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Technology for manufacture of "Low fat" and "Sugar free" shrikhand

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Abstract
The present study was undertaken to evaluate the possibility of complete replacement of the sugar in the shrikhand and reducing fat content to make dietetic product without affecting sensory properties. Chakka was manufactured using skim milk and sweet cream butter milk in combination. Sugar was replaced by intense sweetener sucralose and the bulk of sucrose was replaced by employing prebiotic oligo fiber "fructooligosaccharide (FOS)" and "isomalt". Both the bulk replacers are low in glycemic index. Fat content of the chakka was 1.1 percent and experimental samples containing FOS and isomalt were 0.44 and 0.52 percent respectively. Viscosity of the shrikhand samples were 10584, 9785, 12052 and 15597 cP respectively for laboratory control, market control, FOS and isomalt containing shrikhand. Sucralose containing Isomalt as sucrose bulk replacer had highest overall acceptability and FOS sucralose shrikhand has at par overall acceptability scores compared to laboratory control sample.

Keywords: Shrikhand, Sucralose, isomalt, fructo oligosaccharide, sugar free shrikhand

Introduction
Fermented milk products constitute a vital component of the human diet in many regions of the world. Indian fermented milk products utilize 7 percent of total milk produced and mainly include three major products i.e. *dahi*, shrikhand and *lassi*. Shrikhand is popular dessert and forms part of a delicious supplement on religious functions, particularly in the state of Maharashtra, Gujarat, Karnataka and some parts of South India. Shrikhand is made with hung & strained curd incorporating sugar, saffron, cardamom, diced fruit and nuts together to give a thick smooth creamy texture. These fermented milk products and as shrikhand is one of them have enjoyed reputation for their nutritional and therapeutic value from time immemorial and play an important role in synthesis of vitamin B complex in human body. These products also prevent the stomachic diseases, because several lactic organisms produce natural antibiotics.
Shrikhand contains about 40% or more sugar and 6.0% or more fat. With increase in consumer awareness towards nutrition and increased population with obesity and diabetes, it is very much necessary to produce Shrikhand with no or low sugar added and having reduced fat that can meet the requirement of health conscious consumers for low calorie product as well as persons suffering from diabetes. The number of people with diabetes in India increased from 26·0 million in 1990 to 65·0 million in 2016. The prevalence of diabetes in adults aged 20 years or older in India increased from 5·5% in 1990 to 7·7% in 2016 (Anon, 2018) [2]. The prevalence of overweight and obesity in India is increasing faster than the world average. India has >135 million obese individuals at present. The prevalence of overweight will be more than double among Indian adults aged 20–69 years between 2010 and 2040, while the prevalence of obesity will triple. Specifically, the prevalence of overweight and obesity will reach 30.5% and 9.5% among men, and 27.4% and 13.9% among women, respectively, by 2040 (Shammi *et al.* 2020) [1].
Shelke *et al.* (2014) [3] reported manufacture of low fat sugar free mango shrikhand in which they had added sucralose as an intense sweetener in the shrikhand on percent basis (3.0 to 12% of the final product) and concluded that artificial sweetener sucralose up to 6 percent level is suitable. However clarification on the sweetening power of the sucralose used was missing here. Pandey *et al.* (2018) [4] reported manufacture of shrikhand with Stevia leaf powder. They had used stevia leaf powder on percent basis (2.0 to 6.0% on the final product) and concluded that addition of 4.0 and 6.0% of stevia leaf was more acceptable due to higher overall acceptability score and lesser ash content. Deshmukh *et al.* (2022) [8] reported partial replacement of sugar with the date pulp in manufacture of shrikhand. They reported increase in fiber content of the resultant product.

Materials and Methods

Preparation of Chakka

Fresh mix milk was procured from Vidya dairy AAU, Anand and skim milk was separated in an open discharge 'Alfa Laval' power driven mechanical cream separator. Fresh sweet cream buttermilk [91.42% moisture, 0.45% fat, 3.13% protein and 0.144% lactic acid] was obtained from Kaira District Co-operative Milk Producers' Union Ltd., Anand. Skim milk and was mixed with fresh sweet cream buttermilk (50:50) followed by heating at 90 °C for 10 minutes and then cooled to 42 °C. It was then inoculated @ 1% with starter culture, *Str. lactis* var. *thermophilus* (MD 2) and *Lb. delbrukki subsp bulgaricus* (LBW) which was mixed well, and incubated at 40-42 °C for 5 - 6 hours. When the curd had set firmly (acidity 0.9-1.0% lactic acid), it was broken and placed in a muslin cloth bag for whey drainage (traditional method of whey drainage) for 3 - 4 h. Chakka so obtained had 80.16% moisture, 1.1% fat, 12.96% protein and 1.96% lactic acid.

Intense sweetener: Sucralose and bulking ingredients isomalt and fructooligosaccharide from Ensign Health Care Pvt. Limited, Pune, was procured. Commercial grade white crystalline sugar purchased from local market has been used in laboratory control sample.

Preparation of shrikhand

This Chakka was then mixed with intense sweetener sucralose and blend consisting of either isomalt /fructooligosaccharides as bulking ingredients; sucrose as natural sweetener (in control sample) followed by kneading and then sieving through 200 mesh size sieve. The product obtained was added with cardamom as a flavouring agent. Sucralose was added considering its sweetness as 600 times compared to sucrose and isomalt (0.5 times sweeter) and fructooligosaccharides (0.4 times sweeter) and both are having very low glycemic index of 2.0 and 1.0 respectively.

Analysis of Materials

Analysis of milk, chakka and shrikhand was carried out by standard methods. Fat, total solids, protein, ash, titratable acidity and sucrose content were measured as per FSSAI Manual (2015) [5]. The viscosity of Shrikhand samples was determined using 'Haake' viscosimeter (Model VT-550, M/S. Gebr, HAAKE GmbH, Germany). Sensory characteristics of the shrikhand were evaluated by a panel of 8 judges selected from Dairy Technology department of the college. A 100-point descriptive scale was used for sensory attributes like Flavor, Body & Texture and Color & Appearance.

Statistical Analysis

The mean value of each attribute under study obtained from duplicate samples of five replications (three treatments) were subjected to statistical analysis using 'Completely Randomized Design' (CRD) with equal number of observations Data was analysed using Analysis of Variance (ANOVA) and Critical difference (C.D) in WASP software (CRD) and MS office, 2010

Results and Discussion

In the present study, control and experimental shrikhand samples were prepared in laboratory and one more control sample, as branded sample, was procured from local market in Anand. All the samples were subjected for compositional and physico-chemical analysis and were given to selected panel of judges for sensory evaluation. In the laboratory control shrikhand sample calculated amount of cream having 60 percent fat was added so as to meet legal requirement for fat content of shrikhand, however, in experimental shrikhand samples such addition of cream or any fat source was not carried out so as to have lowest fat content in shrikhand samples.

Effect of replacement of sucrose with intense sweetener on compositional attributes of shrikhand

All the sample under study was subjected to compositional analysis viz. fat, protein, ash, sucrose and total solids content. It could be seen from the Table 1 that total solids content varied from 59.38 (C1, control) to 58.79 (T1, FOS), however, such variation was non-significant ($p<0.05$). Shelke *et al.* (2014) [3] reported development of low fat sugar free mango shrikhand. In their study experimental samples had extremely low total solids content which might be due ti incorporation of mango pulp and absence of bulk replacer for sucrose. Fat content varied significantly among control samples and experimental samples. This was obvious as addition of fat in the form of cream was not done with the aim of producing low fat sugar. Fat content of control sample and market control sample differed significantly ($p<0.05$), however experimental low fat shrikhand samples were statistically at par with each other. Similar trend was observed for FDM content as it is calculated on the basis of fat and total solids. Other compositional values like protein and ash content though varied but such variation was non-significant. The values observed in the present study for protein content were well within the limit of legal requirement. Sucrose content of the control samples were analyzed and was found to be 70.17% (DMB, control) and 72.42 (DMB, Market).

Effect of replacement of sucrose with intense sweetener on physico-chemical attributes of shrikhand

Incorporation of intense sweetener blend in lieu of sucrose resulted in significant effect on physico-chemical attributes under study. Acidity of the market sample was highest followed by control sample, however samples containing intense sweetener blend with lower fat content had lower acidity. Both control samples (laboratory and Market) samples had significantly higher acidity, but experimental sucrose free shrikhand samples had significantly ($p<0.05$) lower acidity. Similar acidity values have been reported by Mehta (2013) [6] for various brands of shrikhand.

Table 1: Compositional properties of Low fat Sugar-free Shrikhand FOS (T1) and Isomalt (T2) as bulking agents, Control sample of Shrikhand (C1) and Market Shrikhand sample (C2)

Attributes	C1 (Control)	C2 (Market)	T1 (FOS)	T2 (Isomalt)	S.Em.	C.D. (0.05)	C.V.%
Total Solids %	59.38±0.50	58.95±0.25	58.79 ±0.31	59.19±0.2	0.11	NS	0.60
Fat %	6.22±0.33	5.58±0.25	0.44±0.11	0.52±0.08	0.10	0.30	6.90
FDM %	10.47±0.55	9.47±0.41	0.82±0.21	0.97±0.16	0.16	0.49	6.73
Protein %	6.46±0.09	6.30±0.18	6.36±0.11	6.50±0.10	0.06	NS	1.95
Ash %	1.19±0.07	1.12±0.08	1.14±0.08	1.16±0.11	0.04	NS	5.37
Sucrose %	41.65±0.45	42.69 ± 0.43	NIL	NIL	-	-	-
Sucrose on dry matter basis %	70.14±1.07	72.42±0.62	NIL	NIL	-	-	-

Each observation is a mean ± SD of five replicate experiment (n = 5); NS = Not significant

Shrikhand samples pH varied from 5.21 (Market sample) to 5.16 (T1 FOS), however incorporation of intense sweetener blend did not impart significant variation in pH. Viscosity, an important criteria for accessing body of the shrikhand was significantly affected by incorporation of isomalt and fructo oligosaccharide as bulk material for replacing the mass of sucrose. Isomalt (bulking ingredient) containing shrikhand samples had highest viscosity (15597 cP) and was significantly higher among all samples. This could be because of oligo fiber/polysaccharide used as bulking ingredient. Water activity decreased upon replacement of sucrose with intense sweetener blend. Isomalt containing shrikhand had lowest water activity (0.906) and market sample (0.935) had significantly higher water activity. Similar values for water activity were reported by Suvera *et al*. (2017) [7].

Table 2: Physico-chemical properties of Low fat Sugar-free Shrikhand having FOS (T1) and Isomalt (T2) as bulking agents, Control sample of Shrikhand (C1) and Market Shrikhand sample (C2)

Attributes	C1 (Control)	C2 (Market)	T1 (FOS)	T2 (Isomalt)	S.Em.	C.D. (0.05)	C.V.%
Acidity (% LA)	1.09±0.08	1.16±0.06	0.93±0.07	0.97±0.07	0.03	0.10	6.88
pH	5.19	5.21	5.16	5.17	0.02	NS	2.31
Viscosity (cP at 25 ^{o}C)	10584±55	9785±43	12052±24	15597±18	17.00	51	0.32
Water activity $_{aw}$	0.928	0.935	0.916	0.906	0.009	0.026	3.87

Each observation is a mean ± SD of five replicate experiment (n = 5); NS = Not significant

Effect of replacement of sucrose with intense sweetener on sensory attributes of shrikhand

Sensory attributes of any food is the major criterion for acceptance or repentance of the food. All the sensory attributes of shrikhand samples were significantly affected by replacement of sucrose with intense sweetener sucralose. Colour and Appearance score improved in sugar free shrikhand, which could be due to significantly (p<0/05) higher viscosity and there by more firmness in the samples. Similar trend was noted for Body and Texture score which increased in sugar free shrikhand samples and T2 sample had significantly higher score. Flavour score of the sugar free shrikhand was at par with the control (C1) sample signifying that the replacement of sucrose and reduction in fat content did not affected the flavour and Sample T2 had highest overall acceptability score while sample C1 and T1 remained statistically at par.

Table 3: Sensory properties of Low fat Sugar-free Shrikhand having FOS (T1) and Isomalt (T2) as bulking agents, Control sample of Shrikhand (C1) and Market Shrikhand (C2)

Sensory Attributes	Colour and Appearance (15)	Body and Texture (30)	Flavour (45)	Overall Acceptability (100)
C1	13.05 ± 0.20	25.52 ± 0.30	42.43 ± 0.29	91.00 ± 0.61
C2	12.58 ± 0.21	24.95 ± 0.52	40.82 ± 0.48	88.35 ± 0.48
T1 (FOS)	13.36 ± 0.20	25.24 ± 0.72	42.50 ± 0.45	91.10 ± 0.74
T2 (IM)	13.31 ± 0.24	26.20 ± 0.41	42.83 ± 0.33	92.34 ± 0.28
S.Em.	0.10	0.23	0.18	0.25
C.D. (0.05)	0.29	0.68	0.53	0.74
C.V.%	1.64	2.00	0.94	0.61

Each observation is a mean ± SD of five replicate experiment (n = 5); Package and bacterial score is taken as 5 respectively.

Conclusion

The current investigation signifies that low fat and sugar free shrikhand with excellent sensory properties could be prepared by using skim milk and butter milk in 50:50 proportion for manufacture of chakka and replacing sucrose completely with blend of intense sweetener sucralose with either isomalt or fructo oligosaccharide as bulk replacer. Such replacement resulted in increase in viscosity compared to both the control samples of shrikhand.

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