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Optimizing of physico-chemical properties of fiber-enhanced Parwal (*Trichosanthes Dioica* L.) sweet by using response surface methodology

Sunil Kumar, Dinesh Chandra Rai, Abhishek Dutt Tripathi and Uday Pratap Singh

Abstract
Parwal sweet' is a most popular 'khoa' based sweet delicacy of northern part of India, especially Uttar Pradesh, Bihar and West Bengal, in India. A process for manufacturing a traditional sweet based on khoa, sugar and β-glucan as main ingredients was optimized. During the investigation, the effect of different levels of khoa, sugar and β-glucan was studied by employing central composite rotatable design. The best formulation was consist of 35% khoa, 31% sugar and 1% β-glucan. This formulation was found to be most suitable for preparation of low calorie and fiber enriched 'parwal sweet' with predicted scores of 8.4, 8.2, 8.6, 8.8 and 22.63 for body and texture, colour and appearance, flavour, overall acceptability and moisture respectively.

Keywords: Fiber-enriched, Parwal, traditional sweet, β-glucan

Introduction
Pointed gourd (*Trichosanthes Dioica* L.) is known of parwal, palwal, parmal, patol, and potala indifferent parts of India and Bangladesh (Khatua *et al*., 2016) [8]. Pointed guard is important tropical and subtropical vegetable crops which is belong to cucurbitaceous family (Singh *et. al*., 2012) [15]. The vegetable is rich in minerals and is enriched with vitamins A, B1, B2, and C (Korus *et al.*, 2020) [9]. Despite having various pharmacological qualities like tannins and saponin, it has very few calories and maintains a healthy level of cholesterol. 7-oxidihydrokarounidol-3-benzoate (Korus *et al.*, 2020) [9]. It is used for commercially produced foods including pickles, jam, and sweets. Native Americans make Parwal sweets by putting Khoa inside a parwal that has already been boiled and then covering it with sugar syrup (Viswas *et. al.*, 2014) [16].

Khoa is a heat desiccated milk product which serves as basic material for several Indian delicacies such as burfi, Peda, Kalakand, Gulabjamun etc. (Amruthakala, 2012; Choudhary *et al.*, 2017) [4]. Khoa has a uniform whitish colour with just a hint of brown, a slightly oily or granular texture, and a rich nutty flavour that is connected to a mildly cooked and sweet taste because of the concentration of lactose, according to regulations from the Food Safety and Standards (Food Products Standards and Food Additives, 2011). (Prasad *et al.*, 2015). Khoa has used in making of Parwal sweet, peda, barfi and kalakand, etc.

The dietary fibre (DF) is a complex mixture of carbohydrate polymer that are associated with a number of other, non-carbohydrate components (K.E. Bach Knudsen, 2001). The cell wall of plants contains (gkg-1 fresh weight) water 600, neutral NCP 50-150, cellulose 100-150, pectic substances 20-80, lipid 5-30, protein 10-20. As the plant tissues age, lignin is laid down encrusting the micro-fibrils (K.E. Bach Knudsen, 2001).

Materials and method
Material
The fresh, organic, well matured and fully developed pointed guard were purchased from the local market of sunderpur, Varanasi, and Milk was procured from Dairy farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, Uttar Pradesh. Sugar (24 Mantra Organic Sugar) procured from big bazar, Varanasi and β-glucan procured from Beta Heart, Beta glucan powder, Herbalife Nutrition.

Method

Preparation of Parwal Sweet

The Khoa was prepared using the procedure as per Aneja *et al*., (2002) [2]. However the Parwal sweet was prepared by the method given by Viswas *et al*., (2014) [16] and additionally, some almond slices were put to improve appearance.

Sensory Attributes

Sensory analysis of the samples was carried out using semi trained panel constituting of 15 respondents using a 9-points Hedonic scale. The responses with respect to the color & appearance, flavor, body & texture and overall acceptability of the samples were collected from each of the respondents and the results were statistically analyzed.

Textural analysis

A texture profile analyzer (TA-XT2i, M/s Stable Micro Systems, UK) was used to analyze the texture profile of Parwal sweet following the method as described by Jha *et al*., (2015) [6]. The samples of 'parwal sweet' were cut into 1.5 cm3 size pieces and their temperature maintained at 25 °C during the textural analysis.

Statistical Analysis

RSM was used to analyse the data produced during the current experiment utilising a central composite rotatable design. The response surface regression method was used to assess the experimental data that were acquired from the design.

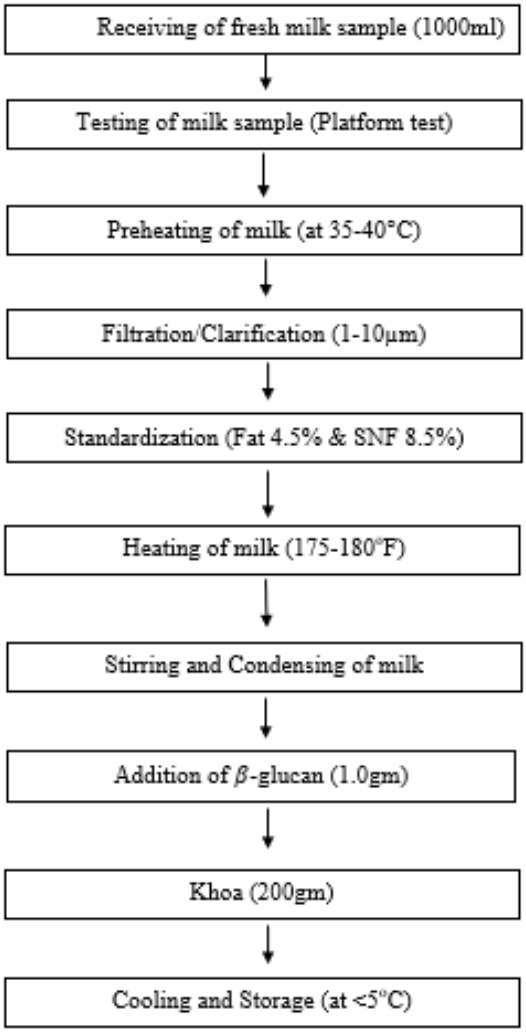

Fig 1: Flow diagram for manufacturing of value-added Pointed Guard (Parwal) Sweet

Optimization of Pointed garud (Parwal) Sweet

According to sensory and physical characteristics data (table 1), the ideal ratio of khowa, sugar, and fibre for a fiber-rich Parwal Sweet is 35%, 31%, and 1.0%, respectively. This kind of combination produces very high-quality products. This optimized product has the highest level of general acceptance, good color, flavor, consumable body, and textural qualities, as well as hardness, chewiness, etc. The physicochemical characteristics of fiber-rich parwal sweet are listed below (table 2).

Result and discussion

Flavour: The average flavour score varied from 2.5 to 8.6 (Table 1). The minimum score was observed from experiment no. T17, while the maximum score was observed in experiment no. T18. Experiment no.18 had 35%, 31% and 1% of Khoa, Sugar and Fiber respectively. The statistical significant value (P>0.0001) and standard deviation (σ=0.021), R^2 is 0.71. It can be seen that with increasing level of fiber, the flavour score decreased linearly at all level of khoa and sugar (Fig. 4.1 a-b). The trend being more perceivable at higher level of khoa and sugar. According to Patel *et al*. (2014; 2015) [12,13] flavour is highly affected by khoa and sugar content.

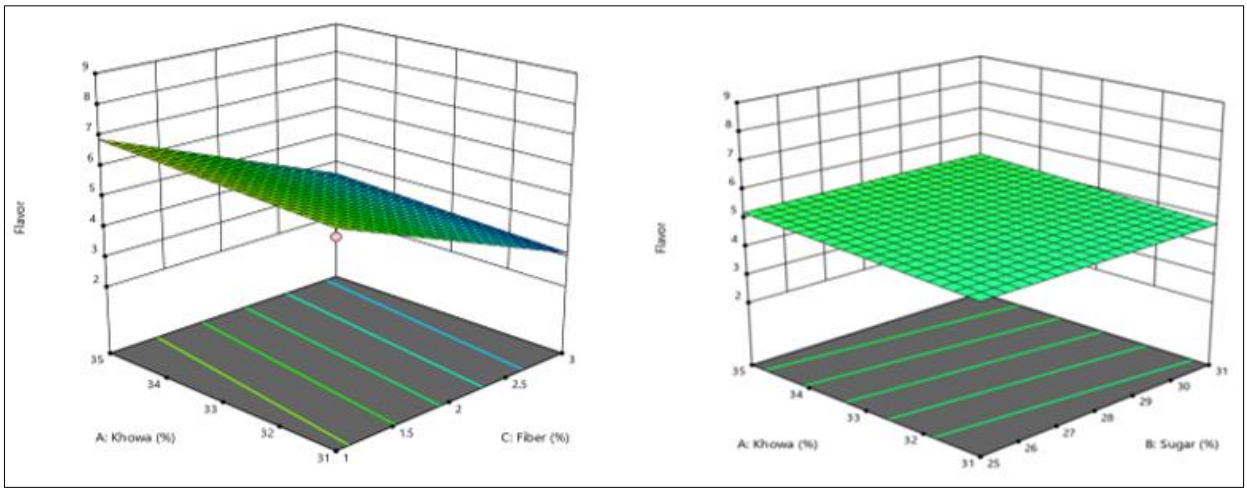

Fig 2(a-b): The interaction of khoa, sugar and fibre on flavour.

Colour and appearance

The average colour and appearance score varied from 2.8 to 8.2 (Table 4.1). The minimum score was observed from experiment no. T20, while the maximum score was observed in experiment no. T18. Experiment no.18 had 35%, 31% and 1% of Khoa, Sugar and Fiber respectively. The statistical significant value (P>0.0006) and standard deviation (σ=0.021), R^2 is 0.80. It can be seen that with increasing level of fiber, the colour and appearance score decreased linearly at all level of khoa and sugar Fig. 4.2 (a-b). The trend being more perceivable at higher level of khoa and sugar.

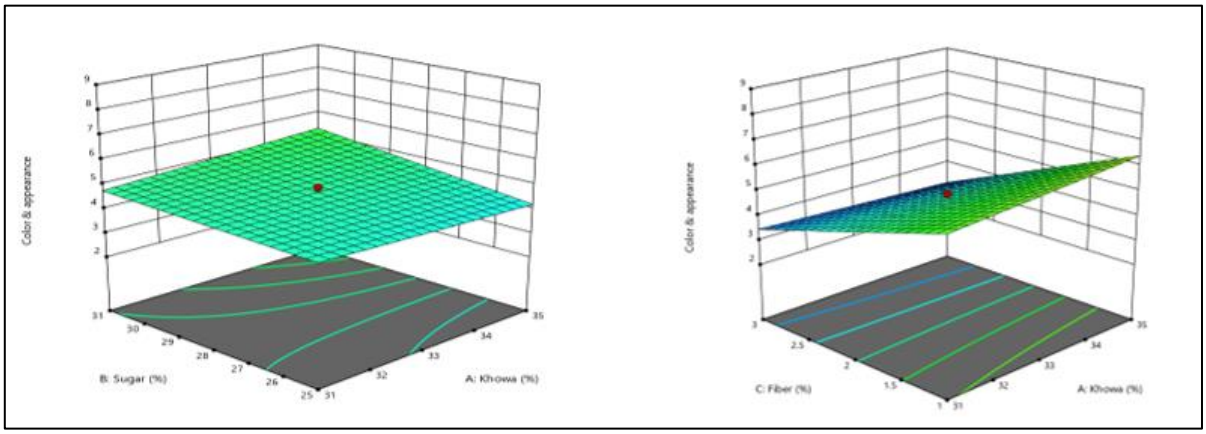

Fig 3(a-b): The interaction of khoa, sugar and fibre on color and appearance

Body & Texture

The average body & texture score varied from 3.4 to 8.4 (Table 4.1). The minimum score was observed from experiment no. T5, while the maximum score was observed in experiment no. T18. Experiment no.18 had 35%, 31% and 1% of khoa, sugar and fiber respectively. The statistical significant value (P>0.003) and standard deviation (σ=0.021), R^2 is 0.91. It can be seen that with increasing level of fibre, the body & texture score decreased linearly at all level of khoa and sugar Fig. 4.3 (a-b). The trend being more perceivable at higher level of khoa and sugar. Body & Texture are directly affected to khoa, sugar and fibre content (Bagheripoor *et al*. 2018) [3].

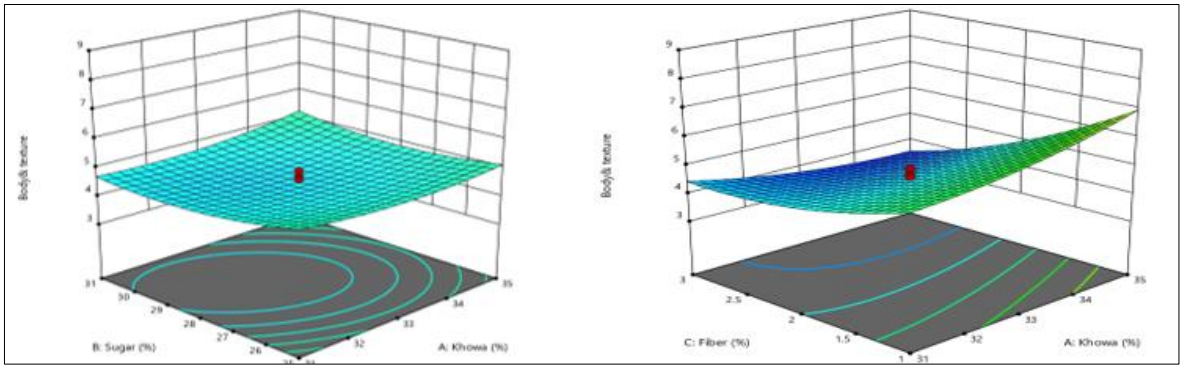

Fig 4(a-b): The interaction of khowa, sugar and fibre on Body and texture

Overall acceptability

The average overall acceptability score varied from 3.2 to 8.8 (Table 4.1). The minimum score was observed from experiment no. T17, while the maximum score was observed in experiment no. T18. Experiment no.18 had 35%, 31% and 1% of khoa, sugar and fibre respectively. The statistical significant value (*P*>0.0004) and standard deviation (σ=0.021), R^2 is 0.66. It can be seen that with increasing level of fibre, the (over-all) acceptability score decreased linearly at all level of khoa and sugar (Fig. 4.4 a-b). The trend being more perceivable at higher level of khoa and sugar. According to Patel, *et al*., (1992) [12] that over-all acceptability was highly affected by khow and sugar content.

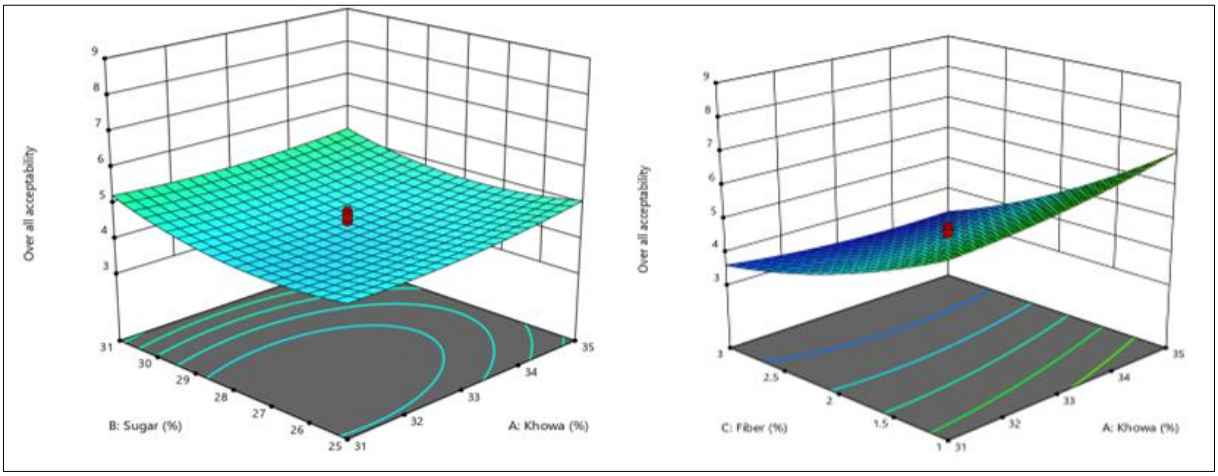

Fig 5(a-b): The interaction of khowa, sugar and fibre on overall acceptability

Moisture

The moisture content is one of the important characteristics related to the shelf life of sweet. The average moisture varied from 16.74 to 23.61 (Table 4.1). The minimum moisture was observed from experiment no. T20, while the maximum moisture was observed in experiment no. T6. Experiment no.T6 had 33%, 22.95% and 2% of khoa, sugar and fibre respectively. The statistical significant value (*P*>0.0001) and standard deviation (σ=0.021), R^2 is 0.76. It can be seen that with increasing level of fiber, the moisture content decreased linearly at all level of khoa and sugar (Fig. 4.5 a-b). The trend being more perceivable at higher level of fibre and sugar. According to Patel *et al*. (2014) [12] the moisture was highly affected by fibre and sugar content.

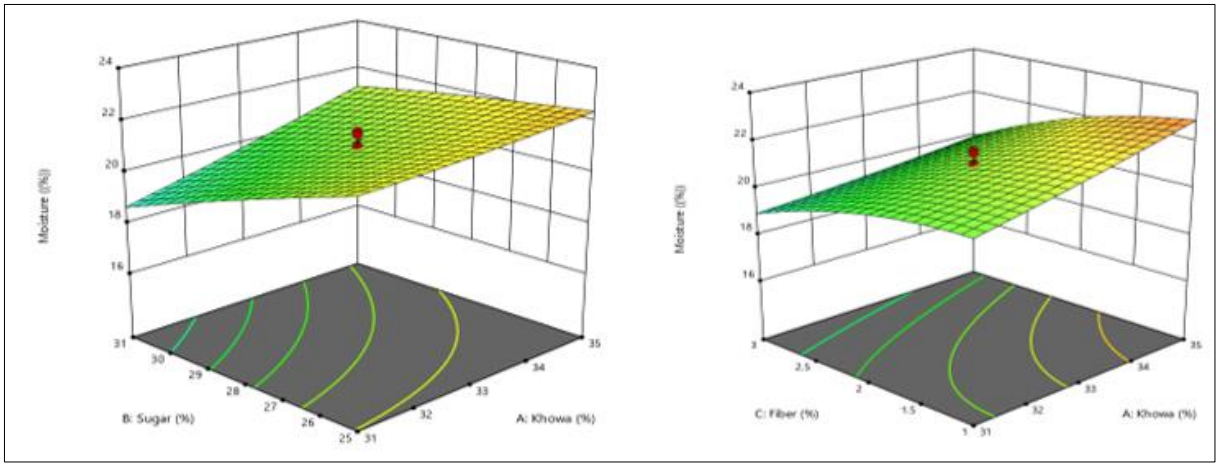

Fig 6(a-b): The interaction of khowa, sugar and fibre on Moisture

Hardness

The average hardness score varied from 386.81 to 1397.28 (Table 4.1). The minimum hardness was observed from experiment no. T7 while the maximum moisture was observed in experiment no. T1. Experiment no. T1 had 29.6%, 28.00% and 2% of khoa, sugar and fibre respectively. The statistical significant value (P>0.023) and standard deviation (σ=0.021), R^2 is 0.43. It can be seen that with increasing level of fibre, the hardness increased linearly at all level of khoa and sugar (Fig. 4.6 a-b). The trend being more perceivable at higher level of fibre and sugar. This result was in agreement with the findings of Jha *et al*., (2015) [6] and Jain, *et al*., (2015) [5] who reported that the increase of total solid content in Parwal Sweet resulted increasing the hardness.

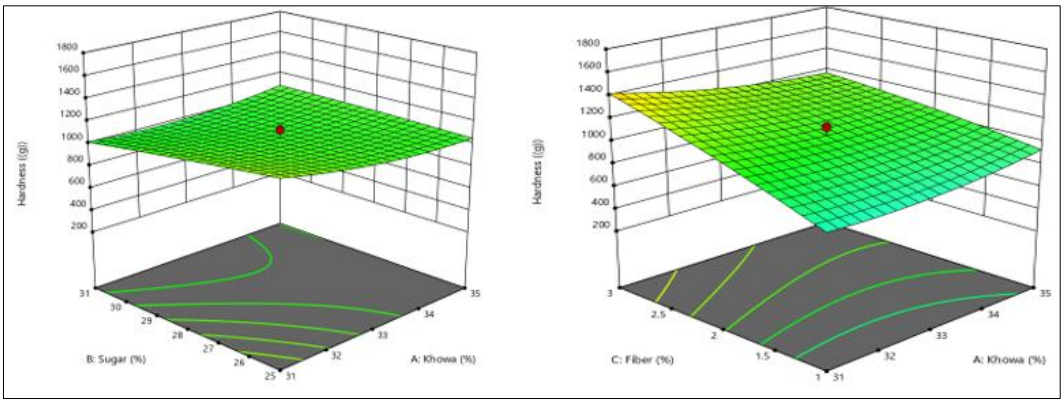

Fig 7(a-b): The interaction of khowa, sugar and fibre on hardness

Adhesiveness

According to the result obtained adhesiveness of Parwal Sweet is increases after mixing with khoa and sugar in comparison to fibre. The average adhesiveness varied from -46.681 to -198.212 (Table 4.1). The minimum adhesiveness was observed from experiment no. T18, while the maximum adhesiveness was observed in experiment no. T9. Experiment no. T9 had 31.0%, 25.00% and 3% of khoa, sugar and fiber respectively. The statistical significant value (P>0.013) and standard deviation (σ=0.021), R^2 is 0.47. It can be seen that with increasing level of fiber, the adhesiveness increased linearly at all level of khoa and sugar (Fig. 4.7 a-b). The trend being more perceivable at higher level of fibre and sugar. This result was in agreement with the findings of Jha *et al*., (2015) [6] who reported that the increase of total solid content in Parwal Sweet resulted in increased adhesiveness.

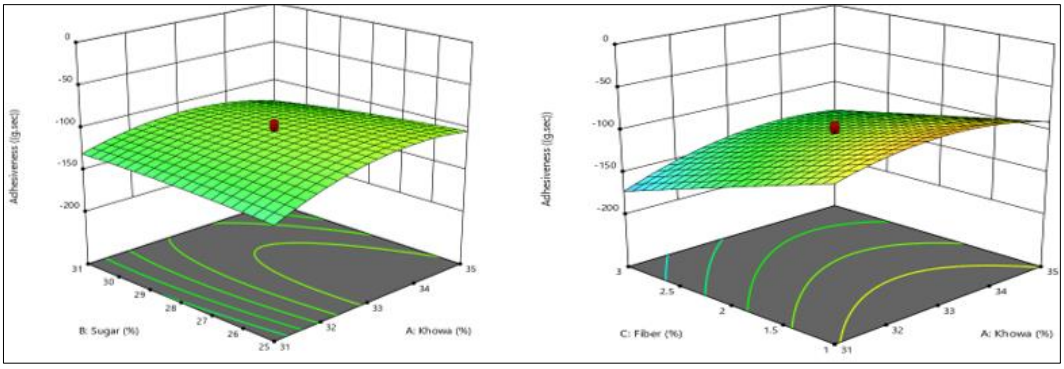

Fig 8(a-b): The interaction of khowa, sugar and fibre on Adhesiveness

Springiness

According to the result obtained springiness of Parwal Sweet increases after mixing with khowa and sugar in comparison to fibre. The average springiness varied from -0.121 to 1.303 (Table 4.1). The minimum springiness was observed from experiment no. T12, while the maximum springiness was observed in experiment no. T5. Experiment no.T5 had 35.0%, 31.00% and 3% of khoa, sugar and fibre respectively. The statistical significant value (P>0.0001) and standard deviation (σ=0.021), R^2 is 0.87. It can be seen that with increasing level of fibre the springiness increased linearly at all level of khoa and sugar (Fig. 4.8 a-b). The trend being more perceivable at higher level of fibre and sugar. This result was in agreement with the findings of Jain *et al*., (2015) [5] who reported that the increase of total solid content in Parwal Sweet resulted in increased springiness.

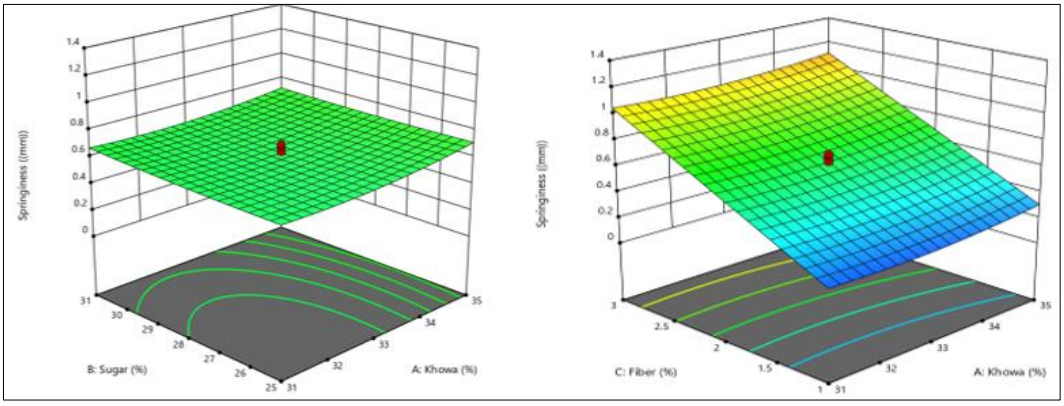

Fig 9(a-b): The interaction of khowa, sugar and fibre on Springiness

Cohesiveness

According to the result obtained cohesiveness of Parwal Sweet is increased after mixing with Khowa and Sugar comparison to fibre. The average cohesiveness varied from 0.196 to 0.872 (Table 4.1)**.** The minimum cohesiveness was observed from experiment no. T12, while the maximum cohesiveness was observed in experiment no. T9. Experiment no. T9 had 31.0%, 25.00% and 3% of khoa, sugar and fiber respectively. The statistical significant value (P>0.055) and standard deviation (σ=0.021), R^2 is 0.77. It can be seen that with increasing level of fiber, the cohesiveness containt increased linearly at all level of khoa and sugar (Fig. 4.9 a-b). The trend being more perceivable at higher level of fibre and sugar. Similar result was found by Jha *et al*., (2015) [6]. According to Londhe *et al*., (2012) [10] cohesiveness of Parwal Sweet increased with higher khoa and sugar content

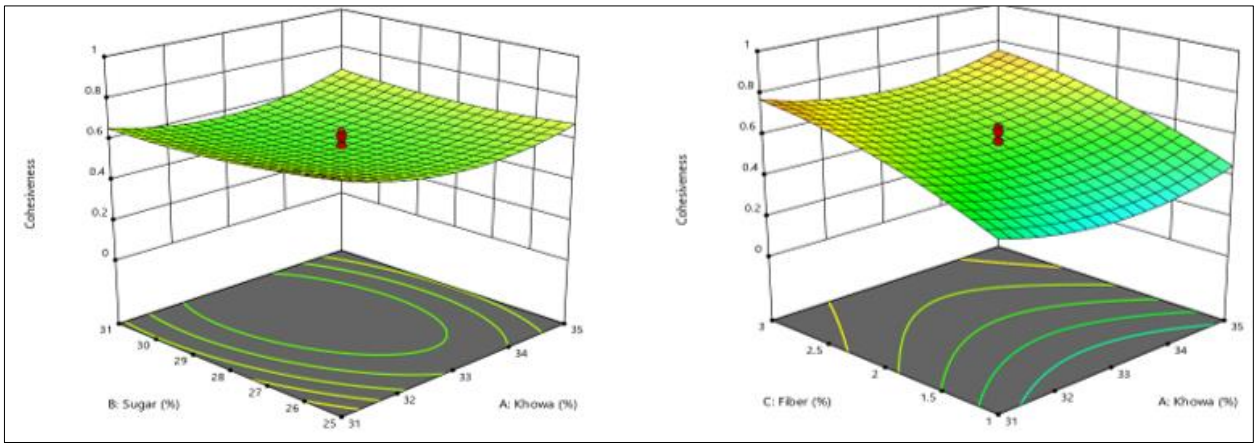

Fig 10(a-b) The interaction of khowa, sugar and fibre on cohesiveness

Gumminess

According to the result obtained Gumminess of Parwal Sweet is increased after mixing with khowa and sugar comparison to fibre. The average gumminess varied from 136.581 to 351.572 (Table 4.1). The minimum gumminess was observed from experiment no. T18, while the maximum gumminess was observed in experiment no. T5. Experiment no.T5 had 35.0%, 31.00% and 3% of khoa, sugar and fibre respectively. The statistical significant value (*P*>0.0012) and standard deviation (σ=0.021), R^2 is 0.88. It can be seen that with increasing level of fibre, gumminess increased linearly at all level of khoa and sugar (Fig. 4.10 a-b). The trend being more perceivable at higher level of fibre and sugar. This result was in agreement with the findings of Jha, *et al*., (2015) [6] and Jain *et al*., (2015) [5] who reported that the increase of total solid content in Parwal Sweet resulted increase of gumminess.

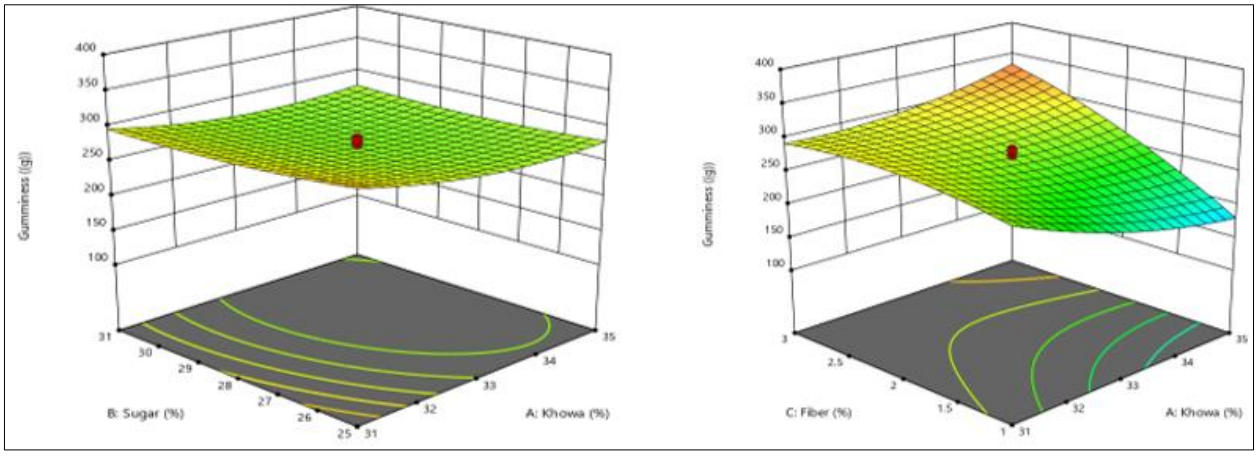

Fig 11(a-b): The interaction of khowa, sugar and fibre on Gumminess

Chewiness

According to the result obtained chewiness of Parwal Sweet is increased after mixing with khoa and sugar in comparison to fibre. The average chewiness varied from 57.547 to 195.615 (Table 4.1). The minimum chewiness was observed from experiment no. T18, while the maximum chewiness was observed in experiment no. T17. Experiment no.T17 had 33.0%, 28.00% and 3.68% of khoa, sugar and fibre respectively. The statistical significant value (P>0.0001) and standard deviation (σ=0.021), R^2 is 0.92. It can be seen that with increasing level of fibre the chewiness increased linearly at all level of khoa and sugar (Fig. 4.11 a-b). The trend being more perceivable at higher level of fibre and sugar. This result was in agreement with the findings of Rasane *et al*., (2015) [14]. Martins *et al*. (2010) reported a significant difference in chewiness between Parwal sweet containing Beta-glucan and samples without Beta-glucan.

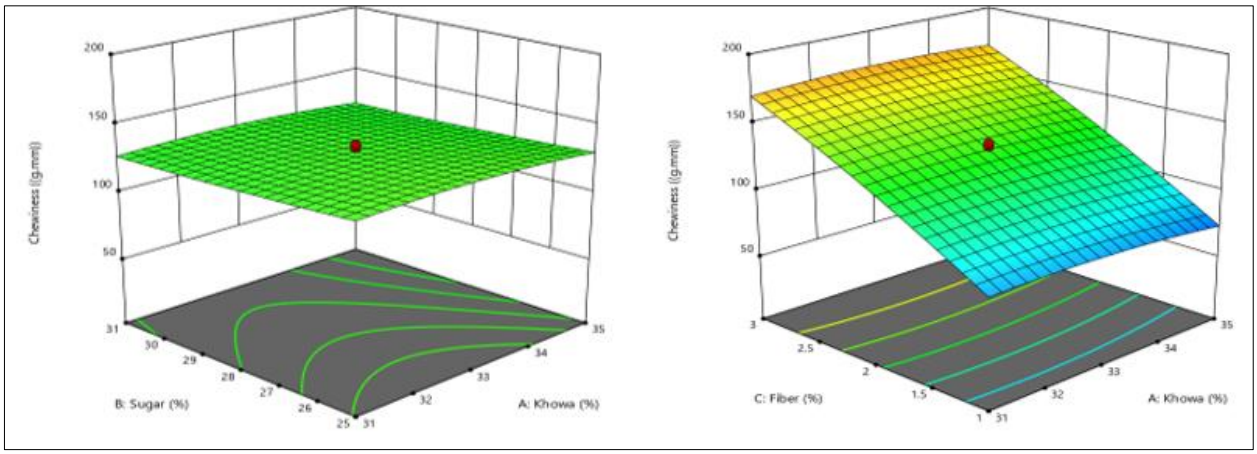

Fig 12(a-b): The interaction of khoa, sugar and fibre on Chewiness

Conclusion

The results of the present investigation showed that beta-glucan the fibre content could be efficiently captured with little interference from the environment or unintended interactions with other dietary components. In addition to other criteria including total dietary, soluble and insoluble dietary fibre analysis. It is best to formulate the designed Whey protein coated fibre enrich Parwal Sweet with the rising customer demand for fibre rich and functional foods in mind. After testing the storability of Whey Protein coated fiber enrich- Parwal Sweets, it was found that it can be stored at room temperature for a longer period of time as compared to normal Parwal Sweet. Due to minimize degradation of product quality and storability loss can be achieved at commercial level.

Table 1: Response surface Methods for the optimization of the fibre rich Parwal Sweet with β-glucan edible coating of statistical analysis of the data.

SN	Khoa (gm.)	Sugar (gm.)	Fiber (gm.)	Flavour	Colour and appearance	Body & Texture	Over all acceptability	Moisture (%)	Hardness	Adhesiveness	Springiness	Cohesiveness	Gumminess	Chewiness
T1	29.6	28	2	3.9	3.6	4.9	4.1	20.48	1397.28	-183.641	0.538	0.869	318.275	124.627
T2	33	28	2	4.6	4.1	4.9	4.5	21.06	1125.62	-134.681	0.663	0.615	284.351	134.621
T3	36.36	28	2	4.5	4.6	4.8	4.3	22.27	1206.81	-152.091	0.782	0.791	319.164	135.081
T4	33	28	2	4.4	4.5	4.3	4.7	21.48	1005.68	-95.642	0.637	0.527	274.691	133.537
T5	35	31	3	3.7	2.9	3.4	3.9	19.71	1286.38	-168.281	1.303	0.834	351.572	162.364
T6	33	22.95	2	5.5	3.8	5.2	4.8	23.61	986.19	-93.194	0.612	0.491	293.187	149.184
T7	31	31	1	8.2	7.9	6.8	8.4	19.72	386.81	-58.637	0.278	0.31	268.193	62.319
T8	33	33.04	2	4.6	5.3	4.9	5.1	18.37	1287.61	-154.218	0.561	0.827	297.081	136.246
T9	31	25	3	4.1	4.6	5.7	4.2	20.61	1686.51	-198.212	1.212	0.872	326.167	166.834
T10	33	28	2	3.7	4.6	4.5	4.8	20.72	1038.63	-96.371	0.682	0.573	264.684	132.647
T11	33	28	2	4.6	3.8	4.2	4.6	20.75	986.53	-92.671	0.697	0.493	281.351	135.681
T12	33	28	1.3182	6.4	5.9	6.7	6.1	22.17	1038.96	-99.373	0.121	0.196	183.537	61.052
T13	35	25	3	3.8	3.1	4.5	3.6	20.42	1196.83	-119.627	1.216	0.764	316.681	169.351
T14	35	25	1	8.1	6.1	7.2	8.2	22.78	961.87	-88.571	0.231	0.681	192.531	62.076
T15	33	28	2	4.6	4.9	4.6	4.4	21.61	1018.28	-98.28	0.581	0.571	268.941	124.651
T16	31	25	1	6.2	5.9	5.7	6.3	20.68	794.38	-78.361	0.149	0.637	289.316	85.613
T17	33	28	3.68	2.5	3.1	3.9	3.2	17.61	1140.57	-136.38	0.991	0.682	286.371	195.615
T18	35	31	1	8.6	8.2	8.4	8.8	22.63	525.16	-46.681	0.252	0.284	136.581	57.547
T19	33	28	2	4.9	4.2	4.7	4.1	20.46	1138.16	-99.519	0.584	0.634	249.618	119.671
T20	31	31	3	3.6	2.8	3.6	3.8	16.74	1238.68	-163.651	1.274	0.712	297.381	178.628

Table 2: Physicochemical properties of Optimized product fibre rich (β-glucan) Parwal Sweet

SN	Organoleptic Properties				Physical properties							Chemical properties						
	Flavour	Colour and appearance	Body and texture	OAA	Moisture (%)	Hard Ness	Adhesiveness	Springiness	Cohesiveness	Gumminess	Chewiness	Protein (%)	Carbohydrate (%)	Fat (%)	Ash (mg)	Total Fibre (gm)	Soluble dietary Fibre (gm)	Insoluble Fibre (gm)
A1	4.4	4.23	8.41	8.81	19.361	1095.985	-132.112	0.849	0.671	292.195	140.626	2.21	20.5	2.0	3.51	17.83	4.33	13.5
A2	4.5	4.28	8.45	8.8	19.381	1097.980	-136.113	0.859	0.634	293.165	143.656	2.3	20.6	2.3	3.54	18.02	4.35	13.67
A3	4.4	4.26	8.43	8.7	19.871	1096.983	-134.114	0.879	0.676	294.194	142.627	2.4	20.7	2.4	3.6	17.71	4.28	13.43
Mean	4.43	4.26	8.43	8.77	19.54	1096.98	-134.11	0.86	0.66	293.18	142.30	2.30	20.60	2.23	3.55	17.85	4.32	13.53
Cov	0.0026	0.0002	0.0001	0.0026	0.0626	0.3314	1.3327	0.0001	0.0005	0.3463	0.4991	0.0032	0.0033	0.0070	0.0010	0.0010	0.0010	0.0010

*OAA Over all acceptability, *(%) Percentage

Table 3: ANOVA for linear model of all responses

Responses	Sum of square	F-value	R_2	CV	P-value
Flavour	37.65	13.0	0.71	19.34	0.0001
Colour and Appearance	34.66	8.78	0.80	17.28	0.0006
Body and Texture	28.23	12.18	0.91	9.86	0.003
Over all acceptability	33.57	10.57	0.66	20.20	0.0004
Moisture	42.68	17.76	0.76	4.33	0.0001
Hardness	6.7	4.16	0.43	21.61	0.023
Adhesiveness	15596.90	4.84	0.47	27.81	0.013
Springiness	2.28	36.56	0.87	21.60	0.0001
Cohesiveness	0.552	3.75	0.77	20.68	0.055
Gumminess	45101.14	8.52	0.88	8.82	0.0012
Chewiness	29802.59	66.39	0.92	9.68	0.0001

Reference

1. Amrutha Kala AL. A survey of lipid composition of Khoa samples in relation to possible adulteration. International journal of dairy technology. 2012;65(3):444-450.
2. Aneja RP, Mathur BN, Chauhan RC, Banerjee AK. Technology of Indian dairy products. Dairy India Publication, New Delhi, India; 2012, 122-125.
3. Bagheripoor N, Khoshgozaran-Abras S, Sohrabvandi S, Khorshidian N, Mortazavian AM, MollaKhalili N. Application of active edible coatings to improve the shelf-life of cheese. Food Science and Technology Research. 2018;24(6):949-962.
4. Choudhary S, Arora S, Kumari A, Narwal V, Sharma V. Effect of quality of milk on maillard reaction and protein oxidation during preparation of cow and buffalo milk khoa. Journal of food science and technology. 2017;54:2737-2745.
5. Jain V, Rasane P, Jha A, Sharma N, Gautam A. Effect of modified atmospheric packaging on the shelf life of Kalakand and its influence on microbial, textural, sensory and physico-chemical properties. Journal of food science and technology. 2015;52:4090-4101.
6. Jha A, Kumar A, Jain P, Gautam AK, Rasane P. Effect of modified atmosphere packaging on the shelf life of lal peda. Journal of food science and technology. 2015;52:1068-1074.
7. Bach Knudsen KE. The nutritional significance of "dietary fibre" analysis. Animal Feed Science and Technology. 2001;90:3-20.
8. Khatua S, Pandey A, Biswas SJ. Phytochemical evaluation and antimicrobial properties of *Trichosanthes dioica* root extract. Journal of Pharmacognosy and Phytochemistry. 2016;5(5):410.
9. Korus A. Changes in the content of minerals, B-group vitamins and tocopherols in processed kale leaves. Journal of Food Composition and Analysis. 2020;89:103464.
10. Londhe G, Pal D, Raju PN. Effect of packaging techniques on shelf life of brown peda, a milk-based confection. LWT-Food Science and Technology. 2012;47(1):117-125.
11. Martins ZE, Pinho O, Ferreira IMPLVO. Impact of new ingredients obtained from brewer's spent yeast on bread characteristics. Journal of food science and technology. 2018;55:1966-1971.
12. Patel AS, Pandey AK. Fortification of Limonia acidissima linn fruit powder to develop the phynolic enriched herbal biscuits. J Biores Eng Technol. 2014;1:74-85.
13. Patel AS, Pradhan RC. Quality ranking of bottle gourd seed cake powder incorporated biscuits using fuzzy analysis of sensory attribute. BIOINFOLET-A Quart J Life Sci. 2015;12(4a):901-908.
14. Rasane P, Beenu Tanwar, Anirban Dey. Khoa: A Heat Desiccated Indigenous Indian Dairy Product. Research Journal of Pharmaceutical, Biological and Chemical Sciences. 2015;6(5):39-48.
15. Singh K. Phytochemical determination and antibacterial activity of *Trichosanthes dioica* Roxb (Patal), Cucurbita Maxima (pumpkin) and Abelmoschus esculentus Moench (Okra) plant seeds (Doctoral dissertation), 2012.
16. Viswas NR, Pandey RK, Singh VP, Dubey M, Chaubey AK. Technology of stuffed Parwal sweet production. International Journal of Research Studies in Biosciences, 2014;2(8):1-5.