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Sensory and textural profile analysis of low calorie fiber enriched herbal gulabjamun

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Abstract

Research was conducted to examine the effect of *Tulsi* as an herb, Oat as fibre content and Sorbitol as fat replacer on the sensory and textural properties of low calorie fiber enriched herbal *Gulabjamun*. The objective of the present research was to develop improved herbal based *Gulabjamun* with health benefits beyond those of traditionally formulated *Gulabjamun*. The product was manufactured by different ratio of Sorbitol (2%, 4% and 6%), Oat flour (10%, 15% and 20%) and *Tulsi* extract (10%, 15% and 20%). The mean values of sensory scores were evaluated of the optimized product and were found significantly ($P < 0.01$) different with the control one. The body and texture (8.33), color and appearance (8.66), flavor (8.33), taste (8.66) and for overall acceptability the mean score found was 8.66. The hardness, springiness and adhesiveness of the developed product was found to be less as compared to that of control *Gulabjamun*, while cohesiveness, gumminess and chewiness were found to be more than control sample.

Keywords: *Gulabjamun*, *tulsi*, sorbitol, oat flour, appearance, flavor, overall acceptability, hardness, springiness, adhesiveness, cohesiveness, gumminess and chewiness

1. Introduction

Gulabjamun refers to the indigenous dairy product. Almost all the states of the country use *Gulabjamun* as one of the essential and most commonly consumed sweet. Different states using different shapes and size of *Gulabjamun* viz; cylindrical, oval and spherical, but most commonly found shape is spherical.

The gross chemical composition of *Gulabjamun* varies widely depending on numerous factors, such as composition and quality of *Khoa*, proportion of ingredients, sugar syrup concentration, etc. The composition of *Gulabjamun*, on the drained weight basis, varies in the following range: moisture 25 – 35 percent, fat 8.5 – 10.5 percent, protein 6 – 7.6 per cent, ash 0.9 – 1.0 per cent and total carbohydrates 43 – 48 per cent.

In *Gulabjamun* manufacture, dipping in sugar syrup is a key unit operation. This gives not only its characteristic sweetness but also its typical texture. The characteristic sweetness is only due to the diffusion of sugar syrup into fried *Gulabjamun* balls. Hence the diffusion is one of the key processes taking place in *Gulabjamun* manufacture.

2. Material and Methods

The experiment "Sensory and Textural Profile Analysis of Low Calorie Fiber enriched Herbal *Gulabjamun*" was conducted in the Laboratory of Animal Husbandry & Dairying and Centre of Food Science & Technology, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi. The experimental techniques were employed as under.

2.1 Sensory evaluation

The sensory analysis of *Gulabjamun* was carried out at 25 °C temperature by a semi-trained panel of 10 judges drawn from staff and students of the Department of Animal Husbandry and Dairying at Banaras Hindu University, Varanasi (India). The judges were asked to score for the sensory attributes viz. color and appearance, flavor, body and texture, sweetness and overall acceptability, on a 9-point Hedonic scale.

2.2 Texture profile analysis (TPA)

TPA on *Gulabjamun* samples was performed by using the Texture Analyzer, TA.XT plus, Exponent Lite (Stable Micro Systems, Surrey, UK). TPA was done to characterize the hardness, adhesiveness, springiness, cohesiveness and gumminess of the product.

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3. Results and Discussions

The data collected on different aspects, as per plan were tabulated and analyzed statistically on the basis of C.R.D. factorial. The findings are also illustrated diagrammatically. The results obtained from the analysis during the course of investigation are presented in this chapter and discussed in detail.

3.1 Sensory Evaluation

3.1.1 Body and Texture

3.1.1.1 Effect of different Sorbitol levels on Body and Texture of low calorie fiber enriched herbal *Gulabjamun*

The body and texture score (8.333) of low calorie fiber enriched herbal *Gulabjamun* was found significant. The maximum mean score of body and texture (8.333) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 6% Sorbitol, while the minimum mean score of (6.00) was obtained when low calorie fiber enriched herbal *Gulabjamun* was prepared with some other combinations of Sorbitol (2%, 4%) with Oat flour and *Tulsi* extract and they were found non-significant (Table 1). An improved sensory score was observed by the addition of Sorbitol by Chetana *et. al.* (2004) [4].

3.1.1.2 Effect of different Oat flour levels on Body and Texture of low calorie fiber enriched herbal *Gulabjamun*

The maximum mean score of body and texture (8.333) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 20% Oat flour. The body and texture score (8.333) of low calorie fiber enriched herbal *Gulabjamun* was significant when it was manufactured with 20% Oat flour. The minimum mean score (6.00) was obtained at different combination of Oat flour with Sorbitol and *Tulsi* extract were found non-significant (Table 1).

3.1.1.3 Effect of different *Tulsi* extract levels on Body and Texture of low calorie fiber enriched herbal *Gulabjamun*

The body and texture score (8.333) of low calorie fiber enriched herbal *Gulabjamun* was found significant. The maximum mean score of body and texture of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 20% *Tulsi* extract, while the minimum mean score of (6.00) was obtained at different combination of *Tulsi* extract with Oat flour and Sorbitol were found non-significant (Table 1). With higher levels addition of *Tulsi* extract the samples were criticized for being heavy bodied (Kumar *et al.*, 2013) [8].

Table 1: Mean Score of Body and Texture w.r. to different treatments

	C(1)	C(2)	C(3)
A1B1	6.000	6.333	6.333
A1B2	6.000	6.333	6.333
A1B3	7.000	6.333	7.000
A2B1	6.000	7.000	7.000
A2B2	7.000	7.667	7.000
A2B3	7.333	6.667	6.000
A3B1	6.000	7.000	6.000
A3B2	7.667	6.333	7.000
A3B3	7.333	7.667	8.333

3.1.1.4 Interactional effect of Sorbitol, Oat flour and *Tulsi* extract on Body and Texture of low calorie fiber enriched herbal *Gulabjamun*

Treatment combination of Sorbitol, Oat flour and *Tulsi* extract

significantly influenced the body and texture of low calorie fiber enriched herbal *Gulabjamun*. The best body and texture score (8.333) has been obtained with $A_3 \times B_3 \times C_3$ combination which was statistically at par with $A \times B \times C$. Significance level is 0.077, which is less than 0.01 and thus have 0.01 significance level (Table 2). The minimum mean score of body and texture (6.00) was obtained with different combination of Sorbitol, Oat flour and *Tulsi* extract were found non-significant. The mean score graph of body and texture w.r. to different treatments has been shown in fig. 2

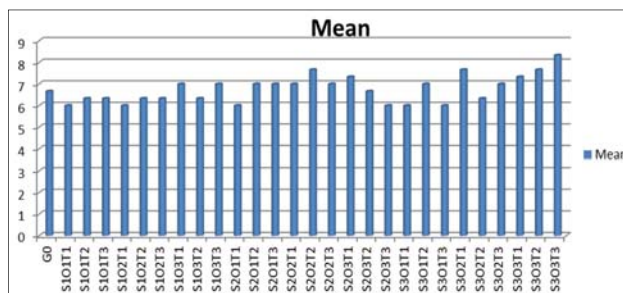


Fig 1: Mean Score Graph of Body and Texture w.r. to different treatments

Table 2: ANOVA table for Body and Texture w.r. to different treatments combinations

Source	D.F	S.S	M.S.S	F-cal	Significance
Cont V/S Treat	1	4.280	4.280	5.978	0.0178
Factor A	2	5.654	2.827	3.948	0.0251
Factor B	2	6.099	3.049	4.259	0.0192
Factor A × B	4	7.012	1.753	2.448	0.0572
Factor C	2	0.173	0.086	0.121	0.8865
Factor A × C	4	1.161	0.290	0.405	0.8041
Factor B × C	4	3.160	0.790	1.103	0.3644
Factor A×B×C	8	8.617	1.077	1.504	0.0077
Error	54	38.667	0.716		
Total	80	70.543			

The standard error means SE (m) of Sorbitol, Oat flour and *Tulsi* extract combinations were 0.4885. The standard error differences of two means were 0.6908. The critical difference (CD) of the combinations of these three different combinations obtained was 0.7807 (Table 3). This value proves the significance of the $A_3 \times B_3 \times C_3$ combination.

Table 3: SE (m), SE (d) and CD Table

	A	B	C	A×B	A×C	B×C	A×B×C	C/T
SE (m)	0.1628	0.1628	0.1628	0.2821	0.2821	0.2821	0.4885	0.1092
SE (d)	0.2303	0.2303	0.2303	0.3988	0.3988	0.3988	0.6908	0.1544
CD	0.4635	0.4635	N.S.	N.S.	N.S.	N.S.	0.7807	0.3108

3.1.2 Color and Appearance

3.1.2.1 Effect of different Sorbitol levels on Color and Appearance of low calorie fiber enriched herbal *Gulabjamun*

The color and appearance score (8.667) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score of color and appearance (8.667) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was manufactured with 6% Sorbitol. While the minimum mean score of color and appearance (5.667) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 4). The results are supported by the work of Chetana *et. al.*, (2004) [4].

3.1.2.2 Effect of different Oat flour levels on Color and Appearance of low calorie fiber enriched herbal Gulabjamun

The color and appearance score (8.667) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score of color and appearance (8.667) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 20% Oat flour. While the minimum mean score of (5.667) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 4). *Gulabjamun* produced was studied, colour and appearance scores were affected by the basic colour differences by the binder materials like Maida flour (Londhe *et. al.*, 2000) [10].

3.1.2.3 Effect of different Tulsi extract levels on Color and Appearance of low calorie fiber enriched herbal Gulabjamun

The color and appearance score (8.667) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score of color and appearance (8.667) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 20% *Tulsi* extract. While the minimum mean score of (5.667) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 4).

Table 4: Mean Score of Color and Appearance w.r. to different treatments

	C(1)	C(2)	C(3)
A1B1	5.667	5.667	5.667
A1B2	6.000	6.000	6.333
A1B3	6.667	5.667	7.333
A2B1	6.333	6.333	6.000
A2B2	6.000	7.000	6.000
A2B3	6.667	6.333	6.000
A3B1	6.333	7.333	7.000
A3B2	6.667	7.333	7.000
A3B3	7.333	7.667	8.667

3.1.2.4 Interactional effect of Sorbitol, Oat flour and Tulsi extract on Color and Appearance of low calorie fiber enriched herbal Gulabjamun

Treatment combination of Sorbitol, Oat flour and *Tulsi* extract significantly influenced the color and appearance of low calorie fiber enriched herbal *Gulabjamun*. The best score of color and appearance (8.667) has been obtained with A₃×B₃×C₃ which was statistically at par with A×B×C. The significance level is 0.0092, which is less than 0.01 thus have 0.01 significance level (Table 5). The minimum mean score (5.667) obtained with different combination of Sorbitol, Oat flour and *Tulsi* extract were found non-significant. The graphical representation of mean score has been shown in fig. 2.

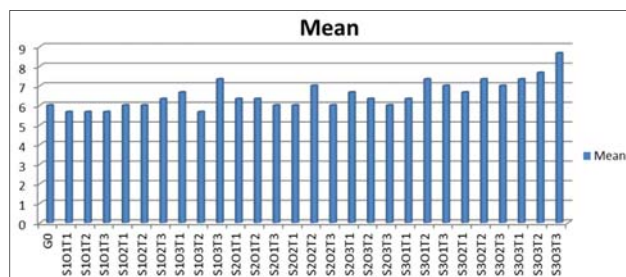


Fig 2: Mean Score Graph of Color and Appearance w.r. to different treatments

Table 5: ANOVA table for Color and Appearance w.r. to different treatments combinations

Source	D.F	S.S	M.S.S	F-cal	Significance
Cont V/S Treat	1	7.638	7.638	12.124	0.0000
Factor A	2	20.518	10.259	16.294	0.0000
Factor B	2	6.222	3.111	4.941	0.0107
Factor A × B	4	2.815	0.704	1.118	0.3578
Factor C	2	0.963	0.481	0.765	0.4705
Factor A × C	4	5.630	1.407	2.235	0.0772
Factor B × C	4	3.704	0.926	1.471	0.2239
Factor A×B×C	8	2.147	0.268	0.426	0.0092
Error	54	34.000	0.630		
Total	80	76.000			

The standard error means SE (m) of Sorbitol, Oat flour and *Tulsi* extract combinations were 0.4582. The standard error differences of two means were 0.6480. The critical difference (CD) of the combinations of these three different combinations obtained was 0.6870 (Table 6). The observed data were in significance level.

Table 6: SE (m), SE (d) and CD Table

	A	B	C	A×B	A×C	B×C	A×B×C	C/T
SE (m)	0.1527	0.1527	0.1527	0.2646	0.2646	0.2646	0.4582	0.1024
SE (d)	0.2160	0.2160	0.2160	0.3741	0.3741	0.3741	0.6480	0.1448
CD	0.4348	0.4348	N.S.	N.S.	N.S.	N.S.	0.6870	0.2916

3.1.3 Flavor

3.1.3.1 Effect of different Sorbitol levels on Flavor of low calorie fiber enriched herbal Gulabjamun

The flavor score (8.333) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean flavor score of (8.333) for low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 6% Sorbitol. While the minimum mean score of (5.667) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 7).

3.1.3.2 Effect of different Oat flour levels on Flavor of low calorie fiber enriched herbal Gulabjamun

The flavor (8.333) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score (8.333) of flavor of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 20% Oat flour. While the minimum mean score (5.667) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 7).

3.1.3.3 Effect of different Tulsi extract levels on Flavor of low calorie fiber enriched herbal Gulabjamun

The flavor score (8.333) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score of flavor (8.333) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 20% *Tulsi* extract. While the minimum mean score (5.667) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 7).

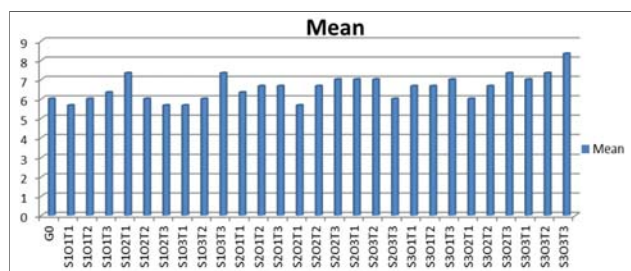
Use up of 3 % level of *Tulsi* extract increases the flavor score; 4 % level led to decrease in flavor score due to presence of excessive amounts of *Tulsi* extract and intense flavour. The addition of treated *Tulsi* extract at the rate of 3% was found to improve the flavor score significantly (Kumar *et. al.*, 2013) [8].

Table 7: Mean Score of Flavor w.r. to different treatments

	C(1)	C(2)	C(3)
A1B1	5.667	6.000	6.333
A1B2	7.333	6.000	5.667
A1B3	5.667	6.000	7.333
A2B1	6.333	6.667	6.667
A2B2	5.667	6.667	7.000
A2B3	7.000	7.000	5.667
A3B1	6.333	6.667	7.000
A3B2	6.000	6.667	7.333
A3B3	7.000	7.333	8.333

3.1.3.4 Interactional effect of Sorbitol, Oat flour, *Tulsi* extract on Flavor of low calorie fiber enriched herbal *Gulabjamun*

Treatment combination of Sorbitol, Oat flour and *Tulsi* extract significantly influenced the flavor of low calorie fiber enriched herbal *Gulabjamun*. The best flavor score (8.333) has been obtained with $A_3 \times B_3 \times C_3$ which was statistically at par with $A \times B \times C$. Significance level is 0.0012 which is less than 0.01 and the level of significance is 0.01 (Table 8). The minimum mean score (5.667) obtained with different combination of Sorbitol, Oat flour, *Tulsi* extract were found non-significant. Mean score has been shown in fig. 3 graphically.

**Fig 3:** Mean Score Graph of Flavor w.r. to different treatments**Table 8:** ANOVA table for Flavor w.r. to different treatments combinations

Source	D.F	S.S	M.S.S	F-cal	Significance
Cont V/S Treat	1	4.334	4.334	6.498	0.0092
Factor A	2	7.506	3.753	5.630	0.0060
Factor B	2	2.543	1.272	1.907	0.1583
Factor A × B	4	2.938	0.735	1.102	0.3651
Factor C	2	3.136	1.568	2.352	0.1049
Factor A × C	4	4.346	1.086	1.630	0.1801
Factor B × C	4	0.198	0.049	0.074	0.9898
Factor A×B×C	8	15.209	1.901	2.852	0.0012
Error	54	36.000	0.667		
Total	80	71.876			

The standard error means SE (m) of Sorbitol, Oat flour and *Tulsi* extract combinations were 0.4715. The standard error difference of two means were 0.6667. The critical difference (CD) of the combinations of these three different combinations obtained was 1.3421 (Table 9) and these data were significant.

Table 9: SE (m), SE (d) and CD Table

	A	B	C	A×B	A×C	B×C	A×B×C	C/T
SE (m)	0.1572	0.1572	0.1572	0.2722	0.2722	0.2722	0.4715	0.1054
SE (d)	0.2222	0.2222	0.2222	0.3849	0.3849	0.3849	0.6667	0.1490
CD	0.4474	N.S	N.S.	N.S.	N.S.	N.S.	1.3421	0.3000

3.1.4 Taste

3.1.4.1 Effect of different Sorbitol levels on Taste of low calorie fiber enriched herbal *Gulabjamun*

The Taste score (8.667) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score of taste (8.667) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was manufactured with 6% Sorbitol, while the minimum mean score of (5.333) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 10).

3.1.4.2 Effect of different Oat flour levels on Taste of low calorie fiber enriched herbal *Gulabjamun*

The Taste (8.667) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score of taste of (8.667) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 20% Oat flour. While the minimum mean score of (5.333) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 10).

3.1.4.3 Effect of different *Tulsi* extract levels on Taste of low calorie fiber enriched herbal *Gulabjamun*

The Taste score (8.667) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score of taste (8.667) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 20% *Tulsi* extract. While the minimum mean score of (5.333) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 10).

Table 10: Mean Score of Taste w.r. to different treatments

	C(1)	C(2)	C(3)
A1B1	5.667	6.333	5.333
A1B2	6.000	6.000	6.333
A1B3	5.333	6.000	6.333
A2B1	6.000	6.333	7.000
A2B2	6.333	7.000	6.667
A2B3	7.333	7.000	5.333
A3B1	5.333	6.333	6.333
A3B2	6.333	6.000	7.000
A3B3	7.000	7.000	8.667

3.1.4.4 Interactional effect of Sorbitol, Oat flour, *Tulsi* extract on Taste of low calorie fiber enriched herbal *Gulabjamun*

Treatment combination of Sorbitol, Oat flour and *Tulsi* extract significantly influenced the taste of low calorie fiber enriched herbal *Gulabjamun*. The best taste score (8.667) has been obtained with $A_3 \times B_3 \times C_3$ which was statistically at par with $A \times B \times C$. Significance level is 0.0035 which shows 0.01 level of significance (Table 11). Since the data is less than 0.01. The minimum mean score (5.333) obtained with different combination of Sorbitol, Oat flour and *Tulsi* extract were found non-significant. The graphical representation of mean score of taste has been shown in fig. 4.

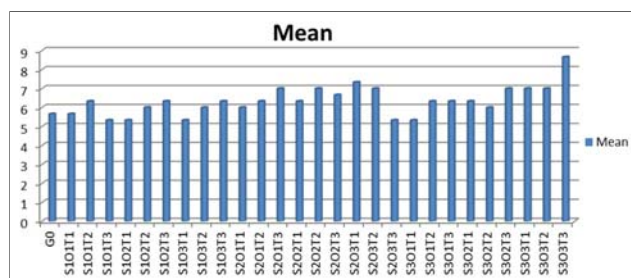


Fig 4: Mean Score Graph of Taste w.r. to different treatments

Table 11: ANOVA table for Taste w.r. to different treatments combinations

Source	D.F	S.S	M.S.S	F-cal	Significance
Cont V/S Treat	1	4.905	4.905	7.224	0.0098
Factor A	2	8.617	4.309	6.345	0.0033
Factor B	2	4.765	2.383	3.509	0.0369
Factor A × B	4	7.531	1.883	2.773	0.0361
Factor C	2	2.395	1.198	1.764	0.1812
Factor A × C	4	5.679	1.420	2.091	0.0947
Factor B × C	4	1.086	0.272	0.400	0.8078
Factor A×B×C	8	12.395	1.549	2.282	0.0035
Error	54	36.667	0.679		
Total	80	79.136			

The standard error mean SE (m) of Sorbitol, Oat flour and *Tulsi* extract combinations were 0.4757. The standard error difference of two means was 0.6727. The critical difference (CD) of the combinations of these three different combinations obtained was 1.3541 (Table 12). All the three data were significant.

Table 12: SE (m), SE (d) and CD Table

	A	B	C	A×B	A×C	B×C	A×B×C	C/T
SE (m)	0.1586	0.1586	0.1586	0.2747	0.2747	0.2747	0.4757	0.1064
SE (d)	0.2242	0.2242	0.2242	0.3884	0.3884	0.3884	0.6727	0.1504
CD	0.4514	0.4514	N.S.	N.S.	N.S.	N.S.	1.3541	0.3027

3.1.5 Overall Acceptability

3.1.5.1 Effect of different Sorbitol levels on Overall Acceptability of low calorie fiber enriched herbal *Gulabjamun*

The overall acceptability score (8.667) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score of overall acceptability of (8.667) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was manufactured with 6% Sorbitol. While the minimum mean score of (5.667) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 13). The overall acceptability of Sorbitol added *Kimchi* samples increased at 5 and 10% of Sorbitol (Ku *et al.*, 1999) [9].

3.1.5.2 Effect of different Oat flour levels on Overall Acceptability of low calorie fiber enriched herbal *Gulabjamun*

The overall acceptability (8.667) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score of overall acceptability (8.667) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 20% Oat flour. While the minimum mean score (5.667) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 13).

3.1.5.3 Effect of different *Tulsi* extract levels on Overall Acceptability of low calorie fiber enriched herbal *Gulabjamun*

The overall acceptability score (8.667) of low calorie fiber enriched herbal *Gulabjamun* was significant. The maximum mean score of overall acceptability (8.667) of low calorie fiber enriched herbal *Gulabjamun* was obtained when it was prepared with 20% *Tulsi* extract, while the minimum mean score (5.667) was obtained at different combination of Sorbitol with Oat flour and *Tulsi* extract were found non-significant (Table 13). Similar results were also reported by Biswas *et al.* (2002) and Jenkins *et al.*, (2002).

Table 13: Mean Score of Overall Acceptability w.r. to different treatments

	C(1)	C(2)	C(3)
A1B1	6.333	6.000	5.667
A1B2	6.667	6.333	5.667
A1B3	6.000	6.667	6.000
A2B1	7.667	5.667	7.000
A2B2	7.000	6.667	6.333
A2B3	7.667	7.333	5.667
A3B1	7.000	7.000	7.000
A3B2	6.667	6.000	7.333
A3B3	6.667	7.333	8.667

3.1.5.4 Interactions effect of Sorbitol, Oat flour, *Tulsi* extract on Overall Acceptability of low calorie fiber enriched herbal *Gulabjamun*

Treatment combination of Sorbitol, Oat flour and *Tulsi* extract significantly influenced the overall acceptability of low calorie fiber enriched herbal *Gulabjamun*. The best overall acceptability score (8.667) has been obtained with $A_3 \times B_3 \times C_3$ which was statistically at par with $A \times B \times C$. Significance level is 0.0022. Which shows 0.01 level of significance. (0.0022 < 0.01) (Table 14). The minimum mean score (5.667) obtained with different combination of Sorbitol, Oat flour and *Tulsi* extract were found non-significant. The mean graph has been shown in fig. 5.

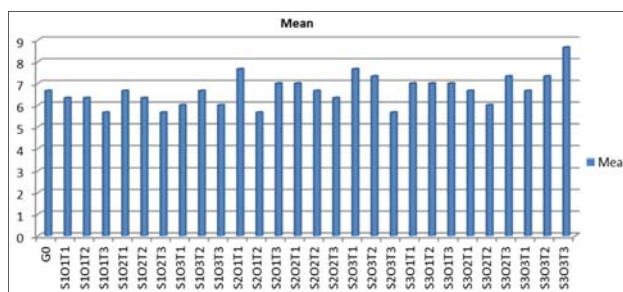


Fig 5: Mean Score Graph of Overall Acceptability w.r. to different treatments

Table 14: ANOVA table for Overall Acceptability w.r. to different treatments combinations

Source	D.F	S.S	M.S.S	F-cal	Significance
Cont V/S Treat	1	3.841	3.841	5.456	0.0378
Factor A	2	12.074	6.037	8.579	0.0006
Factor B	2	2.074	1.037	1.474	0.2382
Factor A × B	4	2.074	0.519	0.737	0.5709
Factor C	2	1.407	0.704	1.000	0.3746
Factor A × C	4	11.407	2.852	4.052	0.0060
Factor B × C	4	2.963	0.741	1.053	0.3889
Factor A×B×C	8	10.000	1.250	1.776	0.0022
Error	54	38.000	0.704		
Total	80	80.000			

The standard error mean SE(m) of Sorbitol, Oat flour and *Tulsi* extract combinations were 0.4844. The standard error difference of two means were 0.6860. The critical difference (CD) of the combinations of these three different combinations obtained was 0.5920 (Table 15). The three data obtained were significant.

Table 15: SE (m), SE (d) and CD Table

	A	B	C	A×B	A×C	B×C	A×B×C	C/T
SE (m)	0.1615	0.1615	0.1615	0.2797	0.2797	0.2797	0.4844	0.4844
SE (d)	0.2283	0.2283	0.2283	0.3955	0.3955	0.3955	0.6860	0.1531
CD	0.4596	N.S.	N.S.	N.S.	N.S.	N.S.	0.5920	0.3082

Gulabjamun has a thin but distinct crust overlaying a soft porous texture (Patel *et al.*, 1992) [11] caused as a result of slow but uniform penetration of syrup throughout the spherical ball. Soaked *Gulab jamun* is soft but should not collapse or distort. Also, it should not be pasty on the palate. Considering these desirable characteristics of *Gulabjamun*, sensory evaluation was carried out with a panel of 12 judges using a 10-point linear rating scale ranging from 0 (low intensity extreme on left end) to 10 (high intensity extreme on opposite end) (Amerine *et al.*, 1965) [12].

The sensory scores of the developed product with fat replacers decreased due to excessive softening and salty flavour and undesirable colour, softening and off-flavour for Sorbitol Sorbitol have no effect on the textural properties of developed low fat cheese. (Koca and Metin, 2004) [7].

3.2 Textural quality of low calorie fiber enriched herbal *Gulabjamun*.

The gumminess, chewiness and adhesiveness of low calorie fiber enriched herbal *Gulabjamun* decreased and cohesiveness increased with increased moisture content in *khoa*. Not much decrease in springiness was noticed due to moisture content in *khoa* was noticed.

Table 16: Textural properties of low calorie fiber enriched herbal *Gulabjamun* as compared to the control *Gulabjamun*

Rheological attribute	Low Calorie Fiber Enriched Herbal <i>Gulabjamun</i>	Control
Hardness (N) × 10 ⁻³	4.839 ± 0.583	5.691 ± 0.714
Adhesiveness (N) × 10 ⁻³	4.626 ± 0.601	6.00 ± 0.211
Cohesiveness	0.662 ± 0.020	0.661 ± 0.04
Gumminess (N) × 10 ⁻³	5.189 ± 0.987	3.763 ± 0.63
Springiness (mn)	08.500 ± 0.710	9.00 ± 0.623
Chewiness (N mm ²)	0.059 ± 0.014	0.034 ± 0.003

Good quality low calorie fiber enriched herbal *Gulabjamun* formed from cow milk can be described with the following rheological attributes:

1. Hardness 4.839 ± 0.583 × 10⁻³ N
2. Adhesiveness 4.626 ± 0.601 × 10⁻³ N
3. Cohesiveness 0.662 ± 0.020
4. Springiness 08.500 ± 0.710 mn,
5. Gumminess 5.189 ± 0.987 × 10⁻³ N and
6. Chewiness 0.059 ± 0.014 N mm².

Rheological characteristics of low calorie fiber enriched herbal *Gulabjamun* prepared from cow milk, Sorbitol, *Tulsi* extract and Oat flour using the technology developed in this project were compared with the help of INSTRON UNIVERSAL TESTING INSTRUMENT. The results are

presented in Table 16. Low calorie fiber enriched herbal *Gulabjamun* samples prepared from cow milk, Sorbitol, *Tulsi* extract and Oat flour in the preliminary investigations were hard. Hardness of low calorie fiber enriched herbal *Gulabjamun* samples from cow milk, Sorbitol, *Tulsi* extract and Oat flour (4.839 × 10⁻³ N), was lesser than that of control (5.691 ± 0.714). Such an improvement in softness of low calorie fiber enriched herbal *Gulabjamun* from cow milk was the result of the modified process developed in this investigation. Yawale and Rao (2012) [13] studied textural profile analysis of effect of maida and baking powder level in *Khoa* powder *Gulabjamun* mix and reported that hardness ranged 2.65 to 4.90 and 2.75 to 4.81 N, respectively.

Low calorie fiber enriched herbal *Gulabjamun* samples from cow milk, Sorbitol, *Tulsi* extract and Oat flour were observed to be less cohesive (0.661 Vs 0.662), less gummy (3.763 × 10⁻³ N Vs 5.189 × 10⁻³ N), less springy (9.0 Vs 11.5 mm) and less chewy (0.034 Vs 0.059 N mm²) in comparison from control *Gulabjamun*. Adhikari (1993) [1] studied the textural characteristics of *Khoa* and *Gulabjamun* made from cow's milk reported that cohesiveness of laboratory and market *Gulabjamun* 0.35 and 0.39, respectively. Yawale and Rao (2012) [13] studied textural profile analysis of effect of maida and baking powder level in *Khoa* powder *Gulabjamun* mix and reported that reduce the level of maida decrease springiness of *Gulabjamun*. Adhikari (1993) [1] studied the textural characteristics of *Khoa* and *Gulabjamun* made from cow's milk reported that chewiness of laboratory and market *Gulabjamun* 12.35 and 17.53 mN mm, respectively.

Adhesiveness of low calorie fiber enriched herbal *Gulabjamun* (4.626 × 10⁻³ N), was found to be lesser than that of control *Gulabjamun* characteristics of two types of *Gulabjamun* were significant as revealed from the sensory acceptability of the two products. Rasane *et al.* (2012) [12] reported that variation in adhesiveness of market samples of *burfi* may be due to variation in sugar content. The use of fat replacers decreased the hardness, springiness, gumminess and chewiness and increased cohesiveness (Koca and Metin, 2004) [7].

The standard method of production of low calorie fiber enriched herbal *Gulabjamun* form cow milk developed in the present investigation can be recommended for industrial production. It was observed that, addition of wheat bran in *Gulabjamun* increased moisture, ash, carbohydrate and fibre content significantly in finished product while per cent ash, fat, protein and total solid content was decreased significantly due to increase in rate of addition of wheat bran. Texture profile analysis of product revealed that addition of wheat bran in *Gulabjamun* progressive decreased hardness towards higher of incorporation. 20 per cent level of wheat bran in *Gulabjamun* decreased the score for cohesiveness, adhesiveness, gumminess and chewiness (Ghube *et al.*, 2015) [5].

4. Conclusion

The finished product was offered to 10 consumers, the overall frequency distribution of consumer's acceptability trial reveals that none of the consumers rated the product below the acceptable score i.e. 6.0. It is concluded that the product is very much liked by the consumers above the age group of above 20 years as compared to consumers of the age group of below 20 years.

The mean score of sensory parameters of the optimized product are as follows:

- I. Body and texture - 8.33

II.	Color and appearance	-	8.66
III.	Flavor	-	8.33
IV.	Taste	-	8.66
V.	Overall Acceptability	-	8.66

From consumer response trial, it is quite logical to conclude that the low calorie, fiber enriched herbal *Gulabjamun* received wide acceptance by all group of consumers especially those consumers suffering from various diseases like diabetes, obesity and heart related problems. It is believed that the product surely shall attract a very wide market acceptance.

Hardness of low calorie, fiber enriched herbal *Gulabjamun* is $4.839 \pm 0.583 \times 10^{-3}$ N was lesser than that of control *Gulabjamun* ($5.691 \pm 0.714 \times 10^{-3}$ N). Low calorie, fiber enriched herbal *Gulabjamun* samples were observed to be more cohesive (0.662 Vs 0.661), more gummy ($5.189 \pm 0.987 \times 10^{-3}$ N Vs $3.763 \pm 0.63 \times 10^{-3}$ N), less springy (08.500 ± 0.710 mm Vs 9.00 ± 0.623 mm) and more chewy (0.059 ± 0.014 mm² Vs 0.034 ± 0.003) in comparison with those from control *Gulabjamun*. The Adhesiveness of low calorie, fiber enriched herbal *Gulabjamun* ($4.626 \pm 0.601 \times 10^{-3}$ N) is quite less than that of control *Gulabjamun* ($6.00 \pm 0.211 \times 10^{-3}$ N). The standard method of production of low calorie, fiber enriched herbal *Gulabjamun* form cow milk along with Sorbitol, Oat flour and *Tulsi* extract developed in the present investigation is recommended for industrial production of functional *Gulabjamun*.

5. References

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