

EFFECT OF SUGAR REPLACEMENT ON CHEMICAL COMPOSITION AND ORGANOLEPTIC PROPERTIES OF SHRIKHAND

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ABSTRACT

Shrikhand is a popular Indian dessert prepared by fermentation of milk. It has a semi-soft consistency and is sweetish sour in taste. Fresh Curd (dahi) prepared was partially strained through a cloth to remove the whey and produce a solid mass called chakka. Chakka was finely mixed with sugar and flavouring agents, to give a sweetish-sour taste. For the present study stevia powder and extract was used to replace sugar. Stevia powder and extract were added in different combination in the experimental products. Control, having 100% sugar was also prepared. The organoleptic evaluation of the products was done by a panel of judges to select the most acceptable level of stevia in shrikhand. The product with most acceptable level of stevia and the control sample was stored for 21 days at refrigeration temperature. During storage products were analyzed for the proximate composition, sensory attributes and microbial load at an interval of 7 days. It was found that shrikhand was acceptable upto 30% substitution of sugar with stevia extract and 20% substitution with stevia powder as compared to the control recipe. The storage study reveals that there was a decrease noticed in fat, protein, moisture and ash in both the control and sample shrikhand during storage. A significant ($P \leq 0.05$) decrease was noticed in the scores for sensory. The microbial load increased significantly ($P \leq 0.05$) during storage.

Keywords: Shrikhand, Stevia, Calories, Nutritive value

INTRODUCTION

India has a very rich variety of fermented foods prepared from milk, cereals, pulses vegetables, fruits and fish. Milk and milk products like curd, buttermilk lassi and Shrikhand is a traditional indigenous fermented semi soft, sweetened whole milk product prepared using Chakka (strained dahi) (Nadaf *et al.*, 2012). Dairy products are likely to remain important dietary components because of their nutritional value, flavor and texture. There will continue to be a demand for traditional, high quality dairy products, despite increasing competition from non- dairy based products (Rathore *et al.*, 2007)

Shrikhand is a semi soft, sweetish sour, whole milk product prepared from lactic fermented curd. The curd (dahi) is partially strained through a cloth to remove the whey and thus produce a solid mass called chakka (the basic ingredient for Shrikhand). This chakka is mixed with the required amount of sugar, etc., to yield Shrikhand. Shrikhand is a delicious and delightful dessert of western India. It is made with chakka (strained dahi/curd) which is finely mixed with sugar and flavouring agents. It has the nutritive goodness of fermented milk products. Like dahi, it is very refreshing particularly during summer months. It is popular because of its characteristics flavour, taste, palatable nature and possible therapeutic value.

The different sources of milk (Cow or Buffalo) can change the total fat, calcium and phosphorus content in the srikhand. Also, the process of fermentation to prepare curd will differ with respect to time and microorganism used. These parameters can change the total acidity of the product. It is also expected that the preparation of chakka by removing whey and incorporation of sugar will affect the moisture content and total solid mass of the srikhand. Shrikhand is inseparable dish in a regular diet of Indians. In all these milk-based products, the biochemical change is the production of lactic acid from lactose by lactic acid bacteria (LAB) like Lactococci, Leuconostocs, Streptococci and Lactobacilli. Shrikhand is a very popular and delicious product liked by many Indian and does consume it regularly during various occasions due to its pleasant

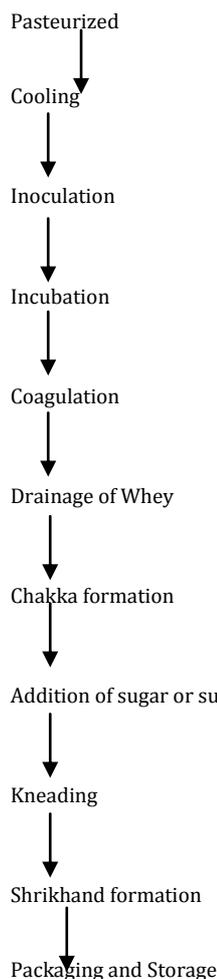
taste and aroma. Shrikhand is prepared on small scale in a highly unorganized manner, which has great impact on microbiological characteristics of shrikhand. Wide variations in the organoleptical, microbiological and chemical qualities of shrikhand have been reported (Sarkar and Mishra, 1997) due to its variation in techniques of production.

Further taste and the appearance of the product can be improved by adding sugar and other ingredients like nuts, colors etc. It may be considered the western equivalent to quarg yogurt (Sarkar, 2008) This low fat fermented product play an important role in synthesis of vitamin B complex in human body and in the prevention of stomachic diseases (Sonawane *et al.*, 2007) and is recommended as health food for specific patients suffering from obesity and cardiovascular disease (Kumar *et al.*, 2008). Because of the change in the economic status and food habit of consumers the other varieties of Shrikhand such as fruit Shrikhand are also in great Demand (Singh, 2007). Recently attempt has been made to improve the nutritive and sensory characters of Shrikhand by adding ashwagandha Powder (Landge *et al.*, 2011) and apple pulp with celosia powder (Kumar *et al.*, 2011), papaya pulp (Nigam *et al.*, 2009), cocoa powder and papaya pulp (Vagdalkar *et al.*, 2002), strawberry pulp (Sonawane *et al.*, 2007), mango pulp (Bardale *et al.*, 1986) etc. In addition with this Shrikhand is often prepared by adding saffron to enhance its color and appearance and flavor.

Material and Method:

Preparation of Shrikhand

Shrikhand was manufactured from cow milk standardized at 4% fat and 8.5% Solid not fat. Milk was heated at 85° C for 30 minutes. It was then cooled down at 28° C and inoculated by the starter culture at the rate of 1.5% and incubated at 28- 30° C for 10-12 hours until a firm coagulum was formed. Coagulum was then crushed and was transferred to a muslin cloth and pressed for expulsion of whey for 4-6 hours. The semi solid mass left after drainage of whey is called chakka, which form the base for shrikhand. Sugar or Sugar replacers and cardmon was then added to the chakka and kneaded properly. Standerdization of milk (4%fat, 8.5% SNF)



Incorporation of Stevia in the products

As this study aims at using Stevia as a sweetener so Stevia was incorporated as a sugar replacer in different ratio. As stevia have bitter after taste so 100% sugar replacement was avoided. Stevia powder was prepared by grinding and sieving stevia leaves while the extract was prepared by boiling gm of 25 stevia leaf powder in 500 ml of water to obtain 6° brix solution. Based on the preliminary trials various ratios of Stevia powder and Stevia extract were selected to be prepared and compared with the control.

Different Ratio of sugar:stevia for shrikhand

Shrikhand
100 % Sugar
90:10 Sugar:Stevia extract
80:20 Sugar:Stevia extract
70:30 Sugar:Stevia extract
60:40 Sugar:Stevia extract
90:10 Sugar:Stevia powder
80:20 Sugar:Stevia powder
70:30 Sugar:Stevia powder
60:40 Sugar:Stevia powder

Analysis of product

Sensory Analysis

The experimental samples were subjected to sensory evaluation using a laboratory type panel, comprising 10 people with previous experience in taste panel procedures. Warm water (about 60° C) was provided for rinsing between samples. Different attributes based on the product were scored using the 9-point hedonic scale. The scale ranged from "like extremely" to "dislike extremely",

corresponding to the highest and lowest scores of "9" and "1", respectively.

The sensory parameters chosen for this study were developed from attributes in the literature and discussions with the panelists.

Chemical Analysis

Cookies were analysed for the following compounds- Moisture, Fat, Protein, Ash, Fiber, Carbohydrate, Energy. Moisture was determined by AOAC (2000) method. Fat content in the sample was estimated Soxhlet extraction method (AOAC, 2000). The protein content was determined by Micro-Kjeldahl's process as described in AOAC (2000). Ash content was determined by the method described in AOAC (2000). The crude fiber content in various samples was determined AACC (1976) method. Carbohydrates were calculated by difference method

$$\text{Carbohydrates} = 100 - (\text{Moisture \%} + \text{Protein \%} + \text{Fat\%} + \text{Ash\%} + \text{Fiber\%})$$

Food energy is estimated using the sum of the product of respective physiological fuel values and contents of protein, carbohydrate and fat. It was expressed in Kcal/100g.

$$\text{Energy} = 4 \times (\text{Carbohydrate} + \text{Protein}) + (9 \times \text{Fat})$$

Microbial Analysis

Microbial analysis were carried out according to the procedure given in APHA (1992). For Total plate count PCA (plate count agar) and for yeast and mould Acidified PDA (potato dextrose agar) was used and was observed.

Result and Discussion

Sensory Analysis of the product to choose the best

The *Stevia* leaves powder and *Stevia* leaves extract were included in shrikhand to replace sugar and the results of sensory evaluation are presented in Table 1

The mean sensory score for colour and appearance of shrikhand showed a slight decrease in colour and appearance as the amount of *Stevia* leaves powder was increasing. The variation in colour and appearance was not significant upto 30% thereafter a significant ($P \leq 0.05$) variation was observed. Similarly a slight decrease in mean sensory score for colour and appearance was observed with an increase in the amount of extract. However the variation was not significant upto 30 % replacement of sugar content. Thereafter a significant ($P \leq 0.05$) variation was reported on a 9 point hedonic scale.

The mean sensory score for flavour of shrikhand showed that 30% replacement of sugar with *Stevia* leaf powder scored better, however the substitution had significantly no effect on the flavour of shrikhand in comparison to the control sample. However 40% replacement of sugar with *Stevia* extract decreased significantly ($P \leq 0.05$) the flavour of shrikhand on 9 point hedonic scale. Replacement of 20% sugar with *Stevia* extract scored better than control. It was noticed that the *Stevia* leaf extract had replaced 30% sugar without affecting the flavour of shrikhand significantly. However 40% substitution of *Stevia* leaf extract significantly ($P \leq 0.05$) decreased the flavour based on 9 point hedonic scale.

Mean sensory score for body and texture revealed that the replacement of sugar upto 30% with *Stevia* leaf powder was significantly not different from the control sample and had no effect on the body and texture of shrikhand in comparison to the control sample. However 40% replacement of sugar with *Stevia* powder decreased significantly ($P \leq 0.05$) the body and texture of shrikhand on 9 point hedonic scale. It was noticed that 20% replacement of sugar with *Stevia* leaf extract does not affect the body and texture of shrikhand significantly. However 30% and 40% substitution of *Stevia* leaf extract significantly ($P \leq 0.05$) decreased the body and texture based on 9 point hedonic scale.

Table 1: Sensory score for colour and appearance of Shrikhand made from blends of *Stevia* Leaf Powder and *Stevia* Leaf Extract

Panelist No.	Control	Sugar replacement with <i>Stevia</i> leaf powder				Sugar replacement with <i>Stevia</i> leaf extract				CD at 5% level
		10%	20%	30%	40%	10%	20%	30%	40%	
Colour and appearance	7.77 ^a	7.74 ^a	7.73 ^a	7.72 ^a	7.67 ^b	7.75 ^a	7.74 ^a	7.73 ^a	7.67 ^b	0.09
Body and Texture	7.79 ^a	7.78 ^a	7.77 ^a	7.75 ^a	7.68 ^b	7.75 ^a	7.72 ^a	7.69 ^b	7.66 ^b	0.09
Mouthfeel	7.85 ^a	7.85 ^a	7.86 ^a	7.87 ^a	7.68 ^b	7.85 ^a	7.86 ^a	7.86 ^a	7.61 ^b	0.11
After taste	7.73 ^a	7.73 ^a	7.74 ^a	7.77 ^a	7.70 ^a	7.74 ^a	7.75 ^a	7.65 ^b	7.63 ^b	0.11
Overall Acceptability	7.85 ^a	7.85 ^a	7.86 ^a	7.88 ^a	7.66 ^b	7.83 ^a	7.81 ^a	7.86 ^a	7.64 ^b	0.14

Any two means not followed by same letters differ significantly at 5% level

The mean sensory score for mouthfeel showed that the replacement of 30% sugar with *Stevia* leaf powder scored the highest and the score till 30% sugar replacement did not differ significantly from the control sample. However 40% replacement of sugar with *Stevia* powder decreased significantly ($P \leq 0.05$) the mouthfeel of shrikhand on 9 point hedonic scale. It was noticed that the *Stevia* leaf extract had replaced 30% sugar without affecting the mouthfeel of shrikhand significantly. However 40% substitution of *Stevia* leaf extract significantly ($P \leq 0.05$) decreased the mouthfeel based on 9 point hedonic scale.

Mean sensory score for after taste revealed that the replacement of sugar by 30% with *Stevia* leaf powder scored the highest. The replacement of sugar by the powder till 30 % did not differ significantly ($P \leq 0.05$) from the control sample. However 40% replacement of sugar with *Stevia* powder decreased significantly ($P \leq 0.05$) the after taste of shrikhand on 9 point hedonic scale. It was showed that *Stevia* leaf extract had replaced 30% sugar without affecting the after taste of shrikhand significantly. However 40% substitution of *Stevia* leaf extract significantly ($P \leq 0.05$) decreased the after taste based on 9 point hedonic scale.

The mean sensory score for overall acceptability of shrikhand showed that the replacement of sugar upto 30% with *Stevia* leaf powder scored the highest. The replacement of sugar by the powder till 30 % did not differ significantly from the control sample. However 40% replacement of sugar with *Stevia* powder decreased significantly ($P \leq 0.05$) the overall acceptability of shrikhand on 9 point hedonic scale. It was noticed that the *Stevia* leaf extract had

replaced 30% sugar without affecting the overall acceptability of shrikhand significantly. However 40% substitution of *Stevia* leaf extract significantly ($P \leq 0.05$) decreased the overall acceptability based on 9 point hedonic scale.

Storage Study of Shrikhand: Chemical Analysis

It is clear from the data collected for the storage study of 100% sugar shrikhand (Table 2) that a decrease is noticed in moisture, protein, fat and pH. The decrease in protein was from 5.80 to 5.72, moisture 32.04 to 31.86, fat decreased from 8.75 to 8.68 % while pH observed was 4.5 at 0 days which decreased to 4.0 after 21 days. Titrable acidity showed an increase, from 0.93 to 1.04

Table 3 present the chemical changes that occurred during storage of shrikhand prepared by replacing 30% sugar with *Stevia* powder (sample shrikhand). There was a decrease noticed in moisture, fat, protein and pH, while an increase was noticed in titrable acidity of shrikhand. Moisture decreased from 34.87 to 34.73, fat changed from 8.77 to 8.70% while protein observed a change from 5.90 to 5.80 in 21 days of storage. Titrable acidity showed an increase from 0.99 to 1.08, while a decrease from 4.3 to 3.8 was noticed in pH.

The energy decreased from 238.15 to 202.56 on substitution of sugar with *Stevia* powder. The decrease was approximately 15%.

Sonawane *et al.*, 2007 observed the same pattern. In their observation also, an increase in the titrable acidity and decrease in moisture during storage of shrikhand (21 days) was observed.

Table 2: Changes in the chemical composition of control shrikhand during Storage

	0 days	7 days	14 days	21 days	CD at 5% level
Moisture	32.04 ^a	32.02 ^b	31.97 ^c	31.86 ^d	0.01
Fat	8.75 ^a	8.73 ^b	8.70 ^c	8.68 ^d	0.01
Protein	5.80 ^a	5.78 ^b	5.75 ^c	5.72 ^d	0.01
Titrable Acidity	0.93 ^a	0.96 ^b	0.98 ^c	1.04 ^d	0.01
Ph	4.5	4.4	4.2	4.0	
Energy	238.15				

Any two means, in a row not followed by same letters differ significantly at 5% level

Table 3: Changes in the chemical composition of Sample Shrikhand during Storage

	0 days	7 days	14 days	21 days	CD at 5% level
Moisture	34.87 ^a	34.85 ^b	34.80 ^c	34.73 ^d	0.01
Fat	8.77 ^a	8.75 ^b	8.72 ^c	8.70 ^d	0.01
Protein	5.90 ^a	5.87 ^b	5.84 ^c	5.80 ^d	0.01
Titrable Acidity	0.99 ^a	1.02 ^b	1.04 ^c	1.08 ^d	0.01
pH	4.3	4.2	4.1	3.8	
Energy	202.56				

Any two means, in a row not followed by same letters differ significantly at 5% level

Sensory analysis

Sensory evaluation is usually performed towards the end of the product development or formulation cycle and is carried out to assess the reaction of judges towards the product and they rate the liking on a scale.

Both the samples prepared were stored at 7 °C ie. in refrigeration for 3 weeks (21 days). The sensory attributes, colour and appearance, taste and flavour, body and texture and overall acceptability were

studied. Table 4 discuss the mean sensory scores for various parameters.

The changes in the colour and appearance of shrikhand kept at 7 °C during 21 days of storage revealed that fresh shrikhand was significantly ($P \leq 0.05$) superior than the others. There was a decreasing trend observed with storage time. The mean score for colour and appearance obtained by shrikhand were in the acceptable range on 9 point hedonic scale.

The changes in the flavour of shrikhand showed a significant ($P \leq 0.05$) decrease in the flavour of shrikhand on storage. The mean

score for flavour obtained by shrikhand were in the acceptable range on 9 point hedonic scale.

Table 4: Changes in the mean sensory characteristic of shrikhand during storage

Storage period in days	Colour and appearance	Taste and Flavor	Body and texture	Overall Acceptability
CONTROL SHRIKHAND (100% SUGAR)				
0	7.86 ^a	7.83 ^a	7.74 ^a	7.92 ^a
30	7.53 ^b	7.51 ^b	7.24 ^b	7.60 ^b
60	6.07 ^c	6.59 ^c	6.13 ^c	6.59 ^c
90	5.81 ^d	5.63 ^d	5.87 ^d	6.00 ^d
CD at 5% level	0.10	0.12	0.10	0.11
Any two means, in a column not followed by same letters differ significantly at 5% level				
SAMPLE SHRIKHAND (30% SUGAR REPLACEMENT WITH STEVIA POWDER)				
0	7.74 ^a	7.91 ^a	7.68 ^a	7.84 ^a
30	7.41 ^b	7.62 ^b	7.38 ^b	7.32 ^b
60	6.98 ^c	6.36 ^c	6.88 ^c	6.45 ^c
90	5.69 ^d	5.22 ^d	5.81 ^d	5.57 ^d
CD at 5% level	0.18	0.19	0.18	0.36
Any two means, in a column not followed by same letters differ significantly at 5% level				

The result for body and texture showed that fresh shrikhand was significantly ($P \leq 0.05$) superior than the others. There was a decreasing trend observed with storage time. The mean score for body and texture obtained by shrikhand were in the acceptable range on 9 point hedonic scale.

The change in the overall acceptability of control shrikhand during 21 days of storage revealed that fresh shrikhand was significantly ($P \leq 0.05$) better than the others. The mean score for overall acceptability obtained by shrikhand were in the acceptable range on 9 point hedonic scale.

Patel et al., 1993 reported that the overall acceptability score of chakka decreased with storage period due to deterioration of flavour. Jain, 2003(a) Nigam et al., 2009, Bhat et al., 2010 and Kumar et al., 2011 also reported decline in the sensory parameters of various dairy based products during refrigeration storage. days were in the acceptable range on 9 point hedonic scale.

Microbial analysis

During the storage duration microbial analysis of the products was performed. For shrikhand Total Plate Count was performed. The analysis of shrikhand was done at one week's interval.

The values of various microbiological characteristics for Shrikhand are presented in Table 5. The initial day TPC was low for both (100% sugar and 30 % Stevia powder) shrikhand sample. The mean values of TPC (log cfu g-1) showed that number of microorganisms increases with increase in storage days. The mean TPC ranged from 1.34 to 2.67 cfu g-1 for control shrikhand and from 1.00 to 2.34 cfu g-1 for sample shrikhand. The results of microbial characteristics reveal that the shrikhand sample can be stored up to three week under refrigerated condition.

Table 5: Total Plate Count (CFU/g) of Shrikhand stored at 7^o C

Days	00	07	14	21
Control	1.34	1.67	2.00	2.67
Sample	1.00	1.34	1.67	2.34

CONCLUSION

The replacement of sugar with stevia was done to increase the nutritional value and reduce calories. Shrikhand prepared with both stevia extract and stevia powder upto 30% and 20% sugar

replacement was found to possess the same property as 100 % sugar shrikhand. The stevia supplemented shrikhand had more

nutrition and upto 18% reduction in energy was observed. Storage study suggested that the shrikhand was acceptable upto 14 days under refrigeration condition.

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