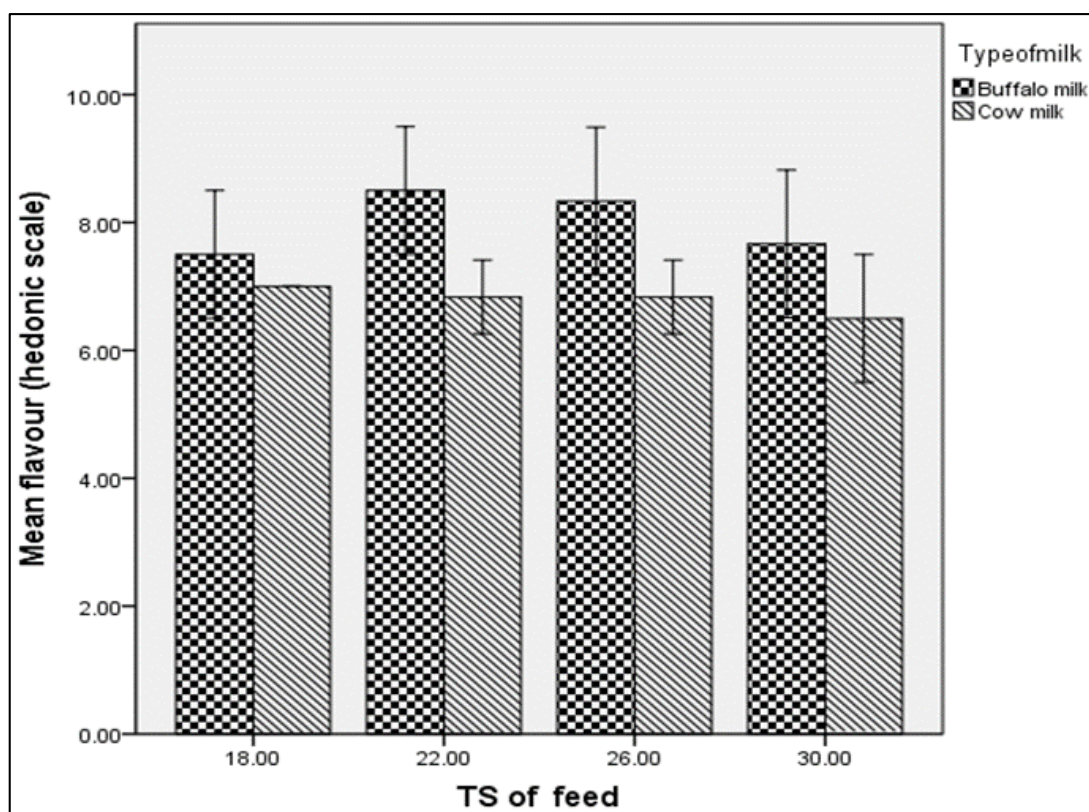**Fig 6:** Effect of type of milk and T.S. of feed on Texture

Fig 7: Effect of type of milk and T.S. of feed on flavor

Process optimization

As there were large number of responses, numerical optimization was carried out using design expert software 10. General factorial design was used to discover the best combination of categorical factors, such as type of raw milk and T.S. of feed etc. The optimized data obtained by software were type of milk best suitable was buffalo milk at 26 % T.S. of milk= 26%. Various predicted values of responses were: L*value= 82.56, a* value= -9.73, b* value= 14.71, Whitening index= 37.12, Flavor =8.33, Color=8, Texture=7.83. The optimized solutions are shown in Table 3.

Table 3: Optimized solutions for milk flake formation system

Type of Milk	TS of milk	L* value	A* value	B* value	Whitening index	Flavor	Color	Texture
B & C	18-30 %	0-100	—	—	-	1-9	1-9	1-9
Buffalo	**26.00**	**82.56**	**-9.73**	**14.71**	**37.12**	**8.33**	**8.00**	**7.83**
Buffalo	22.00	85.20	-8.23	12.05	46.41	8.50	7.75	8.33
Buffalo	30.00	79.75	-8.86	13.11	43.97	7.67	6.92	7.08
Cow	26.00	76.31	-10.3	15.52	31.05	6.83	8.00	7.83
Cow	22.00	74.80	-8.89	12.87	38.84	6.83	7.75	8.33
Buffalo	18.00	80.00	-5.93	14.27	37.58	7.50	7.17	7.33
Cow	18.00	75.26	-6.59	15.08	29.63	7.00	7.17	7.33
Cow	30.00	77.65	-9.52	13.93	32.30	6.50	6.92	7.08

Conclusion
The milk flake formation system was designed for the production of traditional milk product rabri. Effect of type of milk (buffalo milk & cow milk) and different total solids concentrations of milk on were studied. Design expert software 10 was used for the optimization of the final product. Buffalo milk at 26 T.S. concentrations was selected for an optimized product. Various predicted value of responses was: L* value= 82.56, a* value=-9.73, b* value= 14.71, Whitening index= 37.12, Flavor =8.33, Color=8, Texture=7.83 observed in optimized product.

Acknowledgement

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