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Optimization and Nutritional Analysis of Low Calorie Functional Shrikhand

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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

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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_1), 50:25:25(T_2), 25:37.5:37.5(T_3), 0:50:50(T_4) of sugar to aqueous extracts of stevia and liquorice with control (T_0) 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_1), 10% (TG_2), 15% (TG_3), 20% (TG_4) of chakka weight and aqueous extract of dragon fruit peel of 5% (TD_1), 10% (TD_2), 15% (TD_3), 20% (TD_4) 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.

1. 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 [1] named after the Sanskrit word "*Shikharani*", which implies a curd made with fresh sugar, flavouring agents (saffron), fruits and nuts [2]. 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 [3-5]. 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.

1.1 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 [6,7]. 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.

1.2 Natural Sweeteners

Stevia is an herb that contains many vital vitamins and minerals that artificial sweeteners do not [8]. 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 [9]. Stevia is approximately 30 times sweeter than sugar (sucrose), while pure stevioside is 200 times sweeter [10].

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 [11].

1.3 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 [12].

1.4 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 [13]. Because of its high polyphenol content, dragon fruit peel is a good source of natural antioxidants [14].

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).

2. MATERIALS AND METHODS

2.1 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.

2.2 Preparation of Raw Materials for the Functional Shrikhand

2.2.1 Method of aqueous extract of stevia leaf powder

Stevioside was extracted from powdered stevia leaves as per the method developed [15]. 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.

2.2.2 Method of aqueous extract of liquorice herb powder

The extraction of active components from liquorice was carried out as per the method developed [13]. 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 [16]. 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.

2.2.3 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 [17].

2.2.4 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 [18].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.

2.2.5 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 [10].

2.3 Preparation of Functional Shrikhand

Shrikhand was made in accordance with the procedure described by Pugazhenthi TR et al. [19] and it was presented in Flowchart 1.

Skim milk (0.5% fat)

↓

Heating (71°C for 10 min)

↓

Cooling (30 °C)

↓

Inoculation of mixed curd culture (1%)

↓

Incubation (30 ºC 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 liquor ice in 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)

Flowchart 1. Procedure for the preparation of functional shrikhand

Fig. 1. Aqueous extract of stevia leaf powder

Fig. 2. Aqueous extract of liquorice

Fig. 3. Aqueous extract of dragon fruit peel

2.3.1 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 [20]. The hedonic degree of liking scale varies from one to nine, where one represents "dislike extremely" and nine indicates "like extremely".

2.3.2 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 [21].

2.4 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 [22]. Analysis of variance (ANOVA) was conducted to determine whether significant effect exists on sensory scores.

3. RESULTS AND DISCUSSION

3.1 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. [23] 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.

3.2 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_0, T_1, T_2, T_3 and T_4 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 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

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

T_0- Shrikhand prepared with level of incorporation of 100 % sugar i.e. 40% sugar of chakka weight

T_1 – Shrikhand prepared with sugar: aqueous extract of stevia and liquorice at 75:12.5:12.5

T_2 – Shrikhand prepared with sugar: aqueous extract of stevia and liquorice at 50:25:25

T_3 - Shrikhand prepared with sugar: aqueous extract of stevia and liquorice at 25:37.5:37.5

T_4 - 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

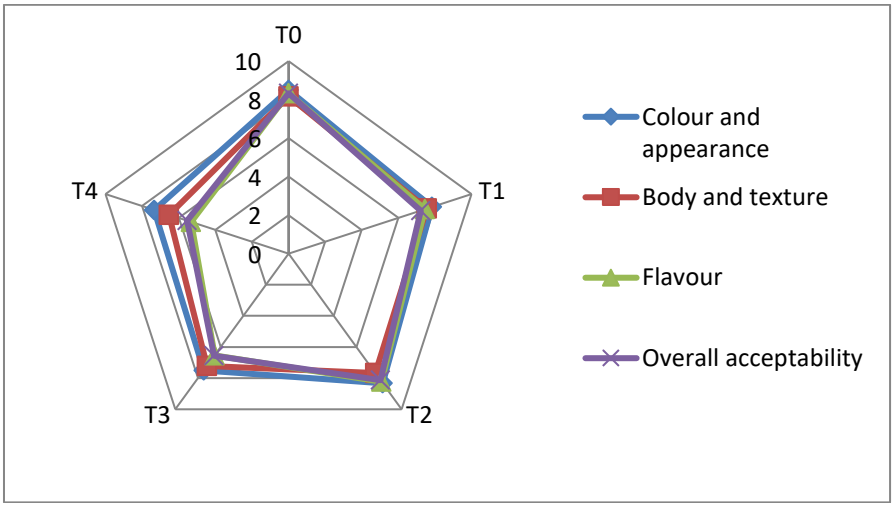


Fig. 4. Effect of combination of natural sweeteners on sensory attributes of shrikhand

3.2.1 Colour and appearance

Maximum colour and appearance score of 8.33±0.21 was found in the treatment T_2 followed by T_1 (7.84 ±0.18), T_3 (7.50 ± 0.19), T_4 (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.

3.2.2 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_2 followed by T_1 (7.56± 0.14), T_3 (7.21 ±0.12), T_4 (6.53 ±0.13) when compared with control shrikhand.

3.2.3 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_2 obtained the highest flavour scores (8.23±0.21), followed by T_1 (7.46 ±0.17), T_3 (6.53 ±0.13) and T_4 (5.32 ±0.14).

3.2.4 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 T_2 followed by T_1 (7.23 ±0.11), T_3 (6.57 ±0.15), T_4 (5.54±0.16) when compared with control shrikhand.

3.2.5 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. [24] 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. [25] 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(T_1), 50:25:25 (T_2), 25:37.5:37.5 (T_3), 0:50:50 (T_4). 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.

3.3 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_0, TG_1, TG_2, TG_3 and TG_4 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.

3.3.1 Colour and appearance

Maximum colour and appearance score of 8.50±0.14 was found in the treatment TG_3 followed by TG_1 (**7**.80±0.16), TG_2 (**7**.50±0.19), TG_4 (7.29±0.12) when compared with control. A highly significant difference existed among treatments and control with respect to colour and appearance.

3.3.2 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_3 received the highest texture score of 8.17±0.21 followed by the treatments TG_1 (7.73±0.21), TG_2 (7.67±0.31) and TG_4 (6.14±0.12).

3.3.3 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_3 obtained the highest flavour scores of 8.59±0.12, followed by TG_1 (7.68±0.134), TG_2 (7.60 ± 0.25) and TG_4 (7.20±0.13).

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

Sensory attributes	T_0	TG_1	TG_2	TG_3	TG_4	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**

@average of six trials
T_0 - Shrikhand prepared with 100 % level of incorporation of sugar i.e. 40% sugar of chakka weight
TG_1 - Shrikhand prepared with 5% of guava pulp of chakka weight
TG_2 - Shrikhand prepared with 10% of guava pulp of chakka weight
TG_3 - Shrikhand prepared with 15% of guava pulp of chakka weight
TG_4 - 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

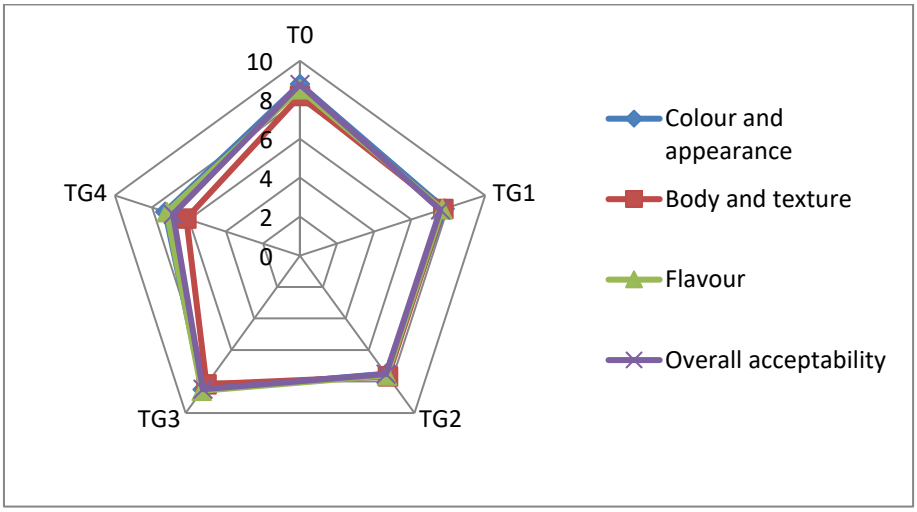


Fig. 5. Effect of guava pulp on sensory attributes of shrikhand

3.3.4 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 TG_3 followed by TG_1 (7.58±0.16), TG_2 (7.52± 0.17), TG_4 (6.86±0.11).

3.3.5 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, TG_3 (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. [26] 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.

3.4 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_0, TD_1, TD_2, TD_3 and TD_4 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.

3.4.1 Colour and appearance

Maximum colour and appearance score of 8.67±0.21 was found in the treatment TD_2 followed by TD_1 (7.84 ±0.18), TD_3 (7.81±.17), TD_4 (7.23 ±0.11) when compared with control. A highly significant difference (P<0.01) existed among the four treatments in colour and appearance.

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

T_0 - Shrikhand prepared with 100 %level of incorporation of sugar i.e. 40% sugar of chakka weight

TG_1 - Shrikhand prepared with 5% of aqueous extract of dragon fruit peel of chakka weight

TG_2 - Shrikhand prepared with 10% of aqueous extract of dragon fruit peel of chakka weight

TG_3 - Shrikhand prepared with 15% of aqueous extract of dragon fruit peel of chakka weight

TG_4 - 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

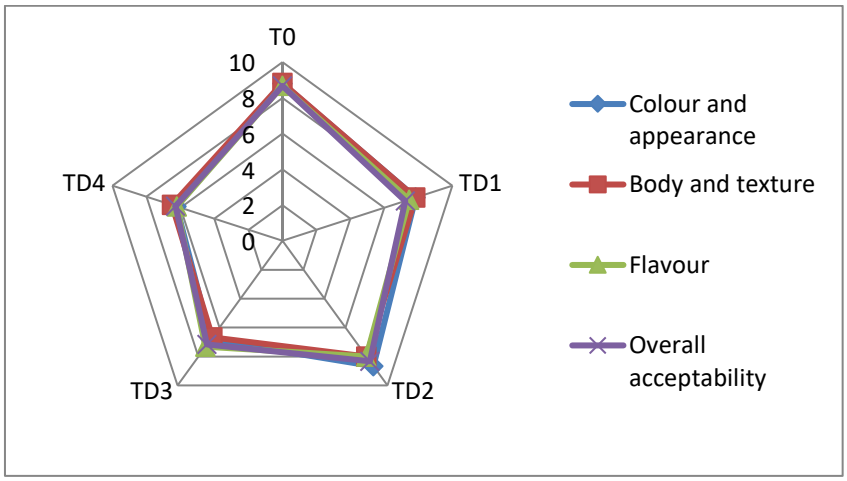


Fig. 6. Effect of aqueous extract of dragon fruit peel on sensory attributes of shrikhand

3.4.2 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 TD_2 followed by TD_1 (7.83±0.31), TD_3 (6.67±0.33), TD_4 (6.50±0.34).

3.4.3 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 TD_2 followed by TD_1 (7.46 ±0.17), TD_3 (7.33±0.21), TD_4 (6.21 ±0.12).

3.4.5 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 TD_2 followed by TD_1 (7.23 ±0.11), TD_3 (7.17±0.17), TD_4 (6.29 ±0.12).

3.4.6 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% (TD_2) 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. [27], 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.

3.5 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.

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.

3.5.1 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 ± 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.

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.

3.5.2 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. [28] who developed shrikhand incorporated with the strawberry pulp.

3.5.3 Total solids

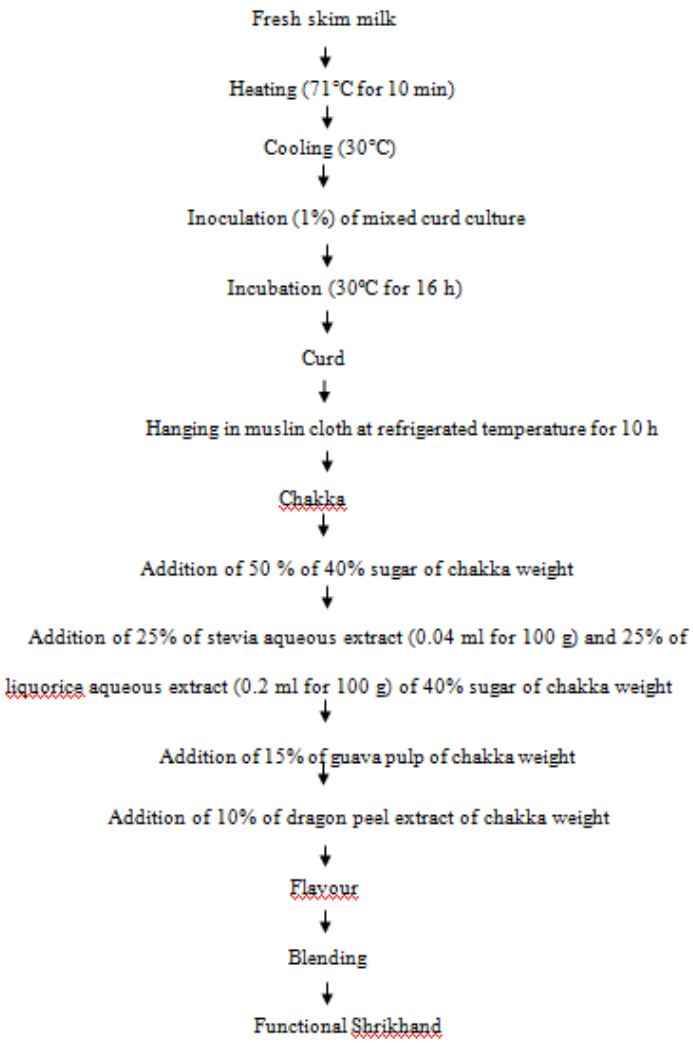
The total solids was highly decreased in the treatment of the functional shrikhand than that of the control, which might be due to the increase in moisture content in the functional shrikhand when compared to the control. There was a highly significant difference ($p \leq 0.01$) observed between the 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. [29] 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.

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)*



Flowchart 2. Procedure for the preparation of optimized functional shrikhand

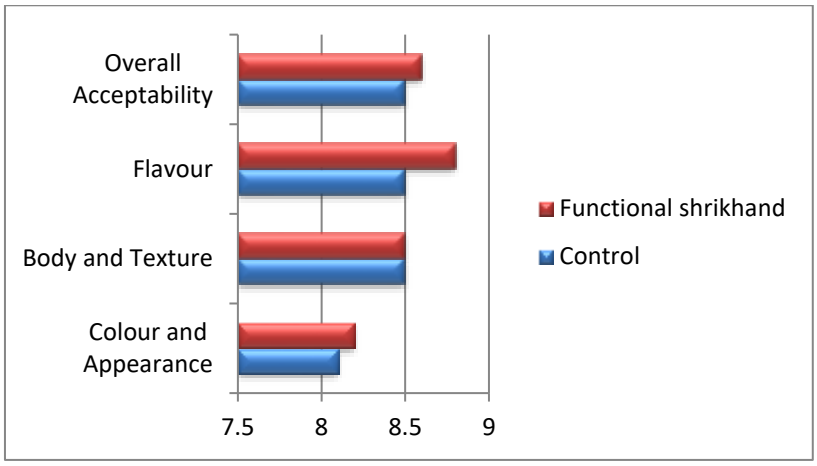


Fig. 7. Graphical representation of sensory score of control and functional shrikhand

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

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

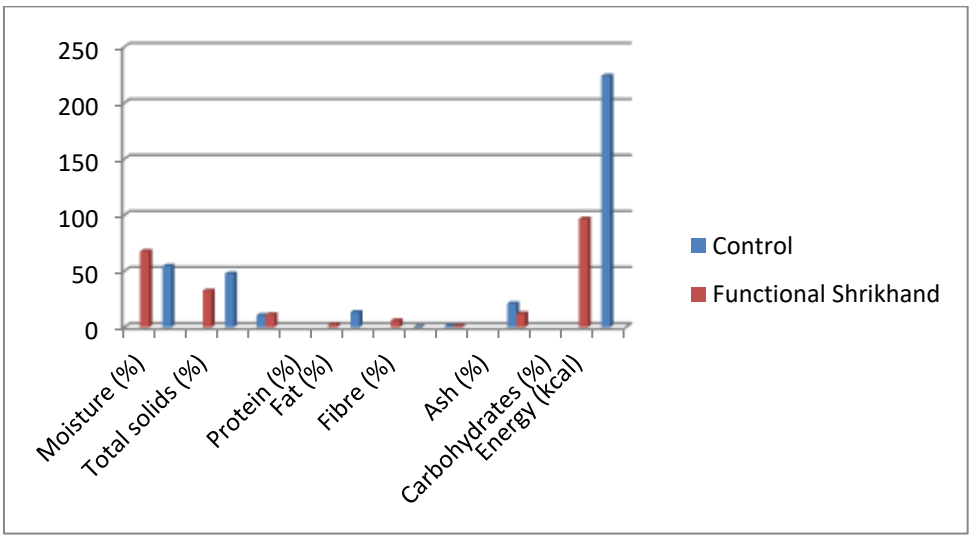


Fig. 8. Graphical representation of proximate composition of control and functional shrikhand

3.5.4 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 [30] 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.

3.5.5 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 inorder 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.

3.5.6 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 [31] 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.

3.5.7 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 [32] 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.*T_1, T_2, T_3, T_4 and T_5 were 0.66%, 0.66%, 0.67%, 0.67%, 0.68% and 0.70%.

3.5.8 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 [33] 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.

3.5.9 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 [34] 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.

4. 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.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ojha N, Chandra R, Rathor K, Satwani D, Kumar A, Srivastava S. Process optimization of herbal shrikhand by incorporating tulsi and turmeric powder. Pharma innov. 2018;7(6):100-102.
2. Srinivas J, Suneetha J, Maheswari KU, Kumari BA, Devi SS, Krishnaiah N. Nutritional analysis of value added Shrikhand. J. pharmacogn. phytochem. 2017;6(5):1438-1441.
3. Goyal SK, Samsher N, Goyal RK. Stevia (*Stevia rebaudiana*) a bio-sweetener: A review. Int J Food Sci Nutr. 2010;61(1):1-10.
4. Ruzainah AJ, Ahmad R, Nor Z, Vasudevan R. Proximate analysis of dragon fruit (Hylecereus polyhizus). Am J Appl Sci. 2009;6(7):1341-6.
5. Singh KV, Kumar R, Singh LAXMAN, Bhaskar ML. Effect of SNF levels of milk on the quality of shrikhand. J. Rural Agric. Res. 2014;14(1):47-48.
6. Swapna G, Chavannavar SV. Shrikhand-value added traditional dairy product. Int J Food Sci Nutr. 2013;2(4):45-51.
7. Tandon N, Anjana RM, Mohan V, Kaur T, Afshin A, Ong K, Dandona L. The increasing burden of diabetes and variations among the states of India: the Global Burden of Disease Study 1990–2016. The Lancet Global Health. 2018;6(12):e1352-e1362.
8. Madan S, Ahmad S, Singh GN, Kohli K, Kumar Y, Singh R, Garg M. *Stevia rebaudiana* (Bert.) Bertoni-A review; 2010.
9. Pérez E, González C, Vaillant F, Lares M. Stevia derivative and its potential uses in diabetic-directed foods. Review. J. Nutr. 2016;3(1):1-20.
10. Raini M, Isnawati A. Kajian: khasiat dan keamanan stevia sebagai pemanis pengganti gula. Media Penelitian dan Pengembangan Kesehatan. 2011;21(4):150020.
11. Sharifi-Rad J, Quispe C, Herrera-Bravo J, Belén LH, Kaur R, Kregiel D, Suleria HAR. Glycyrrhiza genus: Enlightening phytochemical components for pharmacological and health-promoting abilities. Oxidative medicine and cellular longevity. 2021;1-20.
12. Zietemann C, Roberto SR. Production of guava nursery plants (*Psidium guajava* L.) on different substrates. Revista Brasileira de Fruticultura. 2007;29:137-142.
13. Hasneen DF, Zaki NL, Abbas MS, Soliman AS, Ashoush IS, Fayed AE. Comparative evaluation of some herbs and their suitability for skimmed milk yoghurt and cast Kariesh cheese fortification as functional foods. Annals of Agricultural Sciences. 2020;65(1):6-12.
14. MR A. Antioxidant study of pulps and peels of dragon fruits: a comparative study. Int Food Res J. 2010;17:367-375.
15. Ahmad U, Ahmad RS, Imran A, Mushtaqq Z, Hussian SM. Characterization of low calorie ready-to-serve peach beverage using natural sweetener, Stevia (*Stevia rebaudiana* Bertoni). J Nutr Internal Med. 2019;21(1):435-444.
16. Kujur RS, Singh V, Ram M, Yadava HN, Singh KK, Kumari S and Roy BK. Anti diabetic activity and phytochemical screening of crude extract of *Stevia rebaudiana* in alloxan-induced diabetic rats. Pharm Res. 2010;2(4):258–63.
17. Patel HH, Amin BK. Formulation and standardization of different milk ice-cream fortified with pink guava pulp. Int. J. Dairy Sci. 2015;10(5):219-227.
18. Lourith N, Kanlayavattanakul M. Antioxidant and stability of dragon fruit peel colour. Agro Food Industry Hi Tech. 2013;24(3):56-8.
19. Pugazhenthi TR, Agalya A, Sowmya V, Elango A, Jayalalitha V. Preparation of

functional Shrikhand with pomegranate fruit peel extracts. J. pharmacogn. Phytochem. 2020;9(2):2416-24.
20. IS: 6273 [part –II]. Indian standard guide for sensory evaluation of foods (Part II, methods and evaluation cards); 1971.
21. AOAC. Official methods of analysis of the Association of Official Analytical Chemists,18th edition, Vol.1 and 2,Arlington,Virginia, U.S.A; 2006.
22. Snedecor GW, Cochran WG. Statistical methods of analysis, Oxford abd, IBH publishing company, Kolkata; 1989.
23. Ahmad U, Ahmad RS. Anti diabetic property of aqueous extract of *Stevia rebaudiana* Bertoni leaves in Streptozotocin-induced diabetes in albino rats. BMC complementary and alternative medicine. 2018;18(1):1-11.
24. Bishnoi JP, Gehlot R, Siddiqui S. Development of low calorie aonla ladoo using *Stevia rebaudiana*. J. pharmacogn. Phytochem. 2018;7(2):741-745.
25. El-Lahot A, El-Razek A, Amal M, Massoud MI, Gomaa EG. Utilization of glycyrrhizin and licorice extract as natural sweetener in some food products and biological impacts. j. food & dairy sci. 2017;8(3):127-136.
26. Rahate SM, Patil BD, Jaybhay VB, Chaugule CC. Sensory quality of khoa Burfi blended with guava (*Psidium guajava* L.) pulp; 2021.
27. Hafids S, Rahmi SL, Chairunisah AR. Study of low-fat ice cream with the substitution of super red dragon (Hylocereus costaricensis) fruit peel. Indones. J. Food Sci. Technol. 2019;3(1): 23-28.
28. Sonawane VM, Chavan KD, Pawar BK. Effect of levels of strawberry pulp and sugar on chemical composition during storage of Shrikhand. Journal of Dairying, Foods and Home Sciences. 2007;26(3and4):153-8.
29. Shelke PA, Shegokar SR, Shelke RR, Kahaate PA, Chavan SD. Studies on preparation of low fat, sugar free mango shrikhand. Res J Animal Husband Dairy Sci. 2014;5:122-5.
30. Tondare JC, Hembade AS. Nutritional and physico-chemical measurement and characterization of dietetic amrakhand manufactured by using stevia leaf extract powder. Vidyabharati International Interdisciplinary Research Journal. 2021; 2951-6.
31. Bhardwaj PK, Shelly J. Development of guava pulp enriched misthi dahi from toned milk. Haryana Veterinarian. 2016;55(2):141-144.
32. Tondare JC, Hembade AS. Nutritional and physico-chemical measurement and characterization of dietetic amrakhand manufactured by using stevia leaf extract powder. Vidyabharati International Interdisciplinary Research Journal. 2021; 2951-2956.
33. Giri A, Rao HR, V Ramesh. Effect of partial replacement of sugar with stevia on the quality of kulfi. J. Food Sci. Technol. 2014;51(8):1612-1616.
34. Salem AS, Mona IM. Effect of using stevia (*Stevia rebaudina* bertoni) leaves powder as natural non-caloric sweetener on the physico chemical properties of fiber fortified frozen yoghurt. Egypt. J Dairy Sci. 2003;31(1):61-70.

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