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Milk powder incorporation in the cereal-based Nepalese indigenous food *bhakka* and its quality assessment

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Abstract. This work aims to study the effect of milk powder incorporation on the nutritional and sensory quality of our traditional indigenous food, *bhakka*. Different samples were prepared replacing the rice flour by milk powder at different ratios (2.5:97.5, 5:95, 7.5:92.5, 10:90). *Bhakka* prepared from 100% rice flour was considered as control. Sensory-related results showed that 7.5% milk powder and 92.5% rice flour can be mixed to prepare an acceptable quality. The proximate analysis showed protein content of 5.18% in rice flour *bhakka* and 6.7% in milk-powder-incorporated *bhakka*. The milk-powder-incorporated *bhakka* had a fat content of 1.51%, crude fibre content of 0.18%, crude protein content of 6.70%, total ash content of 0.44%, and carbohydrate content of 62.3%, which was higher than that of rice flour *bhakka*. The product prepared can help in combating protein–energy malnutrition, adds a new taste as well as value to our traditional indigenous food.

Keywords and phrases: Bhakka, rice flour, milk powder, proximate composition, indigenous food, sensory evaluation

1. Introduction

Traditional foods are foods and dishes passed down through generations (Kristbergsson & Oliveira, 2016) or consumed over many generations (Saunders, 2010). Traditional foods and dishes are traditional in nature and may have a historical precedent in a national, regional, or local cuisine (Kristbergsson & Oliveira, 2016).

Bhakka is a steam-cooked cereal product, prepared from coarse rice flour; it is indigenous to the *Tharu* community of the Terai but is enjoyed by all (Dangal et al., 2021). *Bhakka*, a simple fluffy rice flour steamed cake is the indigenous and traditional delicacy as well as seasonal income source for people of the *Tharu* community, including the *Rajbanshi* and *Dhimal* communities living on the eastern plains of Nepal, especially in Morang District. Nowadays, it is becoming increasingly popular in other regions and cultures too. No specific legend of naming '*Bhakka*' has been identified yet, but they say it was named so because it is a food cooked with steam. Vapour is 'Bhaff' in the *Tharu* language and eating is 'Khabbe'. So, it is said that 'Bhakha' later became '*Bhakka*' (Rai, 2004). *Bhakka* is generally prepared from Kanchhi rice flour, and selling it is a seasonal business that generally starts in October and ends in February. It is prepared traditionally by soaking cleaned whole rice in water and hand-pounded (in *okhli* or *dhiki*) to fine flour mass to obtain rice flour after the complete draining of water. Nowadays, soaked rice is milled to obtain fine rice flour. The flour obtained is used to make dough of desired property, press-sieved through the wire screens of small mesh sizes or through the mosquito curtain to obtain small granules which are then loosely filled into moulds (small plate, bowl, bicycle bell), and atmospheric steam cooking is done for about 2-3 min after wrapping the shaped mass by muslin cloth (Rai, 2004).

Bhakka is Nepal's traditional indigenous food, which is cheap and affordable by nearly every group of people. Therefore, such foods should be as rich as possible in nutritional terms. Rice flour used to make *bhakka* contains insufficient quantities of vitamin A, iron, and lysine, an essential amino acid (Sautter et al., 2006). The incorporation of milk powder increases the protein content of *bhakka* and fortifies it with lysine as well as enriches it with all kinds of essential amino acids. Milk powder is also richer in different minerals and vitamins compared to rice.

This study was therefore necessary in order to address the deficiencies in *bhakka* rice flour by the partial incorporation of milk powder. The present study aims to investigate the effects of the incorporation of milk powder in the Nepalese indigenous food *bhakka* and helps to introduce *bhakka* to the people as an important traditional and indigenous food of ours and to make them know its nutritional content.

2. Materials and methods

Material procurement

New variety rice (*Oryzae sativa* var. *Ranjeet*) and milk powder (Nestlé EveryDay) were collected from the local market of Dharan, Sunsari.

Methods

Preparation of rice flour

The required amount of the new rice variety (*Oryzae sativa* var. *Ranjeet*) was weighted and cleaned in running water. The cleaned rice was soaked at 20°C for 10 min, as shown in *Fig. 1*. Then, the water was drained off into a container with holes at its base. After draining the water, the rice was grinded in an electric grinder for milling purposes, and the obtained rice flour was sifted in a sieve with a mesh size of d = 1 mm to separate the broken rice, and so fine flour was obtained.

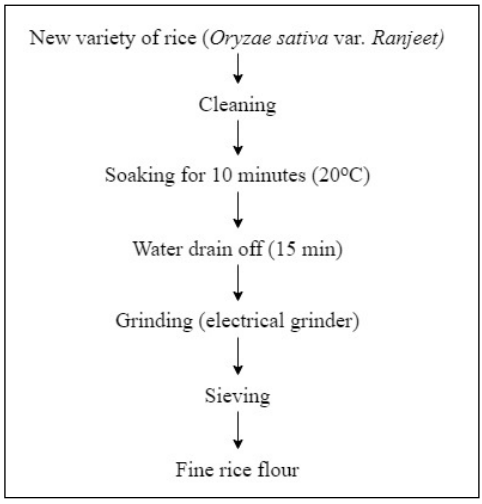


Figure 1. Flowchart for the preparation of rice flour

Preparation of rice flour–milk powder mixes

Four blends were prepared by mixing milk powder with rice flour using an electric blender in the percentage ratios of 2.5:97.5, 5:95, 7.5:92.5, and 10:90, while 100% rice flour served as the control (*Table 1*).

Table 1. Formulation of flour blend

Samples	Rice flour (%)	Milk powder (%)
R	100	0
A	97.5	2.5
B	95	5
C	92.5	7.5
D	90	10

Preparation of bhakka

The method described by Rai (2004) was used with slight modifications in the production of *bhakka*, as shown in *Fig. 2*. The ingredients (flour mix and water) were thoroughly mixed in a bowl by hand to obtain a dough with 29% moisture content. The dough was then forced through the wire net to obtain the granular form of the mixture. Then it was shaped in a bowl, and the excess was removed by hand or by a knife, without pressing. The bowl was then wrapped in a muslin cloth and steamed in inverted position for 2-3 min under atmospheric pressure. The prepared *bhakka* was taken for further analysis.

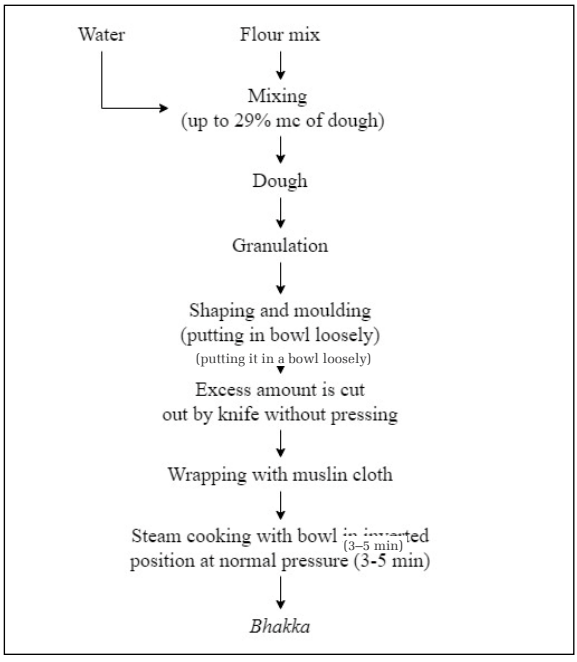


Figure 2. Flowsheet for the preparation of *bhakka*

Determination of proximate composition

Measurements of moisture content, crude fat, crude protein, crude fibre, and carbohydrate content of the rice flour, milk powder, and the prepared *bhakka* samples were carried out using Ranganna's method (1986), and ash content was determined by using the method described in AOAC (2012).

Physical analysis of the bhakkas produced

The diameter was measured by placing three *bhakkas* edge to edge with the help of a scale, rotating them by 90 degrees, measuring again the diameter of the three *bhakkas,* and then taking the average value. Thickness was measured by stacking three *bhakkas* on top of each other and taking the average thickness (Baljeet et al., 2010). The weight of the biscuits was measured as an average of three individual *bhakka*s with the aid of a digital balance (Ayo et al., 2007). The yield of *bhakka* was determined with the method described by Lynch (2007):

$$\text{Yield } \% = \frac{\text{Product weight}}{\text{Raw material weight (Except added water)}} \times 100 \quad (1)$$

Sensory evaluation

Sensory evaluation was determined by a ten-member committee consisting of the teaching staff and students of the Central Department of Food Technology, Dharan, Nepal. Committee members were either regular or occasional consumers of *bhakka*. The samples prepared from each flour blend were presented in coded, disposable plates. Bottled water was provided to the panelists to rinse their mouth. They were instructed to evaluate the coded samples for flavour, appearance, texture, and overall acceptability. Each sensory attribute was rated on a 9-point Hedonic scale (1 = disliked extremely, 5 = neither like nor dislike, while 9 = liked extremely) (*Ranganna*, 2005).

Statistical analysis

All data obtained from the sensory analysis were subjected to the Kruskal–Wallis H test using the statistical software R 64 4.0.2, which was developed by R core team, and then were presented as mean values with standard deviations. The statistical analysis was run with a confidence level of 95%. Differences between treatments were established with Dunn's Multiple-Comparison test, and the best sample was subjected to proximate analysis and physical analysis.

3. Results and discussion

The proximate composition of raw materials

The proximate compositions of rice flour and milk powder were analysed and are presented in *Table 2*.

Table 2. Proximate composition of rice flour and milk powder

Parameter	Rice flour (%)	Milk powder (%)
Moisture	12.10 ± 0.417	2.26 ± 0.110
Crude protein	7.18 ± 0.206	20.32 ± 0.960
Crude fat	0.20 ± 0.014	15.74 ± 0.790
Crude fibre	0.25 ± 0.018	0 ± 0.0
Total ash	0.40 ± 0.013	5.10 ± 0.205
Carbohydrate	79.87 ± 1.120	56.58 ± 1.210

Note: The values are the means of triplicate samples, and the values after "±" are standard deviations.

The crude protein, moisture, crude fat, crude fibre, and total ash content of the rice flour resulted from the analysis are shown in *Table 2*. The values fall in the range of flour as described by *Arora* (1980). Also, milk powder was analysed for its proximate composition. The obtained values can be seen in *Table 2*. The protein content of rice flour was found to be 7.17%, while it was observed to be 20.32% in milk powder. Also, the fat content of both constituents was observed: for rice flour, it was found to be 0.19% and 15.74% for milk powder.

Sensory analysis

All the scores from sensory analysis were summed up, and the best varieties were established by statistical analysis. The Kruskal–Wallis H test followed by Dunn's test at 95% level of confidence ($p < 0.05$) showed that the control and samples A, B, C, and D were significantly different from each other. The mean sensory evaluation scores of the *bhakka* samples are shown in *Table 3*.

The Kruskal–Wallis H test (at $p \leq 0.05$) followed by Dunn's Multiple-Comparison Test was carried out to find out the significant differences between the control and four formulations. The results obtained are shown in *Fig. 3*.

Table 3. Mean sensory scores of different samples of milk-powder-incorporated *bhakka*

	Parameters			
Formulation	**Colour**	**Texture**	**Flavour**	**Overall acceptability**
R	$6.3^{bc} \pm 1.06$	$5.7^{a} \pm 0.67$	$5.7^{d} \pm 0.67$	$6.1^{ac} \pm 0.57$
A	$6.1^{b} \pm 0.74$	$6.0^{a} \pm 0.67$	$6.2^{ad} \pm 0.79$	$5.9^{a} \pm 0.74$
B	$6.8^{ac} \pm 0.63$	$6.4^{a} \pm 0.52$	$7.0^{ac} \pm 0.82$	$6.7^{abc} \pm 0.48$
C	$7.6^{a} \pm 0.52$	$7.7^{b} \pm 0.48$	$7.5^{bc} \pm 0.71$	$7.9^{b} \pm 0.57$
D	$6.5^{bc} \pm 0.53$	$6.4^{a} \pm 0.52$	$7.6^{c} \pm 0.84$	$6.9^{ab} \pm 0.74$

Note: Mean ± Standard deviation of sensory evaluation score. Means with the same superscripts within a column are not significantly different ($p < 0.05$).
R = Control sample (100% rice flour *bhakka*);
A = Milk-powder-incorporated *bhakka* (2.5:97.5);
B = Milk-powder-incorporated *bhakka* (5:95);
C = Milk-powder-incorporated *bhakka* (7.5:92.5);
D = Milk-powder-incorporated *bhakka* (10:90).

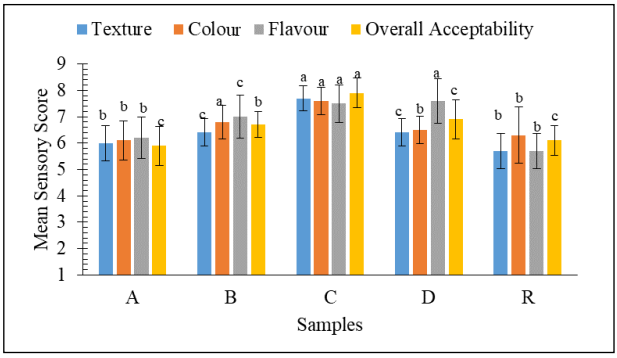


Figure 3. Mean sensory scores of different samples of *bhakka*

Colour

The colour of R showed no significant difference between A, B, and D. The sensory colour scores showed greater acceptability for sample C, which had an adequate amount of milk powder, which could be due to an increase in fat content, as the content of fat in *milk powder recipes* will also affect the colour of milk powder, and, generally, the colour of whole milk powder is yellow (Samantha, 2019).

Texture

The texture of R, A, B, and D showed no significant differences between one another, while C was significantly different from R, A, B, and D. The scores from the sensory analysis showed sample C as the best. This might be due to balancing the decreasing proportion of amylose by increasing the proportion of protein. Amylose was found to positively correlate with rice texture (*Juliano*, 1965; *Williams et al.*, 1958). High protein content in rice causes a reduction in stickiness after cooking (Primo et al., 1962).

Flavour

There was no significant difference between the flavour of A and R and that of A and B. Samples B, C, and D also showed no significant difference between one another. However, the mean sensory score shows sample D as superior among four samples. This might be due to the higher proportion of the added milk powder.

Overall acceptability

The overall acceptability of R showed no significant difference between A, B, and D. The overall acceptability mean showed C as the superior. Samples A, B, and the control R were found to be stickier, whereas sample D was found to have more firm texture. This might be due to the increase in protein content, as high protein content in rice causes a reduction in stickiness after cooking (Primo et al., 1962).

Proximate analysis of milk-powder-incorporated bhakka *and rice flour* bhakka

The proximate analysis of the best sample, C, as suggested by the sensory analysis, and of normal rice flour *bhakka* was carried out. The result is tabulated in *Table 4*.

The ash content of *bhakka* was increased in milk-powder-incorporated *bhakka*. The increase in ash content may be due to the high mineral content of milk powder. The moisture ranged from 28.82% in milk-powder-incorporated *bhakka* to 36.63% in rice *bhakka*. It is because 36% moisture content was to be maintained to prepare self-standing dough for rice *bhakka*, whereas for preparing self-standing dough of milk-powder-incorporated *bhakka*, only 29% moisture was to be maintained. The fat content of milk-powder-incorporated *bhakka* was higher than that of rice *bhakka*. No definite trend in increase or decrease in crude fibre content was observed. *Bhakka* showed an increase in protein content when milk powder concentration was increased.

Table 4. Proximate analysis of milk-powder-incorporated and normal rice *bhakka*

Parameters	Milk-powder-incorporated *bhakka*	Rice *bhakka*
Moisture (%)	28.82 ± 0.22	36.63 ± 0.470
Crude fat (%)	1.51 ± 0.010	0.14 ± 0.010
Crude protein (%)	6.70 ± 0.112	5.18 ± 0.020
Crude fibre (%)	0.18 ± 0.002	0.18 ± 0.003
Total ash (%)	0.45 ± 0.014	0.28 ± 0.002
Carbohydrate (%)	62.34 ± 0.344	57.59 ± 0.490
Total energy (kJ/100g)	1,212.31 ± 0.420	1,055.74 ± 0.475

Note: The values are the means of triplicate samples, and the values after "±" are standard deviations.

Hence, the incorporation of milk powder improved the nutritional composition of *bhakka* in terms of protein and fat, which may contribute towards combating protein–energy malnutrition. It also adds a new taste and value to our indigenous food *bhakka*.

Physical analysis

Bhakka was analysed for its physical properties, diameter, weight, and thickness, which were found to be d = 9.27 cm, m = 28.73 g, and t = 1.57cm respectively.

The yield of bhakka

The yield of *bhakka* was found to be 124.53%. The yield of the final product can be increased by minimizing processing loss and by taking the production to mass scale.

4. Conclusions

The results obtained from the sensory analysis of the flour mix showed that the composite flour blends could be suitable for *bhakka* production. This study also revealed that the proximate composition of *bhakka* produced from the flour blends is better compared to that of made solely from rice flour, and hence milk powder can be incorporated up to 7.5% substitution level based on the sensory score. The energy value was found to be 1,212.3 kJ/100 g of milk-powder-incorporated *bhakka.* The product prepared could help in combating protein–energy malnutrition, adds a new taste as well as adds value to our traditional indigenous food.

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