

OPTIMIZATION AND NUTRITIONAL ANALYSIS OF LOW CALORIE

FUNCTIONAL SHRIKHAND

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(T₁), 50:25:25(T₂), 25:37.5:37.5(T₃), 0:50:50(T₄) of sugar to aqueous extracts of stevia and liquorice with control (T₀) 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% (TG₁), 10% (TG₂), 15% (TG₃), 20% (TG₄) of chakka weight and aqueous extract of dragon fruit peel of 5% (TD₁), 10% (TD₂), 15% (TD₃), 20% (TD₄) of chakka weight to incorporate fibre and antioxidant properties in shrikhand respectively. 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. As a result of sensory evaluation, the shrikhand 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 scored the highest overall acceptability of 8.13±0.26, 8.49±0.14 and 8.33±0.49 respectively. The mean ± SE values of moisture, total solids, protein, fat, fibre, total ash content, carbohydrates and energy of the control were 54.43±0.03, 47.57±0.02, 10.56±0.09, 13.14±0.02, 0, 0.98±0.01, 20.89±0.07 and 224.03±4.15 whereas the corresponding

average values of the functional shrikhand were 67.61 ± 0.05 , 32.39 ± 0.01 , 11.21 ± 0.04 , 2.39 ± 0.03 , 5.78 ± 0.09 , 0.99 ± 0.02 , 12.02 ± 0.05 and 96.43 ± 3.26 respectively.

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 [17] named after the Sanskrit word "*Shikharani*", which implies a curd made with fresh sugar, flavouring agents (saffron), fruits and nuts [29]. 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 [26]. 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.

Need for low-calorie shrikhand

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 [31]. Until in recent times, synthetically produced highly concentrated sweeteners were the only realistic solution to the challenge of taking away sugars from food and beverages without sacrificing sweetness. Since then, people have begun to look for natural sweeteners that may be a suitable substitute for sugar.

Natural sweeteners

Stevia is an herb that contains many vital vitamins and minerals that artificial sweeteners do not [15]. The main constituents present were glycosides such as stevioside, steviol and rebaudioside A and B. The other constituents present in Stevia were ascorbic acid, b-carotene, chromium, cobalt, magnesium, iron, potassium, phosphorous, riboflavin, thiamin, tin, zinc, and so forth. Stevia is also rich in natural antioxidants and therapeutic characteristics that aid in the regulation of blood pressure, cholesterol, and diabetes [19]. Stevia is approximately 30 times sweeter than sugar (sucrose), while pure stevioside is 200 times sweeter [22].

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 [24].

Source of fibre

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 [34].

Source of antioxidant property

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 [10]. Because of its high polyphenol content, dragon fruit peel is a good source of natural antioxidants [16].

The primary objective of the current study was conducted to optimize the low calorie functional shrikhand with nutritional and therapeutic properties from the extract of natural sweeteners viz. liquorice and stevia along with the guava pulp (to increase fibre content) and aqueous extract of dragon fruit peel(to increase antioxidant activity).

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

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 **i.e. 1 g of stevia powder in 45 ml of hot distilled water**. The mixture was thoroughly shaken **manually** 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). **For this study, 2 g of stevia leaf powder was dissolved in 90 ml of hot distilled water and the aqueous extract of stevia was presented in fig.1.**



Fig.1. Aqueous extract of stevia leaf powder

Method of aqueous extract of liquorice herb powder

The extraction of active components from liquorice was carried out as per the method developed [10]. In brief, liquorice root powder was dissolved (1:10 w/v) in hot distilled water at 70°C to facilitate extraction **i.e. 1 g of liquorice in 10 ml of hot distilled water**. 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 [13]. **For this study, 5 g of liquorice was dissolved in 50 ml of hot distilled water** and the aqueous extract of 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 [18].

Method of 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 [14]. 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.



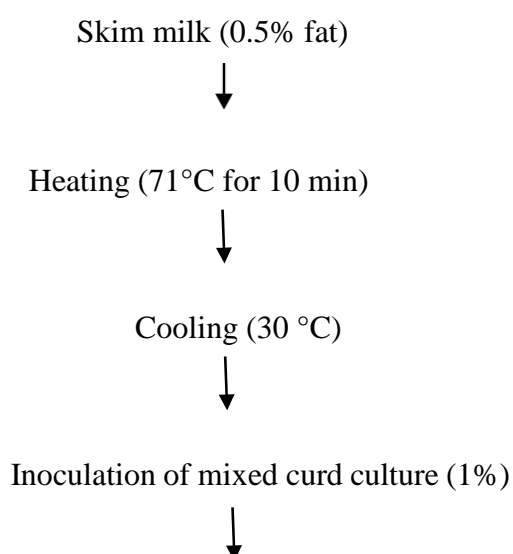
Fig.3. Aqueous extract of dragon fruit peel

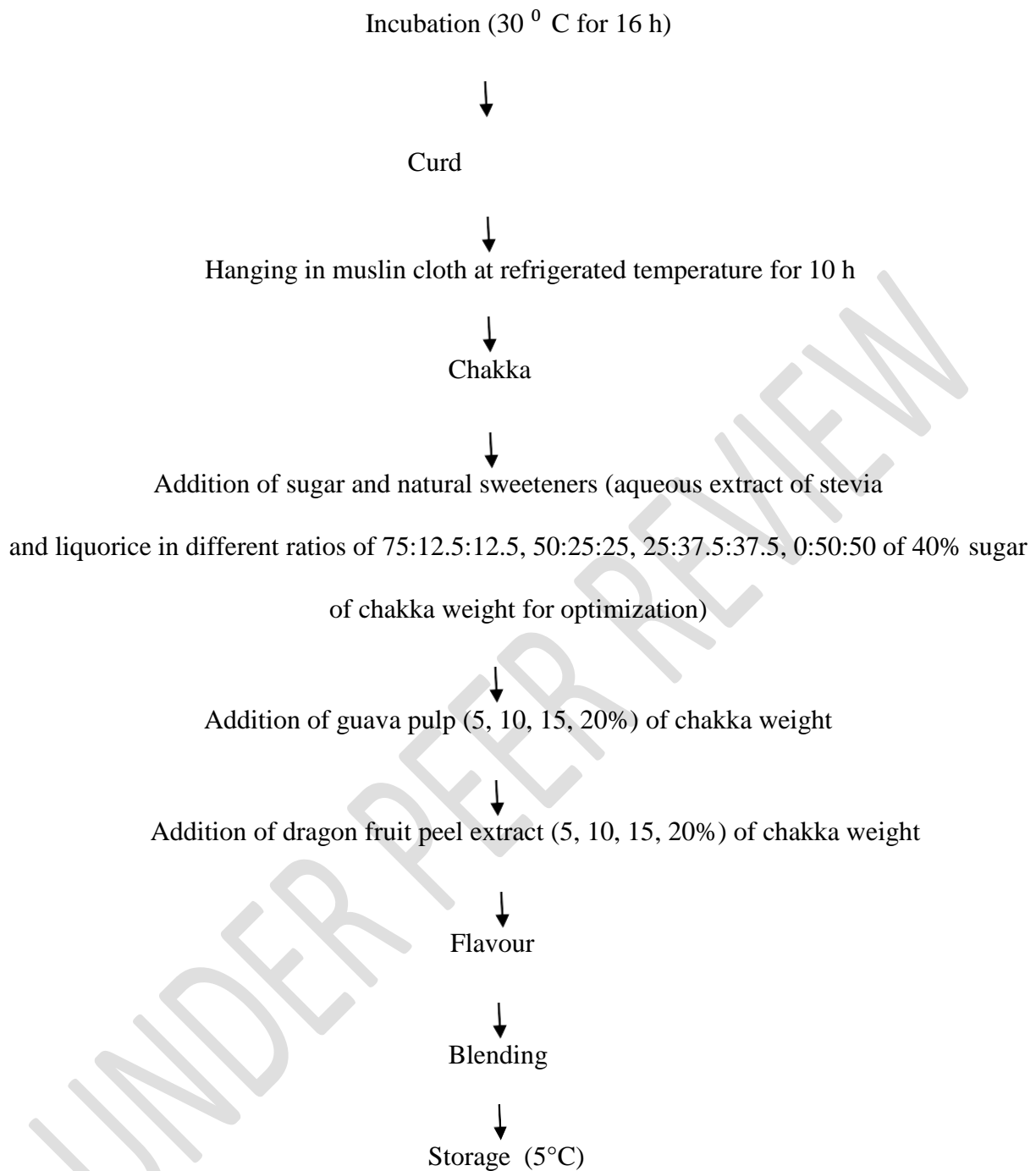
Non-reducing sugar of the aqueous extracts of stevia and liquorice

The non-reducing sugar of aqueous extract of stevia and liquorice was determined as per the method developed [22].

Preparation of Functional Shrikhand

Shrikhand was made in accordance with the procedure described by **Pugazhenthil TR et al.2020** and it was presented in flowchart 1.





Flowchart 1. Procedure for the preparation of functional shrikhand

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 [11]. The hedonic degree of liking scale varies from one to nine, where one represents “dislike extremely” and nine indicates “like extremely”.

Proximate composition of functional shrikhand

The proximate composition viz. moisture, fat, protein, fibre, carbohydrates, total solids, energy and total ash content of the control and functional shrikhand were analysed as per the method developed [3].

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 [27]. 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 ± 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 ± 0.43 . The non-reducing sugar of the aqueous extract of liquorice root was found to be 1.34 ± 0.35 respectively.

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

Parameter	Aqueous extract	
	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 T₀, T₁, T₂, T₃ and T₄ 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 ₀	T ₁	T ₂	T ₃	T ₄	F value
Colour and Appearance	8.50±0.22 ^d	7.84 ±0.18 ^b	8.33±0.21 ^c	7.50 ± 0.19 ^a	7.34 ±0.12 ^a	17.950**
Body and Texture	8.17±0.21 ^d	7.56± 0.14 ^c	7.67±0.21 ^{bc}	7.21 ±0.12 ^b	6.53 ±0.13 ^a	17.013**
Flavour	8.33±0.21 ^d	7.46 ±0.17 ^c	8.23±0.21 ^d	6.53 ±0.13 ^b	5.32 ±0.14 ^a	32.841**
Overall Acceptability	8.33±0.22 ^d	7.23 ±0.11 ^c	8.13±0.26 ^d	6.57 ±0.15 ^b	5.54 ±0.16 ^a	21.822**

@average of six trials

T₀- Shrikhand prepared with level of incorporation of 100 % sugar i.e. 40% sugar of chakka weight

T₁ – Shrikhand prepared with sugar: aqueous extract of stevia and liquorice at 75:12.5:12.5

T₂ – Shrikhand prepared with sugar: aqueous extract of stevia and liquorice at 50:25:25

T₃ - Shrikhand prepared with sugar: aqueous extract of stevia and liquorice at 25:37.5:37.5

T₄ - 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 T₂ followed by T₁ (7.84 ± 0.18), T₃ (7.50 ± 0.19), T₄ (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 T₂ followed by T₁ (7.56 ± 0.14), T₃ (7.21 ± 0.12), T₄ (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 T₂ obtained the highest flavour scores (8.23 ± 0.21), followed by T₁ (7.46 ± 0.17), T₃ (6.53 ± 0.13) and T₄ (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 ± 0.26 was found in the treatment T₂ followed by T₁ (7.23 ± 0.11), T₃ (6.57 ± 0.15), T₄

(5.54±0.16) when compared with control shrikhand.

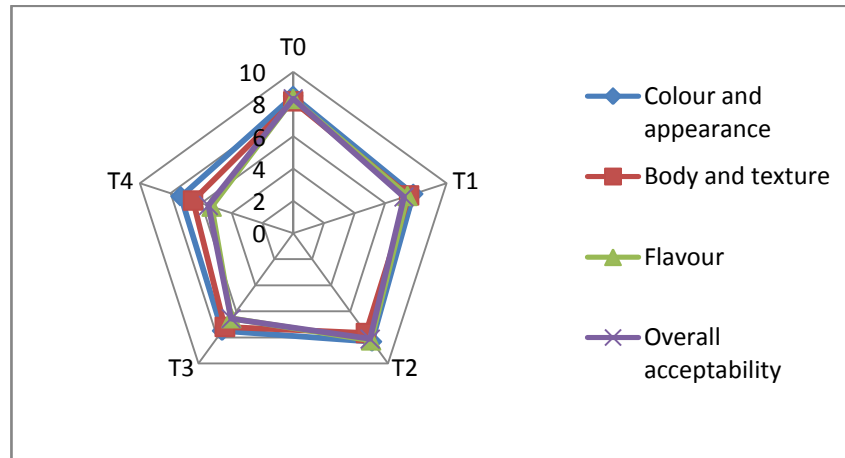


Fig.4. Effect of combination of natural sweeteners on sensory attributes of shrikhand

Discussion for the 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) studied the utilization of glycyrrhizin and licorice extract (LE) from *Glycyrrhiza glabra* L as a sugar substitute in toffee and cake preparation. The toffee with 50:50 ratio of sugar and glycyrrhizin showed the highest sensory acceptability whereas 250 mg of glycyrrhizin as 50% sugar replacer in cakes had no significant change in the organoleptic properties but reduced their caloric value. Replacing 25% of the glucose syrup using licorice extract (1.37 g/100 g) resulted in a higher score for sweetness, flavour, general acceptability, and lack of bitterness when compared to those prepared with a greater concentration of licorice extract.

In the present study, sugar to aqueous extracts of stevia and liquorice was added at four

different ratios viz. 75:12.5:12.5(T₁), 50:25:25 (T₂), 25:37.5:37.5 (T₃), 0:50:50 (T₄). From Table 2, it is noticed that the ratio of 50:25:25 had the maximum overall acceptability of about 8.13±0.26 and statistically revealed a highly significant difference from the rest of the treatments. In the other treatments, the quantity of natural sweeteners was 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 T₀, TG₁, TG₂, TG₃ and TG₄ 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	T₀	TG₁	TG₂	TG₃	TG₄	F value
Colour and Appearance	8.80±0.12 ^d	7.80±0.16 ^{bc}	7.50±0.18 ^{ab}	8.50±0.14 ^c	7.29±0.12 ^a	25.05**
Body and Texture	8.20±0.13 ^c	7.73±0.21 ^b	7.67±0.31 ^b	8.17±0.21 ^c	6.14±0.12 ^a	4.521 [*]
Flavour	8.54±0.14 ^c	7.68±0.14 ^b	7.60 ± 0.25 ^b	8.59±0.12 ^c	7.20±0.13 ^a	24.603**

Overall Acceptability	8.79±0.13 ^d	7.58±0.16 ^b	7.52± 0.17 ^b	8.49±0.14 ^c	6.86±0.11 ^a	37.778**
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@average of six trials

T₀ - Shrikhand prepared with 100 % level of incorporation of sugar i.e. 40% sugar of chakka weight

TG₁ - Shrikhand prepared with 5% of guava pulp of chakka weight

TG₂ - Shrikhand prepared with 10% of guava pulp of chakka weight

TG₃ - Shrikhand prepared with 15% of guava pulp of chakka weight

TG₄ - 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±0.14 was found in the treatment TG₃ followed by TG₁ (7.80±0.16), TG₂ (7.50±0.19), TG₄ (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 TG₃ received the highest texture score of 8.17±0.21 followed by the treatments TG₁ (7.73±0.21), TG₂ (7.67±0.31) and TG₄ (6.14±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 TG₃ obtained the highest flavour scores of 8.59±0.12, followed by TG₁ (7.68±0.134), TG₂ (7.60 ± 0.25) and TG₄ (7.20±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 ± 0.14 was found in the treatment TG₃ followed by TG₁ (7.58 ± 0.16), TG₂ (7.52 ± 0.17), TG₄ (6.86 ± 0.11).

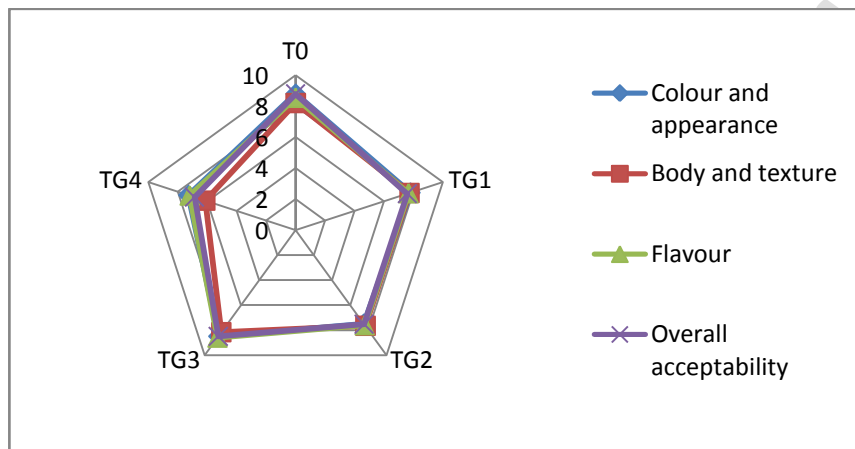


Fig. 5. Effect of guava pulp on sensory attributes of shrikhand

Discussion for the effect of guava pulp on sensory attributes of shrikhand

The average sensory scores for guava pulp incorporated shrikhand as 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, TG₃ (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 T₀, TD₁, TD₂, TD₃ and TD₄ 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 ₀	TD ₁	TD ₂	TD ₃	TD ₄	F value
Colour and appearance	8.83±0.17 ^d	7.84 ±0.18 ^{bc}	8.67±0.21 ^{cd}	7.81±.17 ^b	7.23 ±0.11 ^a	16.950**
Body and texture	8.83±0.31 ^d	7.83±0.32 ^{bc}	8.01±0.00 ^c	6.67±0.33 ^{ab}	6.50±0.34 ^a	51.485**
Flavour	8.67±0.42 ^d	7.46 ±0.17 ^{bc}	8.03±0.00 ^c	7.33±0.21 ^b	6.21 ±0.12 ^a	31.841**
Overall acceptability	8.67±0.42 ^d	7.23 ±0.11 ^b	8.33±0.49 ^c	7.17±0.17 ^{ab}	6.29 ±0.12 ^a	21.822**

@average of six trials

T₀ - Shrikhand prepared with 100 %level of incorporation of sugar i.e. 40% sugar of chakka weight

TG₁ - Shrikhand prepared with 5% of aqueous extract of dragon fruit peel of chakka weight

TG₂ - Shrikhand prepared with 10% of aqueous extract of dragon fruit peel of chakka weight

TG₃ - Shrikhand prepared with 15% of aqueous extract of dragon fruit peel of chakka weight

TG₄ - 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 TD₂ followed by TD₁ (7.84 ± 0.18), TD₃ (7.81 ± 0.17), TD₄ (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 ± 0.00 was found in the treatment TD₂ followed by TD₁ (7.83 ± 0.31), TD₃ (6.67 ± 0.33), TD₄ (6.50 ± 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 ± 0.00 was found in the treatment TD₂ followed by TD₁ (7.46 ± 0.17), TD₃ (7.33 ± 0.21), TD₄ (6.21 ± 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 ± 0.49 was found in the treatment TD₂ followed by TD₁ (7.23 ± 0.11), TD₃ (7.17 ± 0.17), TD₄ (6.29 ± 0.12).

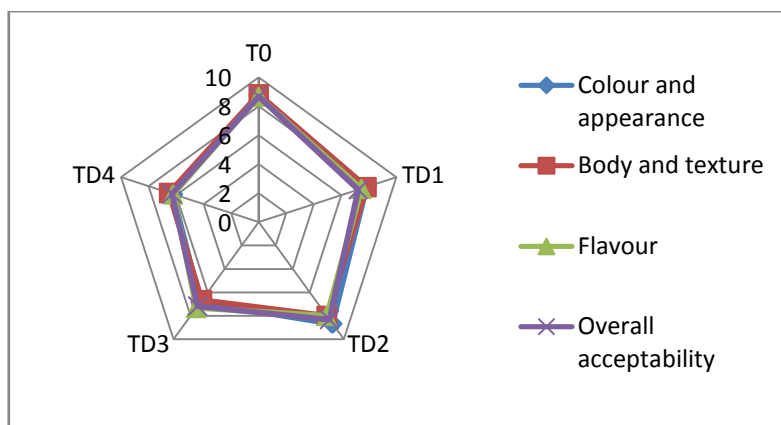


Fig. 6. Effect of aqueous extract of dragon fruit peel on sensory attributes of shrikhand

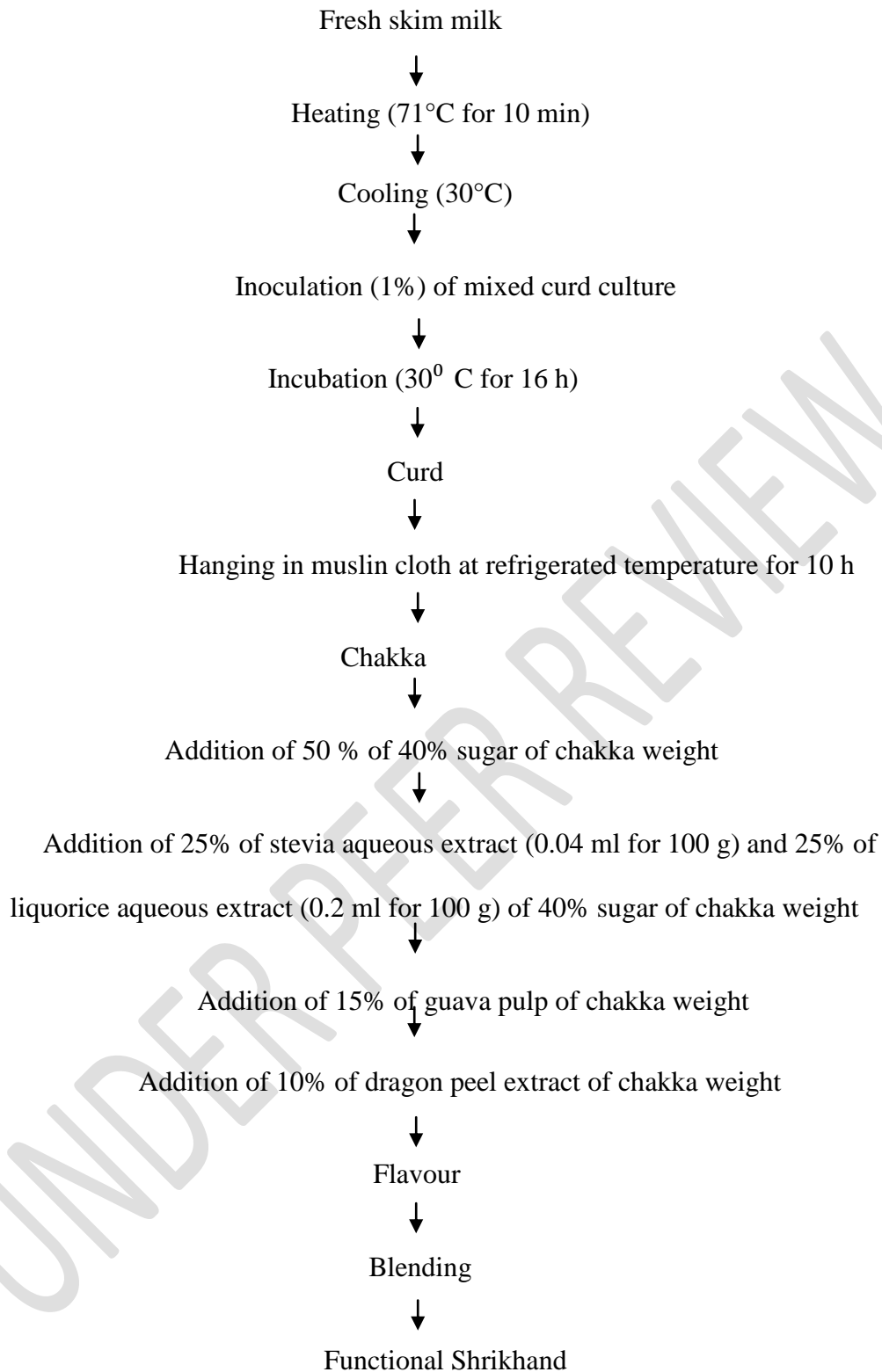
Discussion for the effect of aqueous extract of dragon fruit peel on sensory attributes of shrikhand

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% (TD₂) 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 Hafids *et 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 in flowchart 2.



Flowchart 2. Procedure for the preparation of optimized functional shrikhand

The mean sensory scores of functional shrikhand is 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) [@] values of sensory evaluation of control and optimized functional shrikhand

Sensory attributes	Control	Functional shrikhand	t value
Colour and Appearance	8.17 ±0.21	8.20 ±0.21	2.600*
Body and Texture	8.50± 0.22	8.52± 0.16	1.66 ^{NS}
Flavour	8.50 ±0.23	8.87 ±0.12	37.835**
Overall Acceptability	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≤0.01)

*- Significant (P≤0.05)

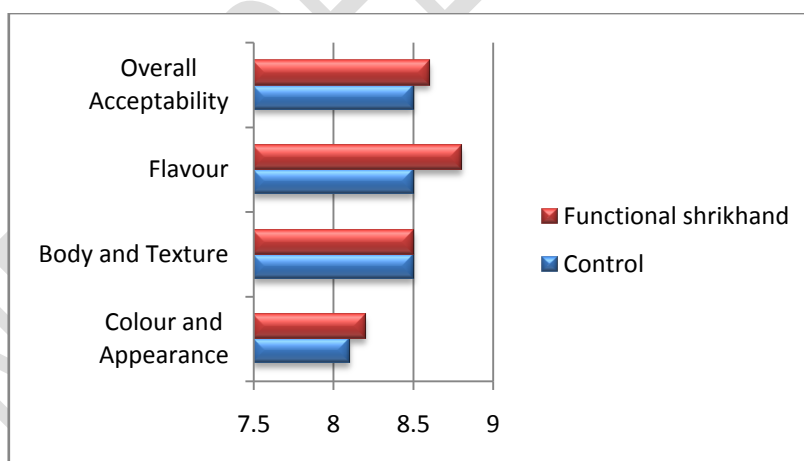


Fig.7. Graphical representation of sensory score of control and functional shrikhand

Proximate composition of functional shrikhand

The results of proximate composition viz. moisture, fat, protein, fibre, carbohydrates, total solids, energy and total ash content of the control and functional shrikhand were

presented in the table 6 and fig.8. The mean \pm SE values of moisture, total solids, protein, fat, fibre, total ash content, carbohydrates and energy of the control were 54.43 \pm 0.03, 47.57 \pm 0.02, 10.56 \pm 0.09, 13.14 \pm 0.02, 0, 0.98 \pm 0.01, 20.89 \pm 0.07 and 224.03 \pm 4.15 whereas the corresponding average values of the functional shrikhand were 67.61 \pm 0.05, 32.39 \pm 0.01, 11.21 \pm 0.04, 2.39 \pm 0.03, 5.78 \pm 0.09, 0.99 \pm 0.02, 12.02 \pm 0.05 and 96.43 \pm 3.26 respectively.

Statistical analysis revealed that there was a highly significant difference ($p \leq 0.01$) observed in the values of moisture, total solids, protein, fat, fibre, carbohydrates and energy between control and functional shrikhand.

Table 6. (Mean \pm SE) @ values of proximate composition of control and optimized functional shrikhand

Proximate composition	Control	Functional Shrikhand	t value
Moisture (%)	54.43 \pm 0.03	67.61 \pm 0.05	51.05**
Total solids (%)	47.57 \pm 0.02	32.39 \pm 0.01	96.79**
Protein (%)	10.56 \pm 0.09	11.21 \pm 0.04	5.87**
Fat (%)	13.14 \pm 0.02	2.39 \pm 0.03	194.40**
Fibre (%)	0	5.78 \pm 0.09	1637.69**
Ash (%)	0.98 \pm 0.01	0.99 \pm 0.02	1.97 ^{NS}
Carbohydrates (%)	20.89 \pm 0.07	12.02 \pm 0.05	829..76**
Energy (kcal)	224.03 \pm 4.15	96.43 \pm 3.26	8423.76**

@average of six trials

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

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

NS- Non-significant ($P > 0.05$)

** -Highly Significant ($P \leq 0.01$)

Moisture content

The mean moisture content of a treatment prepared in this study revealed a significantly higher value (67.61 ± 0.05) than the control sample (54.43 ± 0.03) respectively. The increase in the moisture percentage of the treatment was due to higher moisture content in the aqueous extracts as well as in the guava pulp. The results were in quite similar with the findings of Sonawane *et al.*(2007) who developed shrikhand incorporated with the strawberry pulp.

Total Solids

The total solids was highly decreased in the treatment of the functional shrikhand than that of the control, which might be due to the increase in moisture content in the functional shrikhand when compared to the control. There was a highly significant difference ($p\leq 0.01$) observed between the control and treatment. This may be due to the added guava pulp and also the natural sweeteners. A similar result was also discussed by Shelke *et al.* (2014) who developed a low fat sugar free mango shrikhand. In their study, they discussed that the presence of mango pulp and absence of bulk replacer for sucrose results in the decrease in total solids of shrikhand.

Protein Content

The protein content of the control and functional shrikhand was 10.56 ± 0.09 and 11.21 ± 0.04 respectively. There was a significant difference between the control and functional shrikhand. This significant difference may be due to the presence of protein content in the guava pulp as well as in the stevia aqueous extract. These findings were in comparable with Tondare & Hembade (2021) who developed a dietetic amarakhand added with 30% of mango pulp and different ratios of sugar to stevia extract as 30: 70 (T1), 25: 75 (T2), 20: 80

(T3), 15: 85 (T4) and 10:90 (T5) and control sample 100: 0 (T0). In their study, it was found that the protein content increases with increase in the concentration of the stevia extracts in the dietetic amarakhand.

Fat Content

The total fat content of the functional shrikhand (2.39 ± 0.03) was lower than the control (13.14 ± 0.02) because the whole milk which was commonly used in the preparation of shrikhand has been replaced by a skim milk in order to reduce the fat content and the caloric value of the functional shrikhand. There was a highly significant difference between the control and functional shrikhand. Hasneen *et al.* (2020) also found similar findings in the skimmed milk yoghurt fortified with herbal extracts. According to their study, the fat content of the skimmed milk yoghurt was about 1.20^a respectively.

Fibre Content

The total fibre content in the functional shrikhand was higher 5.78 ± 0.09 than the control (0), which showed a highly significant increase due to the presence of fibre content in the added guava pulp. Similar findings were also discussed by Bhardwaj and Shelly (2016) who reported that the guava pulp enriched misthi dahi from toned milk with 7% sugar+ 5% guava pulp having fibre content of 4.24 whereas the fibre of the control misti dahi with 7% sugar was 0.00 respectively.

Total Ash Content

The total ash content in the functional shrikhand (0.99 ± 0.02) was slightly higher than the control (0.98 ± 0.01), which showed no significant increase. These findings were quite similar with Tondare and Hembade (2021) who reported that the ash percentage in all control

shrikhand and treated samples were not significantly differed. In their findings, the mean value for ash content of the control and treatments that are added with different ratios of stevia and sugar viz. T₁, T₂, T₃, T₄ and T₅ were 0.66%, 0.66%, 0.67%, 0.67%, 0.68% and 0.70%.

Carbohydrate Content

The carbohydrate content of the developed product was significantly decreased due to reduction in sugar level as compared to control sample and increased level of zero calories containing stevia leaf and liquorice aqueous extracts. The results were comparable with Giri and Rao (2014) who developed dietetic kulfi by replacing 50, 60 and 70% sugar with 0.05, 0.06 and 0.07% refined stevia extract powder. In their findings, they found that the specific gravity, melting rate, percentage of carbohydrates, and total calorie content all significantly decreased with larger replacement amounts of sugar, whereas the freezing point, hardness, fat, protein, ash, and moisture percentage all significantly increased. As a result of their study, the level of carbohydrates was decreased from 22.8% in control to 16.4% in the treated sample.

Caloric Value

The caloric value of the functional shrikhand was significantly lowered when compared with the control shrikhand. It was observed that the energy value of the developed product was about 96.43 ± 3.26 kcal whereas the control has about 224.03 ± 4.15 kcal respectively. The decrease in the caloric value of the functional shrikhand was due to the substitution of sugar by non-caloric stevia and liquorice extracts and may also due to the usage of skim milk. The results were in accordance with Salem & Massoud (2003) who

developed the frozen yoghurt and found that the sugar replaced by stevia lowers the calorie value of product about 33.86% when 75% sucrose was replaced.

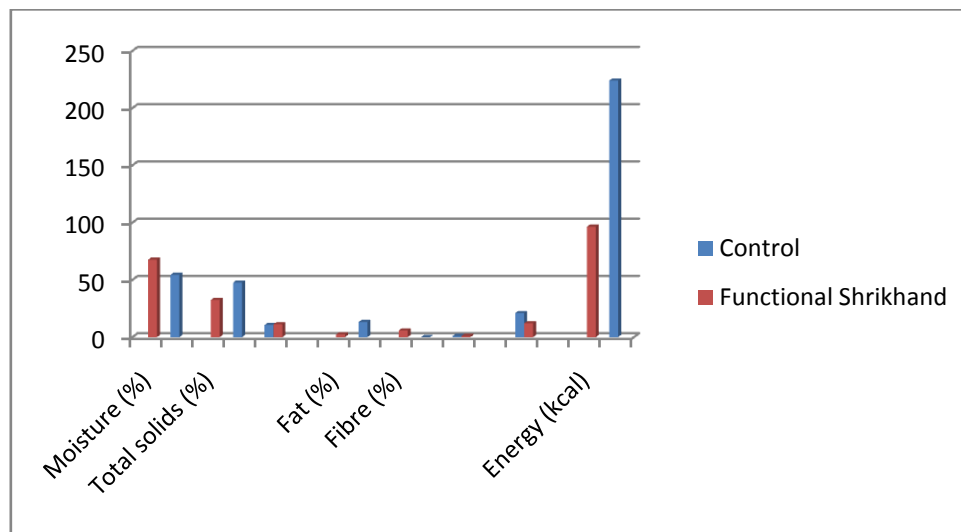


Fig.8. Graphical representation of proximate composition of control and functional shrikhand

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 of sensory evaluation, it can be concluded that the partial replacement of sugar with natural sweeteners (stevia and liquorice) doesn't majorly affect the sensory attributes of the functional shrikhand. It can be said that the addition of aqueous extracts of stevia and liquorice to shrikhand reduces 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. The optimized functional shrikhand was analysed for its proximate composition and it revealed that there was a**

highly significant difference ($p \leq 0.01$) observed in the values of moisture, total solids, fat, fibre, protein, carbohydrates and energy between control and functional shrikhand. For future work, the optimized product need to be analysed for its physico-chemical and functional properties.

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