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## Development of nutritionally enhanced khoa-mishri sweet (laddu) using spirulina powder

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### Abstract

Khoa-mishri sweet (laddu) is a popular traditional sweet dessert of Uttar Pradesh and Maharashtra. Both the health benefits of mishri and Spirulina are enriched in the beverage. Mishri boosts the immune system and spirulina is highly proteinaceous. The present study was carried out to optimize the level of khoa (80%, 70%, 60% and 50%) mishri (20%, 30%, 40% and 50%) and spirulina (0.5g, 1g and 1.5g) for the preparation of spirulina enriched khoa-mishri sweet (laddu). Sweet (laddu) is based on khoa, mishri and spirulina powder. The levels of ingredients were optimized on the basis of sensory attributes (colour and appearance, flavour and taste, body and texture and overall acceptability) using Randomized Block Design. The optimized conditions for variables i.e. khoa, mishri and spirulina were obtained as 70%, 30% and 1g respectively. The researcher added spirulina which is blue green algae for nutritional enhancement. The result indicates increased values of protein and carbohydrate and decreased values of other parameters.

**Keywords:** Khoa, mishri, spirulina powder, enrichment, physicochemical, textural, microbial, overall acceptability

### Introduction

Khoa-mishri laddu is being produced in unorganized sector of India by conventional method. Khoa-mishri sweet's composition, processing, nutritional value from Spirulina powder are all unknown. Till date standard technology not available and its taste and texture vary from shop to shop and differ in different area. By doing this work, stabilization of product processing as well as value addition by spirulina having protein rich laddu in market.

Under controlled temperatures and conditions, the product known as Khoa is made by partly extracting water from any kind of milk and/or adding milk solids and then heating the resulting mixture (FSSAI standards, 2017).

The term "mishri" refers to crystallized sugar lumps. Mishri has its origins in India and Persia. Mishri is made by boiling sugar solution and making layers at 70 degree brix after cooling. Because of the cooling of supersaturated sugar solutions, a crystallization process occurred (Husband *et al*, 2014) [4]. Mishri is a better alternative to refined sugar since it is unprocessed. Compared to ordinary white sugar, rock sugar has a lower glycemic index than refined sugar. It is a healthier alternative to table sugar because of its high concentration of vitamins, minerals, and amino acids (especially vitamin B12). It also serves as an amazing mouth freshener. The tiny can be comes with a host of health benefit:- treats common cold and cough, promote digestion, boosts energy and culinary benefits (Binu *et al*, 2019) [2].

Microalgae from fresh water, spirulina are widely utilized as a nutritional supplement. As a result of its wide range of applications, this alga has been dubbed a wonder medicine. Immunity is boosted, and the body's ability to fight off numerous illnesses is improved. In addition to its antioxidant qualities, spirulina has been shown to have anticancer capabilities as well. Spirulina has a significant impact on metabolic illnesses such as diabetes, hypertension, anemia, and more. As a result of its many health benefits, spirulina is an essential natural substance for enhancing human health (Mohan *et al*, 2014) [6]. No toxicological impacts on human health have been found in Spirulina, which has been granted the Generally Recognized as Safe (GRAS) designation (Food and Drug Administration, 2002). Studies using this microalga have shown an improvement in food quality in terms of nutrients (Morais *et al*, 2006; Marco *et al*, 2014; Lucas *et al*, 2017) [5]. According to Rosario *et al*, (2015) [7] spirulina has 55-70% protein, 15-25% carbohydrate, 18% essential fatty acid and 5-12% of Vitamins, minerals and pigments like carotenes, chlorophyll a and phycocyanin.

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## Materials and Method

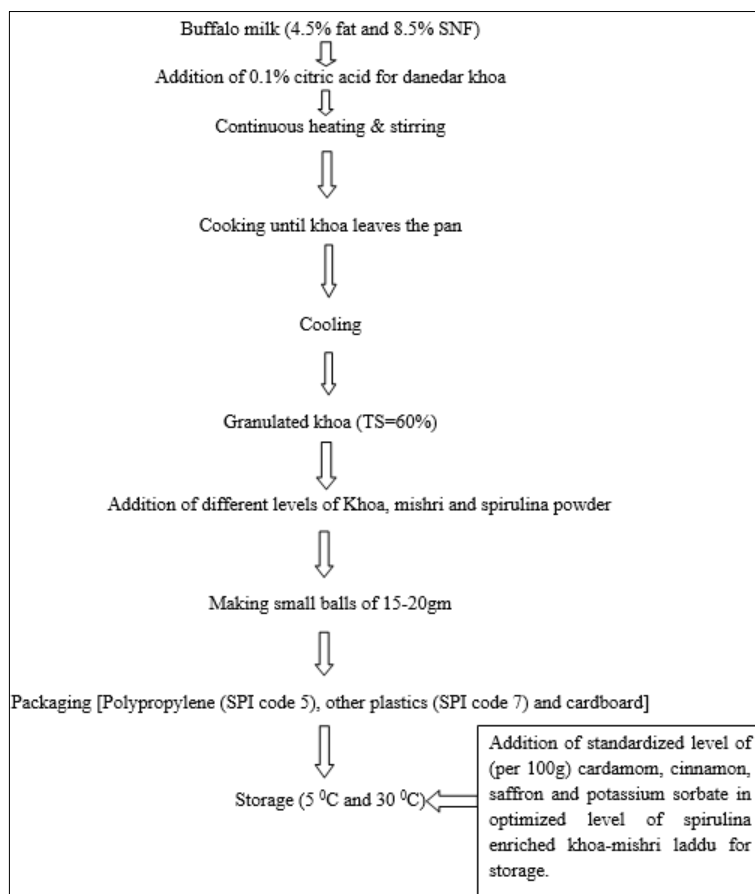
Methods and approaches used in the current research “Development and Shelf Life Studies of Spirulina Enriched Khoa Mishri Sweet (Laddu)” was carried out in the laboratory of Food and Dairy Technology, Warner College of Dairy Technology, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, 211007, India.

The study was carried out in following phases:

1. Procurement and collection of ingredients like buffalo

milk, mishri, spirulina powder (online purchase of ‘ecolive’ brand) were bought from local market of Allahabad, U.P.

- Development of value added spirulina enriched khoa-mishri laddu: Most acceptable value added addition level of Spirulina powder i.e. 0.5g, 1g and 1.5g with khoa (80%, 70%, 60% and 50%) and mishri (20%, 30%, 40%, and 50%).
- Nutritional and organoleptic evaluation.



**Fig 1:** Flow diagram for manufacture of Spirulina enriched khoa mishri sweet (laddu)

## Results and Discussion

**Table 1:** Table showing the mean value of physico-chemical analysis of final prepared spirulina enriched khoa-mishri laddu

Treatments	Total Carbohydrate (%)	Protein (%)	Fat (%)	Ash (%)	Moisture (%)	Total Solid (%)	Colour ('L') value	Colour ('a') value	Colour ('b') value
T <sub>0</sub>	28.11	14.03	19.22	3.60	35.03	64.97	54.30	3.13	6.25
T <sub>1</sub>	26.35	16.20	17.86	3.73	35.85	64.12	40.11	-1.63	10.39
T <sub>2</sub>	26.89	19.05	18.50	3.78	31.79	68.20	38.31	-2.45	10.88
T <sub>3</sub>	27.36	20.67	18.98	3.85	29.13	70.86	36.13	-2.52	10.49
T <sub>4</sub>	28.82	16.07	16.55	3.46	35.09	64.91	38.37	-1.54	10.05
T <sub>5</sub>	29.33	18.90	17.31	3.50	30.95	69.04	35.44	-2.36	10.70
T <sub>6</sub>	29.91	20.35	17.32	3.54	28.86	71.14	30.46	-3.41	10.88
T <sub>7</sub>	31.25	15.88	15.27	3.20	34.40	65.60	39.25	-1.36	11.16
T <sub>8</sub>	32.30	18.37	15.34	3.25	30.75	69.25	38.52	-2.19	11.41
T <sub>9</sub>	32.86	19.40	15.82	3.29	28.65	71.35	35.95	-2.57	11.70
T <sub>10</sub>	35.40	15.50	13.19	2.93	32.94	67.05	42.43	-1.22	11.07
T <sub>11</sub>	36.58	16.57	13.53	3.10	30.43	69.56	40.98	-1.28	11.56
T <sub>12</sub>	37.10	18.10	13.91	3.16	27.71	72.28	38.56	-1.85	12.44
S. Ed. (±)	0.039	0.027	0.031	0.029	0.052	0.033	0.236	0.165	0.316
C. D. (P = 0.05)	0.078	0.054	0.062	0.058	0.104	0.065	0.470	0.328	0.630

**Table 2:** Table showing the mean value of physico-chemical analysis of final prepared spirulina enriched khoa-mishri laddu

Treatments	Titration Acidity (%LA)	Free Fatty Acid (%)	Lactose (%)	DPPH	HMF (moles/gm)	TBA (Mg/monoaldehyde/kg)	Peroxide Value (meq/kg)
T <sub>0</sub>	0.82	0.54	18.39	19.34	17.37	0.72	0.63
T <sub>1</sub>	0.77	0.51	17.73	20.85	16.87	0.67	0.60
T <sub>2</sub>	0.79	0.49	17.49	22.32	16.59	0.66	0.57
T <sub>3</sub>	0.83	0.45	17.45	23.86	16.48	0.65	0.54
T <sub>4</sub>	0.72	0.41	16.62	20.22	16.26	0.65	0.51
T <sub>5</sub>	0.73	0.41	16.34	21.74	15.95	0.65	0.49
T <sub>6</sub>	0.76	0.41	16.07	23.25	15.46	0.63	0.48
T <sub>7</sub>	0.64	0.37	15.99	19.80	15.16	0.60	0.47
T <sub>8</sub>	0.66	0.32	15.45	21.33	15.07	0.60	0.46
T <sub>9</sub>	0.70	0.30	15.36	22.84	14.82	0.60	0.46
T <sub>10</sub>	0.51	0.30	14.98	19.28	14.15	0.57	0.42
T <sub>11</sub>	0.57	0.26	14.48	20.77	14.29	0.55	0.39
T <sub>12</sub>	0.59	0.24	14.21	22.26	14.07	0.53	0.33
S. Ed. (±)	0.023	0.025	0.206	0.038	0.288	0.021	0.032
C. D. (P = 0.05)	0.046	0.050	0.411	0.077	0.575	0.042	0.064

**Nutritional evaluation:** Table 1 and 2 reveals the physicochemical analysis of 13 treatments of spirulina enriched khoa-mishri sweet. It was found that the nutritional content, specifically carbohydrate, protein and total solid increases with the increased level of spirulina. Fat, moisture, titratable acidity, FFA, DPPH, TBA, HMF and peroxide value decreased with increased level of spirulina.

**Organoleptic evaluation:** Table 4 reveals sensory analysis of 13 treatments final prepared spirulina enriched laddu on 9 point hedonic scale. It can be concluded from the table that, laddu having 70% khoa, 30% mishri and 1g spirulina (T<sub>5</sub>) has best score of colour and appearance, flavour and taste, body and texture and overall acceptability.

**Table 3:** Table showing organoleptic quality or sensory evaluation of final prepared spirulina enriched khoa-mishri laddu

Treatments	Colour and appearance	Flavor and taste	Body and texture	Overall acceptability
T <sub>0</sub>	7.00	7.24	7.68	7.60
T <sub>1</sub>	7.20	7.18	7.33	6.50
T <sub>2</sub>	7.80	7.76	7.65	7.60
T <sub>3</sub>	7.50	7.45	7.46	7.00
T <sub>4</sub>	7.40	7.32	7.52	7.00
T <sub>5</sub>	8.00	8.54	8.22	8.50
T <sub>6</sub>	7.60	7.50	7.78	7.40
T <sub>7</sub>	7.00	6.24	6.76	6.40
T <sub>8</sub>	7.60	7.00	7.22	7.10
T <sub>9</sub>	7.40	6.65	7.00	6.74
T <sub>10</sub>	6.20	5.67	5.88	5.60
T <sub>11</sub>	6.80	6.48	6.50	6.50
T <sub>12</sub>	6.50	6.00	6.12	6.00
S. Ed. (±)	0.036	0.054	0.049	0.271
C. D. (P = 0.05)	0.071	0.107	0.099	0.541

**Fig 1:** Showing spirulina enriched khoa-mishri sweet (laddu)

### Conclusion

The present study reveals that the spirulina enriched khoa-mishri sweet (laddu) prepared with 70% khoa, 30% mishri

and 1g spirulina level were accepted on organoleptic parameters and this most acceptable level was found in satisfactory range during storage. It was found that the spirulina enriched laddu is nutritious. Their nutritional value is greater than the control sample. Thus this valuable sweet has higher acceptability on organoleptic characters and this spirulina enriched sweet brings considerable advantages.

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