

## OPTIMIZATION OF LOW CALORIE FUNCTIONAL SHRIKHAND WITH NATURAL SWEETENERS, FRUIT PULP AND FRUIT PEEL EXTRACT

### Abstract

Shrikhand is a fermented dairy product and it is well-known in the western half of India's southern peninsula. The high sugar content of shrikhand contributes to total energy intake; carbohydrates are the food group that both dieters and diabetics are most limited from eating. An attempt was made to develop shrikhand by substituting sugar with aqueous extracts of stevia and liquorice, followed by the addition of guava pulp and aqueous extracts of dragon fruit peel at various levels. Initially, sugar of 40% of chakka weight was substituted by aqueous extracts of stevia and liquorice in four different ratios viz., 75:12.5:12.5 (T<sub>1</sub>), 50:25:25 (T<sub>2</sub>), 25:37.5:37.5 (T<sub>3</sub>), 0:50:50 (T<sub>4</sub>) of sugar to aqueous extracts of stevia and liquorice with control (T<sub>0</sub>) in the ratio of 100:0:0 and the low calorie shrikhand was optimized. Then it was followed by the addition of guava pulp at different concentrations viz., 5% (TG<sub>1</sub>), 10% (TG<sub>2</sub>), 15% (TG<sub>3</sub>), 20% (TG<sub>4</sub>) of chakka weight and dragon fruit peel extract of 5% (TD<sub>1</sub>), 10% (TD<sub>2</sub>), 15% (TD<sub>3</sub>), 20% (TD<sub>4</sub>) of chakka weight to incorporate fibre and antioxidant properties in shrikhand. Using a 9-point hedonic scale, sensory qualities (colour and appearance, body and texture, flavour and overall acceptability) of the developed product were evaluated by the semi-trained panels. In terms of sugar to aqueous extract of stevia and liquorice, the sensory evaluation revealed that the treatment T<sub>2</sub> (50:25:25) scored the highest overall acceptability of 8.13±0.26 among the four treatments whereas in terms of guava pulp, treatment TG<sub>3</sub> (15%) scored the highest overall acceptability of 8.49±0.14. While in case of aqueous extract of dragon fruit peel, the treatment TD<sub>2</sub> (10%) scored the highest overall acceptability of 8.33±0.49 among the four different treatments. Finally, the shrikhand was

optimized with 50:25:25 ratio of sugar to aqueous extract of stevia and liquorice, 15% of guava pulp of chakka weight and 10% of aqueous extract of dragon fruit peel of chakka weight.

**Keywords:** Low calorie shrikhand, stevia, liquorice, guava pulp, dragon fruit peel extract

## **Introduction**

Shrikhand is a semi-solid food with a sweetish-sour flavour that is often created from lactic fermented whole milk curd. Shrikhand is a famous fermented milk product [14] named after the Sanskrit word "*Shikharani*", which implies a curd made with fresh sugar, flavouring agents (saffron), fruits and nuts [22]. The curd (dahi) is partially strained through a muslin cloth to remove whey and thus produce a solid mass called chakka, the basic ingredient for shrikhand [20]. It is very popular in Maharashtra, Gujarat, and Karnataka. According to Food Safety and Standards Regulations (2011), shrikhand means the semi-soft concentrated composite milk product obtained from chakka or skimmed milk chakka to which milk fat and sugar is added or by any other process which leads to a product of same composition and characteristics. It may also contain permitted non-dairy ingredients.

Shrikhand includes 40% sugar or more and 6.0% fat or more. With increased consumer awareness of nutrition and an increase in the population suffering from obesity and diabetes, it is essential to produce shrikhand with no or low sugar added and reduced fat that can meet the needs of health-conscious consumers looking for a low-calorie product as well as people suffering from diabetes.

Stevia is an herb that contains many vital vitamins and minerals that artificial sweeteners do not [12]. Stevia is also rich in natural antioxidants and therapeutic characteristics that aid in the regulation of blood pressure, cholesterol, and diabetes [16]. Stevia is approximately 30 times sweeter than sugar (sucrose), while pure stevioside is 200 times sweeter [18].

Liquorice is a shrub in the Leguminosae family. Among 30 different species, *Glycyrrhiza uralensis*, *Glycyrrhiza inflata*, and *Glycyrrhiza glabra* are the most studied liquorice herbs. Glycyrrhizin, the primary ingredient of liquorice root, is safe to use in diabetes meal formulations and is 50 times sweeter than sucrose. The biological properties of the genus *Glycyrrhiza*, including as antibacterial, antifungal, anti-inflammatory, antioxidant and cytotoxic properties, are widely used [19].

Guava has a strong, sweet and pleasant scent and is a good source of vitamins A and C, folic acid and minerals such as potassium, copper and manganese. Guava has a low-calorie profile of key nutrients and just a single guava fruit (100 g) contains four times the vitamin C amount of an orange. The addition of guava adds tremendous nutritional content, a nice flavour and medicinal qualities. [24].

Dragon fruit peel contains 30-35% of the fruit's weight and is not being used effectively. The peel of dragon fruit holds an ability to be transformed into functional food. [9] Because of its high polyphenol content, dragon fruit peel is a good source of natural antioxidants. [13].

The primary objective of the current study is to optimize the functional shrikhand with nutritional and therapeutic properties from the extract of traditional herbs viz. liquorice and stevia along with the guava pulp and aqueous extract of dragon fruit peel.

## **MATERIALS AND METHODS**

### **Selection of raw materials**

Skim milk, good quality cane sugar, guava fruit (*Psidium guajava* -the common guava) and dragon fruit (*Hylocereus undatus*) were purchased from the local market. Stevia leaf powder and organic liquorice (*Athimathuram* in Tamil) herb powder were purchased from Merlion Naturals, Ahmedabad, Gujarat.

## **Preparation of raw materials for the functional shrikhand**

### **Method of aqueous extract of stevia leaf powder**

**Fig.1. Aqueous extract of stevia leaf powder**



Stevioside was extracted from powdered stevia leaves as per the method developed [1]. The dried ground leaves of stevia were mixed with hot water (65°C) in a 1:45 (w/v) ratio. The mixture was thoroughly shaken and stored at room temperature for 24 h. It was stirred twice a day. After 24 hours, the resulting mixture was filtered using Whatman filter paper no.1 and the filtrate obtained was evaporated at 45°C using a rotary vacuum evaporator (EYELA N-1110S 115V). The aqueous extract of stevia was presented in fig.1.

### **Method of aqueous extract of liquorice herb powder**

The extraction of active components from liquorice was carried out as per the method developed [7]. In brief, liquorice root powder was dissolved (1:10 w/v) in hot distilled water at 70°C to facilitate extraction. The suspension was filtered out twice, one time via cheese cloth and the second time using Whatman filter paper no.1. The clear aqueous extract was used immediately [10]. The aqueous extracted liquorice was presented in fig.2.



## **Fig.2.Aqueous extract of liquorice**

### **Method of guava pulp extraction**

The fruits were rinsed with clear water to get off dirt before being cut into medium-sized sections followed by blanching for 5 minutes prior to sieving the fine pulp [15].

### **Method of aqueous extract of dragon fruit peel**

#### **Fig.3. Aqueous extract of dragon fruit peel**



The dragon fruit peel has been extracted using distilled solvent and adjusted to pH 5 by using citric acid in accordance with the developed method [11]. The dragon fruit was washed and peeled by hand. The peels were powdered after being cut into little pieces (2 mm), subsequently dried at 50°C and then powdered. The powder was macerated in distilled water (1:50) for 60 min before being filtered. The resultant solution was evaporated in a vacuum evaporator at 60°C. The extract was kept at -20° C till use. The aqueous extract of dragon fruit peel was represented in fig.3.

### **Non-reducing sugar of the aqueous extracts of stevia and liquorice**

The non-reducing sugar of aqueous extract of stevia and liquorice was determined as per the method developed [18].

### **Preparation of Functional Shrikhand**

Shrikhand was made in accordance with the procedure described by De in 1991.

Chart 1 :

Skimmilk (0.5%fat)



Heating (71°C for 10 min)



Cooling (30 °C)



Inoculation of mixed curd culture (1%)



Incubation (30 °C for 16 h)



Curd



Hanging in muslin cloth at refrigerated temperature for 10 h



Chakka



Addition of sugar and natural sweeteners (aqueous extract of stevia and liquoricein different ratios of 75:12.5:12.5, 50:25:25, 25:37.5:37.5, 0:50:50 of 40% sugar of chakka weight for optimization)



Addition of guava pulp (5, 10, 15, 20%) of chakka weight

Addition of dragon fruit peel extract (5, 10, 15, 20%) of chakka weight



Flavour



Blending



Storage(5°C)

### **Sensory evaluation of functional shrikhand**

Each panelist was served with a standard score card ('9' point hedonic scale) for recording score for sensory attributes such as colour and appearance, flavour, body and texture and overall acceptability of the product. The semi trained judges were served with a 50 g of each sample. The score card for sensory evaluation is made as per [8]. The hedonic degree of liking scale varies from one to nine, where one represents "dislike extremely" and nine indicates "like extremely".

### **Statistical analysis**

The data obtained were tabulated and subjected to statistical analysis using IBM SPSS® 20.0 for Windows® software as per the standard procedure [21]. Analysis of variance (ANOVA) was conducted to determine whether significant effect exists on sensory scores.

## **RESULTS AND DISCUSSION**

### **NON-REDUCING SUGAR OF AQUEOUS EXTRACTS OF STEVIA AND LIQUORICE**

The non-reducing sugar (%) of the aqueous extract of stevia is presented in Table 1 and it was found to be  $2.77 \pm 0.68$ . The result obtained for the non-reducing sugar of stevia aqueous extract was comparable to the value obtained by Ahmad *et al.* (2019) who found that the non-reducing sugar (%) of aqueous extract of stevia was  $3.13 \pm 0.43$ . The non-reducing sugar of the aqueous extract of liquorice root was found to be  $1.34 \pm 0.35$  respectively.

**Table 1. values of non-reducing sugar of aqueous extracts of stevia and liquorice**

<b>Parameter</b>	<b>Aqueous extract</b>
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	Stevia	Liquorice
Non – reducing sugar (%)	2.77± 0.68	1.34± 0.35

@- average of six trials

### SENSORY EVALUATION SCORE OF SHRIKHAND PREPARED WITH DIFFERENT LEVELS OF INCORPORATION OF AQUEOUS EXTRACT OF STEVIA AND LIQUORICE

The samples with the lowest quantity of added sweetener were shown first, followed by samples with the medium and maximum amounts of sweetener, and panelists were directed to evaluate each sample to assess the sensory parameters. After receiving sample information, each panelist was provided with a tray carrying five treated samples, each coded as T<sub>0</sub>, T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and T<sub>4</sub> along with a spoon and a glass of water to wash their palates in between assessments. The outcomes of the sensory evaluation using the 9-point hedonic scale are presented in Table 2 and Fig.4.

**Table 2. values of sensory evaluation of shrikhand prepared with different levels of incorporation of aqueous extracts of stevia and liquorice**

Sensory attributes	T <sub>0</sub>	T <sub>1</sub>	T <sub>2</sub>	T <sub>3</sub>	T <sub>4</sub>	F value
Colour and Appearance	8.50±0.22 <sup>d</sup>	7.84 ±0.18 <sup>b</sup>	8.33±0.21 <sup>c</sup>	7.50 ± 0.19 <sup>a</sup>	7.34 ±0.12 <sup>a</sup>	17.950**
Body and	8.17±0.21 <sup>d</sup>	7.56± 0.14 <sup>c</sup>	7.67±0.21 <sup>bc</sup>	7.21 ±0.12 <sup>b</sup>	6.53 ±0.13 <sup>a</sup>	17.013**

<b>Texture</b>						
<b>Flavour</b>	8.33±0.21 <sup>d</sup>	7.46 ±0.17 <sup>c</sup>	8.23±0.21 <sup>d</sup>	6.53 ±0.13 <sup>b</sup>	5.32 ±0.14 <sup>a</sup>	32.841**
<b>Overall Acceptability</b>	8.33±0.22 <sup>d</sup>	7.23 ±0.11 <sup>c</sup>	8.13±0.26 <sup>d</sup>	6.57 ±0.15 <sup>b</sup>	5.54 ±0.16 <sup>a</sup>	21.822**

@average of six trials

T<sub>0</sub>- Shrikhand prepared with level of incorporation of 100 % sugar i.e. 40% sugar of chakka weight

T<sub>1</sub> – Shrikhand prepared with sugar: aqueous extract of stevia and liquorice at 75:12.5:12.5

T<sub>2</sub> – Shrikhand prepared with sugar: aqueous extract of stevia and liquorice at 50:25:25

T<sub>3</sub> -Shrikhand prepared with sugar: aqueous extract of stevia and liquorice at 25:37.5:37.5

T<sub>4</sub> -Shrikhand prepared with sugar: aqueous extract of stevia and liquorice at 0:50:50

\*\*-Highly Significant (P<0.01)

Means bearing different superscripts within rows differ significantly

### Colour and Appearance

Maximum colour and appearance score of 8.33±0.21 was found in the treatment T<sub>2</sub> followed by T<sub>1</sub> (7.84 ±0.18), T<sub>3</sub> (7.50 ± 0.19), T<sub>4</sub> (7.34 ±0.12) when compared with control and there was a highly significant difference (P<0.01) in colour and appearance scores observed among different treatment combinations and control.

### Body and Texture

There was a highly significant difference (P<0.01) in texture scores observed in different treatment combinations. Maximum texture scores of 7.67±0.21 was found in the treatment T<sub>2</sub> followed by T<sub>1</sub> (7.56± 0.14), T<sub>3</sub> (7.21 ±0.12), T<sub>4</sub> (6.53 ±0.13) when compared with control shrikhand.

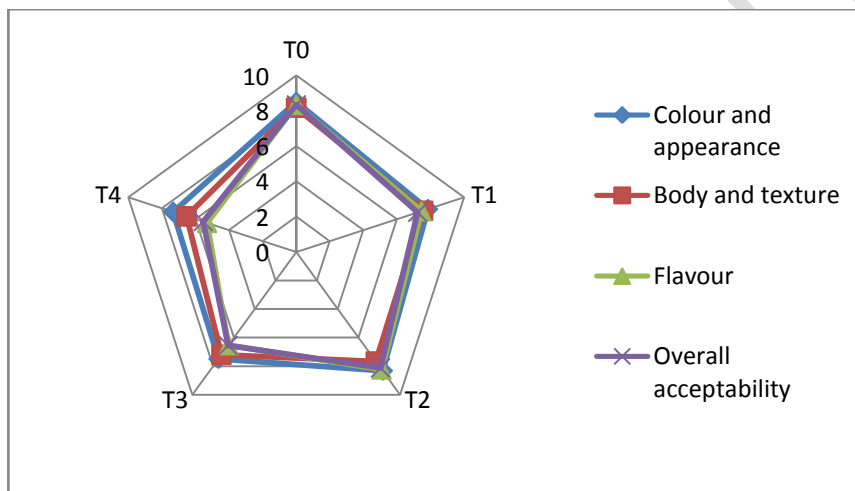
### Flavour

Among the different treatment combinations, a highly significant difference (P<0.01) in flavour scores has been observed. When compared with control shrikhand, the treatment T<sub>2</sub> obtained the highest flavour scores (8.23±0.21), followed by T<sub>1</sub> (7.46 ±0.17), T<sub>3</sub> (6.53 ±0.13)

and T<sub>4</sub> (5.32 ±0.14).

### Overall Acceptability

There was a highly significant difference ( $P < 0.01$ ) in overall acceptability scores observed among different treatment combinations. Maximum overall acceptability scores of  $8.13 \pm 0.26$  was found in the treatment T<sub>2</sub> followed by T<sub>1</sub> ( $7.23 \pm 0.11$ ), T<sub>3</sub> ( $6.57 \pm 0.15$ ), T<sub>4</sub> ( $5.54 \pm 0.16$ ) when compared with control shrikhand.



**Fig.4. Effect of combination of natural sweeteners on sensory attributes of shrikhand**

The results of sensory evaluation obtained in the present study are in accordance with that of Bishnoi *et al.* (2018) who developed a low calorie anola laddu by replacing the sugar with stevia at a different level of about 0, 25, 50 and 100 %. In their study, the sugar replaced with 50 percent of stevia was highly accepted among the different treatments. The results were also comparable with the findings of El-Lahot *et al.* (2017) who indicated that toffee prepared from replacing sugar with glycyrrhizin at 50:50 ratio showed the highest organoleptic properties.

In the present study, sugar to aqueous extracts of stevia and liquorice was added at four different ratios viz. 75:12.5:12.5 (T<sub>1</sub>), 50:25:25 (T<sub>2</sub>), 25:37.5:37.5 (T<sub>3</sub>), 0:50:50 (T<sub>4</sub>). From

Table 2, it is noticed that the ratio of 50:25:25 had the maximum overall acceptability of about  $8.13 \pm 0.26$  and statistically revealed a highly significant difference from the rest of the treatments. In the other treatments, the quantity of natural sweeteners were insufficient to produce an acceptable taste at a lower concentration, while a higher concentration produced a bland and bitter taste. Hence, the ratio of 50:25:25 was considered as optimum and selected for further studies.

### **SENSORY EVALUATION SCORE OF SHRIKHAND PREPARED WITH DIFFERENT LEVELS OF INCORPORATION OF GUAVA PULP**

The samples with the lowest quantity of guava pulp was shown first, followed by samples with the medium and maximum amounts of pulp, and panelists were directed to evaluate each sample to assess the sensory parameters. After receiving sample information, each panelist was provided with a tray carrying five treated samples, each coded as T<sub>0</sub>, TG<sub>1</sub>, TG<sub>2</sub>, TG<sub>3</sub> and TG<sub>4</sub> along with a spoon and a glass of water to wash their palates in between assessments. The outcomes of the sensory evaluation using the 9-point hedonic scale are presented in Table 3 and Fig.5.

**Table 3.(Mean± SE) @ values of sensory evaluation of shrikhand prepared with different levels of incorporation of guava pulp**

Sensory attributes	T <sub>0</sub>	TG <sub>1</sub>	TG <sub>2</sub>	TG <sub>3</sub>	TG <sub>4</sub>	F value
Colour and Appearance	8.80±0.12 <sup>d</sup>	7.80±0.16 <sup>bc</sup>	7.50±0.18 <sup>ab</sup>	8.50±0.14 <sup>c</sup>	7.29±0.12 <sup>a</sup>	25.05**
Body and Texture	8.20±0.13 <sup>c</sup>	7.73±0.21 <sup>b</sup>	7.67±0.31 <sup>b</sup>	8.17±0.21 <sup>c</sup>	6.14±0.12 <sup>a</sup>	4.521*
Flavour	8.54±0.14 <sup>c</sup>	7.68±0.14 <sup>b</sup>	7.60 ± 0.25 <sup>b</sup>	8.59±0.12 <sup>c</sup>	7.20±0.13 <sup>a</sup>	24.603**
Overall Acceptability	8.79±0.13 <sup>d</sup>	7.58±0.16 <sup>b</sup>	7.52± 0.17 <sup>b</sup>	8.49±0.14 <sup>c</sup>	6.86±0.11 <sup>a</sup>	37.778**

@average of six trials

T<sub>0</sub> - Shrikhand prepared with 100 %level of incorporation of sugar i.e. 40% sugar of chakka weight

TG<sub>1</sub>- Shrikhand prepared with5% of guava pulp of chakka weight

TG<sub>2</sub>- Shrikhand prepared with 10% of guava pulp of chakka weight

TG<sub>3</sub> - Shrikhand prepared with 15% of guava pulp of chakka weight

TG<sub>4</sub> - Shrikhand prepared with 20% of guava pulp of chakka weight

\*- Significant (P<0.05)

\*\*-Highly Significant (P<0.01)

Means bearing different superscripts within rows differ significantly

### Colour and appearance

Maximum colour and appearance score of 8.50±0.14was found in the treatment TG<sub>3</sub> followed by TG<sub>1</sub> (7.80±0.16), TG<sub>2</sub> (7.50±0.19), TG<sub>4</sub> (7.29±0.12) when compared with control. A highly significant difference existed among treatments and control with respect to colour and appearance.

## Body and texture

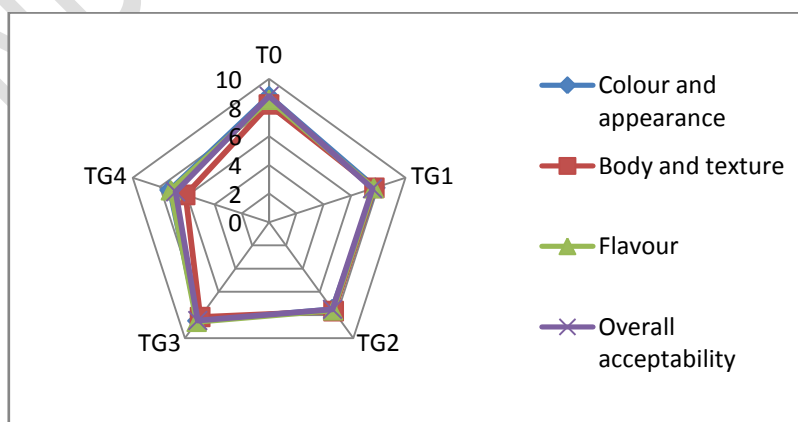
In several treatment combinations, a significant difference ( $P < 0.05$ ) in texture scores was observed. When compared with other treatments, the treatment TG<sub>3</sub> received the highest texture score of  $8.17 \pm 0.21$  followed by the treatments TG<sub>1</sub> ( $7.73 \pm 0.21$ ), TG<sub>2</sub> ( $7.67 \pm 0.31$ ) and TG<sub>4</sub> ( $6.14 \pm 0.12$ ).

## Flavour

Among different treatment combinations, a highly significant difference ( $P < 0.01$ ) in flavour scores has been observed. When compared with other treatments and control shrikhand, the treatment TG<sub>3</sub> obtained the highest flavour scores of  $8.59 \pm 0.12$ , followed by TG<sub>1</sub> ( $7.68 \pm 0.134$ ), TG<sub>2</sub> ( $7.60 \pm 0.25$ ) and TG<sub>4</sub> ( $7.20 \pm 0.13$ ).

## Overall acceptability

There was a highly significant difference ( $P < 0.01$ ) in overall acceptability scores observed in different treatment combinations. Maximum overall acceptability score of  $8.49 \pm 0.14$  was found in the treatment TG<sub>3</sub> followed by TG<sub>1</sub> ( $7.58 \pm 0.16$ ), TG<sub>2</sub> ( $7.52 \pm 0.17$ ), TG<sub>4</sub> ( $6.86 \pm 0.11$ ).



**Fig. 5. Effect of combination of guava pulp on sensory attributes of shrikhand**

The average sensory scores for guava pulp incorporated shrikhandas presented in Table 3, revealed that the incorporation of four different levels of guava pulp in shrikhand significantly altered the overall sensory attributes when compared with the control shrikhand. Among the four treatments, TG<sub>3</sub> (shrikhand with 15 percent of guava pulp) had scored the highest overall acceptability.

The results of the present study agreed with the outcome of Rahate *et al.* (2021) who have developed the technology to standardize the process for the preparation of khoa burfi blended with guava pulp at different levels of 11, 14 and 17 percent. The results of their findings showed that the burfi blended with 14 percent of guava pulp had scored the maximum sensory score.

#### **SENSORY EVALUATION SCORE OF SHRIKHAND PREPARED WITH DIFFERENT LEVELS OF INCORPORATION OF AQUEOUS EXTRACT OF DRAGON FRUIT PEEL**

The samples with the lowest quantity of dragon peel extract was shown first, followed by samples with the medium and maximum amounts of peel extract and panelists were directed to evaluate each sample to assess the sensory parameters. After receiving sample information, each panelist was provided with a tray carrying five treated samples, each coded as T<sub>0</sub>, TD<sub>1</sub>, TD<sub>2</sub>, TD<sub>3</sub> and TD<sub>4</sub> along with a spoon and a glass of water to wash their palates in between assessments. The outcomes of the sensory evaluation using the 9-point hedonic scale are presented in Table 4 and Fig. 6.

**Table 4. (Mean± SE) @ values of sensory evaluation of shrikhand prepared with different levels of incorporation of aqueous extract of dragon fruit peel**

Sensory attributes	T <sub>0</sub>	TD <sub>1</sub>	TD <sub>2</sub>	TD <sub>3</sub>	TD <sub>4</sub>	F value
Colour and appearance	8.83±0.17 <sup>d</sup>	7.84 ±0.18 <sup>bc</sup>	8.67±0.21 <sup>cd</sup>	7.81±.17 <sup>b</sup>	7.23 ±0.11 <sup>a</sup>	16.950**
Body and texture	8.83±0.31 <sup>d</sup>	7.83±0.32 <sup>bc</sup>	8.01±0.00 <sup>c</sup>	6.67±0.33 <sup>ab</sup>	6.50±0.34 <sup>a</sup>	51.485**
Flavour	8.67±0.42 <sup>d</sup>	7.46 ±0.17 <sup>bc</sup>	8.03±0.00 <sup>c</sup>	7.33±0.21 <sup>b</sup>	6.21 ±0.12 <sup>a</sup>	31.841**
Overall acceptability	8.67±0.42 <sup>d</sup>	7.23 ±0.11 <sup>b</sup>	8.33±0.49 <sup>c</sup>	7.17±0.17 <sup>ab</sup>	6.29 ±0.12 <sup>a</sup>	21.822**

@average of six trials

T<sub>0</sub> - Shrikhand prepared with 100 %level of incorporation of sugar i.e. 40% sugar of chakka weight

TG<sub>1</sub> - Shrikhand prepared with 5% of aqueous extract of dragon fruit peel of chakka weight

TG<sub>2</sub> - Shrikhand prepared with 10% of aqueous extract of dragon fruit peel of chakka weight

TG<sub>3</sub> - Shrikhand prepared with 15% of aqueous extract of dragon fruit peel of chakka weight

TG<sub>4</sub> - Shrikhand prepared with 20% aqueous extract of dragon fruit peel of chakka weight

\*\*-Highly Significant (P≤0.01)

Means bearing different superscripts within rows differ significantly

### Colour and appearance

Maximum colour and appearance score of 8.67±0.21 was found in the treatment TD<sub>2</sub> followed by TD<sub>1</sub> (7.84 ±0.18), TD<sub>3</sub> (7.81±.17), TD<sub>4</sub> (7.23 ±0.11) when compared with control. A highly significant difference (P<0.01) existed among the four treatments in colour and appearance.

### Body and texture

There was a highly significant difference (P<0.01) in texture scores observed in

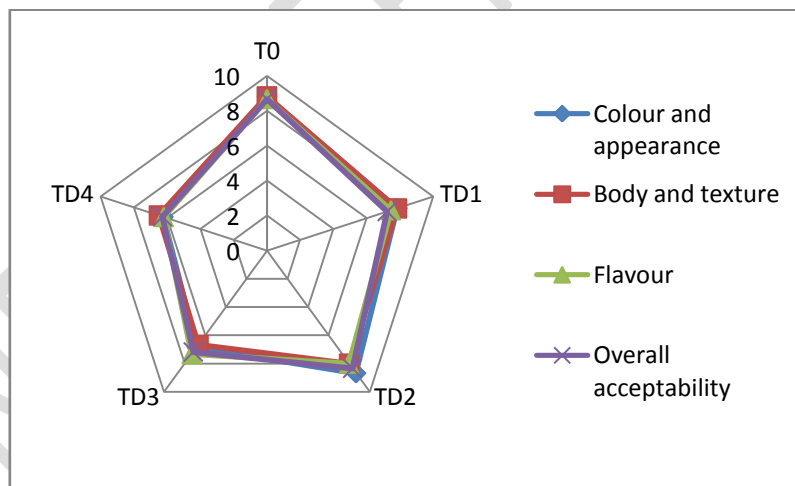
different treatment combinations. Maximum texture scores of  $8.01 \pm 0.00$  was found in the treatment TD<sub>2</sub> followed by TD<sub>1</sub> ( $7.83 \pm 0.31$ ), TD<sub>3</sub> ( $6.67 \pm 0.33$ ), TD<sub>4</sub> ( $6.50 \pm 0.34$ ).

### Flavour

There was a highly significant difference ( $P < 0.01$ ) in flavour scores observed in different treatment combinations. Maximum flavour scores of  $8.03 \pm 0.00$  was found in the treatment TD<sub>2</sub> followed by TD<sub>1</sub> ( $7.46 \pm 0.17$ ), TD<sub>3</sub> ( $7.33 \pm 0.21$ ), TD<sub>4</sub> ( $6.21 \pm 0.12$ ).

### Overall acceptability

There was a highly significant difference ( $P < 0.01$ ) in overall acceptability scores observed in different treatment combinations. Maximum overall acceptability scores of  $8.33 \pm 0.49$  was found in the treatment TD<sub>2</sub> followed by TD<sub>1</sub> ( $7.23 \pm 0.11$ ), TD<sub>3</sub> ( $7.17 \pm 0.17$ ), TD<sub>4</sub> ( $6.29 \pm 0.12$ ).



**Fig. 6. Effect of combination of dragon peel extract on sensory attributes of shrikhand**

Table 4 shows the average sensory score of functional shrikhand with different concentration of dragon fruit peel extract incorporated at 5, 10, 15 and 20 percent respectively. All samples incorporated with dragon fruit peel were found to be satisfactory

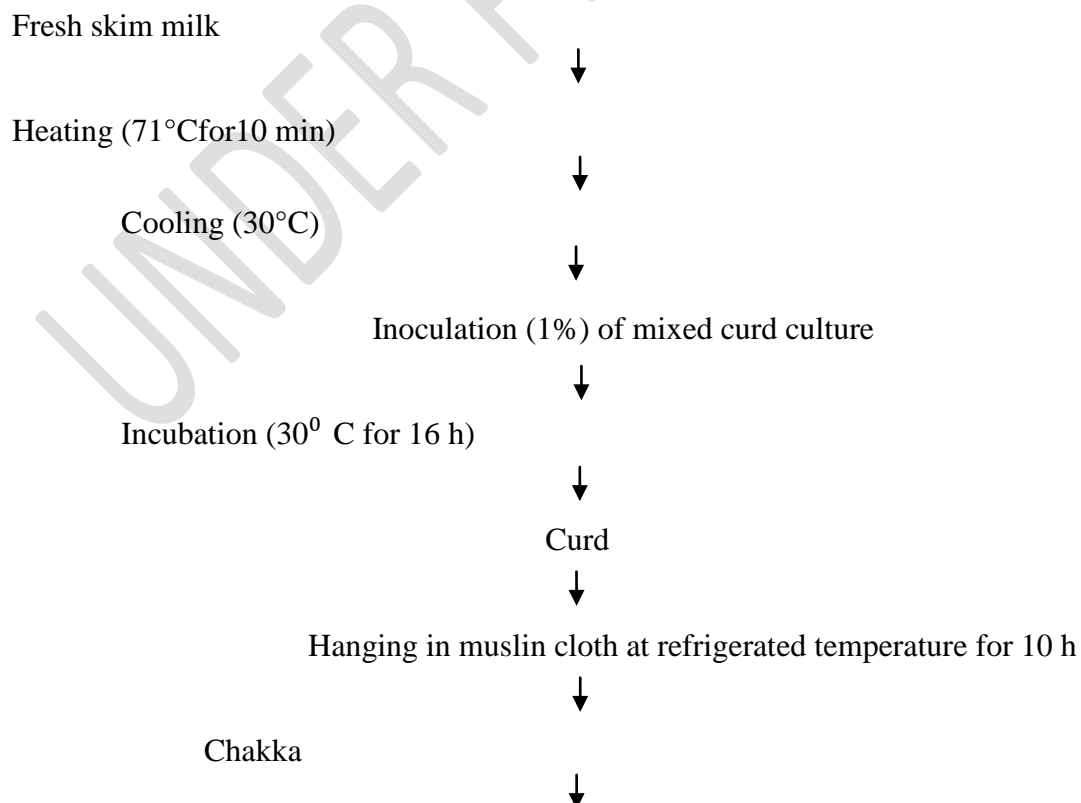
but 10% (TD<sub>2</sub>) of inclusion level of dragon fruit peel extract showed the highest sensory score among the four treatments. Statistical analysis revealed that among the four levels of incorporation of dragon fruit peel extract, the 10% inclusion level received the highest sensory score of 8.33±0.49.

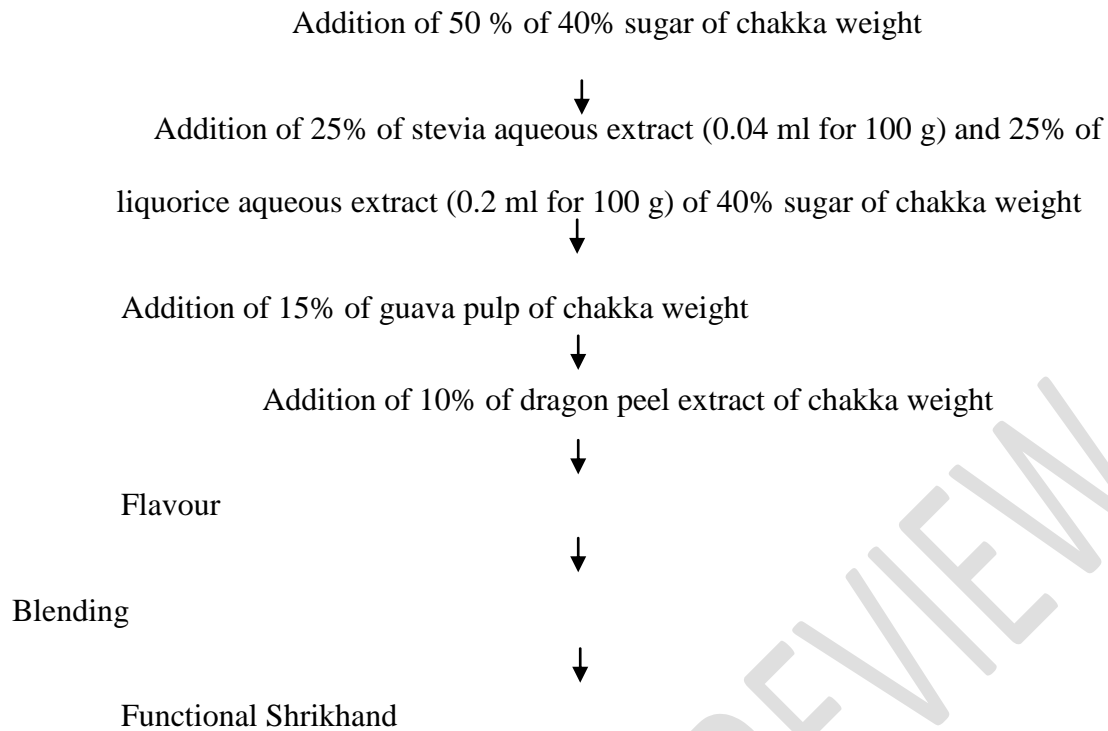
The results of the present research work are in agreement with the findings of Hafidset al. (2019), who observed that 8% of red dragon peel was found to be the best to make a low fat ice cream by conducting sensory evaluation.

### **OPTIMIZATION OF FUNCTIONAL SHRIKHAND WITH AQUEOUS EXTRACTS OF STEVIA AND LIQUORICE, GUAVA PULP AND DRAGON FRUIT PEEL EXTRACT**

The flow chart for the preparation of optimized functional shrikhand with natural sweeteners, fruit pulp and fruit peel extract is presented below.

Chart 2 :





The mean sensory scores of functional shrikhandis presented in Table 5 and Fig 7. The developed functional shrikhand outscored the control in all parameters, viz. colour and appearance, body and texture, flavour and overall acceptability.

**Table 5. (Mean± SE)<sup>@</sup> values of sensory evaluation of control and optimized functional shrikhand**

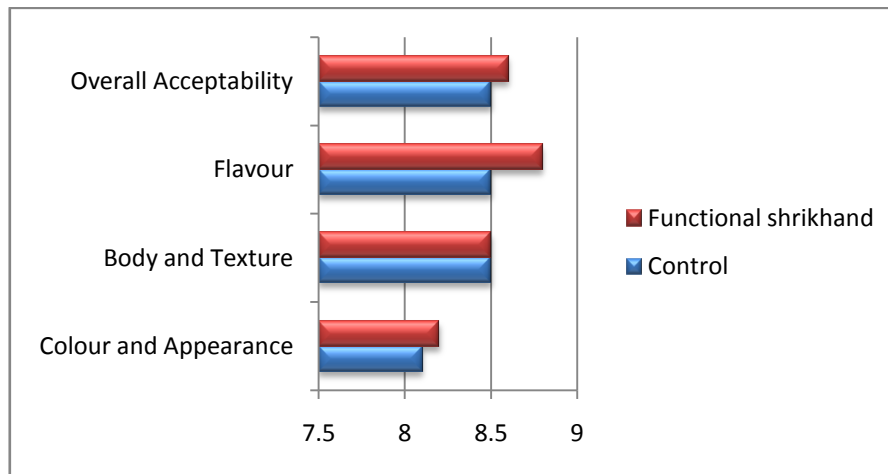
Sensory attributes	Control	Functional shrikhand	t value
<b>Colour and Appearance</b>	8.17 ±0.21	8.20 ±0.21	2.600*
<b>Body and Texture</b>	8.50± 0.22	8.52± 0.16	1.66 <sup>NS</sup>
<b>Flavour</b>	8.50 ±0.23	8.87 ±0.12	37.835**
<b>Overall Acceptability</b>	8.53± 0.22	8.60± 0.13	4.929*

@-average of six trials

Control- Shrikhand prepared with 100 % level of incorporation of sugar i.e. 40% sugar of chakka weight

Functional shrikhand - Shrikhand prepared with sugar: aqueous extractS of stevia and liquorice at 50:25:25 of 40% sugar of chakka weight, 15% of guava pulp of chakka weight and 10% aqueous extract of dragon fruit peel of chakka weight

NS- Non-significant ( $P>0.05$ )  
\*\*-Highly Significant ( $P\leq 0.01$ )  
\*- Significant ( $P\leq 0.05$ )



**Fig.7. Graphical representation of sensory score of control and functional shrikhand**

## CONCLUSION

It is concluded from the results that the replacement of sugar with stevia leaf extract and liquorice extract in the ratio of 50:25:25 ( $T_2$ ), 15% of guava pulp ( $TG_3$ ) and 10% of dragon fruit peel extract ( $TD_2$ ) in the preparation of shrikhand was mostly preferred in terms of sensory attributes. Based on the results obtained, it can be concluded that addition of aqueous extracts of stevia leaf and liquorice to shrikhand could reduce the calorie consumption by lowering the amount of carbohydrates in the final product. In addition to this, the added guava pulp and dragon fruit peel extract can improve the nutritional and functional properties of the developed shrikhand.

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