International Journal of Food Science and Nutrition
www.foodsciencejournal.com
ISSN: 2455-4898
Received: 25-07-2026, Accepted: 24-08-2026, Published: 08-09-2026
Volume 11, Issue 3, 2026, Page No. 260-265

Development of grape pulp-enriched low-calorie shrikhand using stevia and sorbitol as a bulking agent

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DOI: https://doi.org/10.66856/ijfsn.2026.11.3.11160

Abstract
The present study was undertaken to develop a low-calorie functional shrikhand by complete replacement of sucrose with stevia, using sorbitol as a bulking agent and grape pulp as a source of additional nutritional and antioxidant benefits. The product was standardized through successive optimization of stevia, sorbitol and grape pulp levels, followed by evaluation of sensory, compositional, physicochemical, antioxidant and microbiological characteristics during refrigerated storage. Based on sensory, compositional and physicochemical characteristics, 10% grape pulp was selected for the final product. The optimized grape pulp enriched shrikhand showed a DPPH radical inhibition of 66.814%, compared with 33.158% in the low-calorie control without grape pulp. The calorific values of sugar-based shrikhand, stevia-sorbitol low-calorie shrikhand and grape pulp enriched low-calorie shrikhand were 280.91, 220.12 and 187.80 kcal/100 g, respectively. During refrigerated storage, the optimized grape pulp product remained acceptable up to 21 days, compared with 35 days for the sugar control The study demonstrates the feasibility of developing a grape pulp enriched low-calorie shrikhand using stevia and sorbitol while retaining acceptable sensory characteristics and improving antioxidant activity.

Keywords: Stevia, sorbitol, grape pulp, low-calorie dairy product, antioxidant activity, DPPH, storage stability

Introduction

Shrikhand has typical semi solid consistency and derived from Sanskrit word "Shrikharini" meaning a curd preparation with added sugar, flavoring agent, fruits and nuts after removal of whey portion (Gavane *et al*., 2010). showing a characteristics firmness and palatability and most famous desirable product most in northern india. The consistency is influenced to great extent by the moisture, fat and sugar levels in shrikhand (Singh, 2006). Consumption of sugar based dairy products has decreased and showing more interest on products that are prepared with artificial sweeteners having more nutritional value, more antioxidant properties. Stevia is a small perennial shrub that has been used for centuries as a bio-sweetener. Its white crystalline compound (stevioside) is the natural herbal sweetener with no calories (Goyal *et al*., 2010). health conscious consumers enjoy the taste of sugar free SHRIKHAND with grape pulp. Stevia is a high-intensity bio-sweetener, while sorbitol is a sugar alcohol that can provide bulk in reduced-sugar food systems. The use of a bulking agent is particularly important in products in which sucrose is completely replaced because high-intensity sweeteners do not reproduce the structural contribution of sucrose. Grapes are rich in phytochemicals including phenolic compounds, stilbenes, anthocyanins and proanthocyanidins, which contribute to antioxidant activity. The thesis therefore investigated grape pulp as a functional ingredient in low-calorie shrikhand.

Phases: The objectives of the study were to standardize stevia and sorbitol levels for low-calorie shrikhand, determine an acceptable level of grape pulp, evaluate the functional properties of the grape pulp enriched product during storage, and determine the suitable level of cardamom for flavour and keeping quality.

Formulation of grape pulp enriched low calorie Shrikhand

Preparation of Dahi

Milk is standardized to 4.5% fat and 8.5% SNF, filtered through muslin cloth and heated in directly at 90°C for 10 minutes and cooled to 37°C. The milk was inoculated with LF 40 strain @ 1.5%. The milk was incubated at 37°C until desired firmness and acidity reached to 0.8-0.9% lactic acid. Preparation of chakka After having the desired acidity and the firmness in dahi, whey was drained from the curd through suspended muslin cloth and was hanged for 6-8 hours to get solid mass known as chakka.

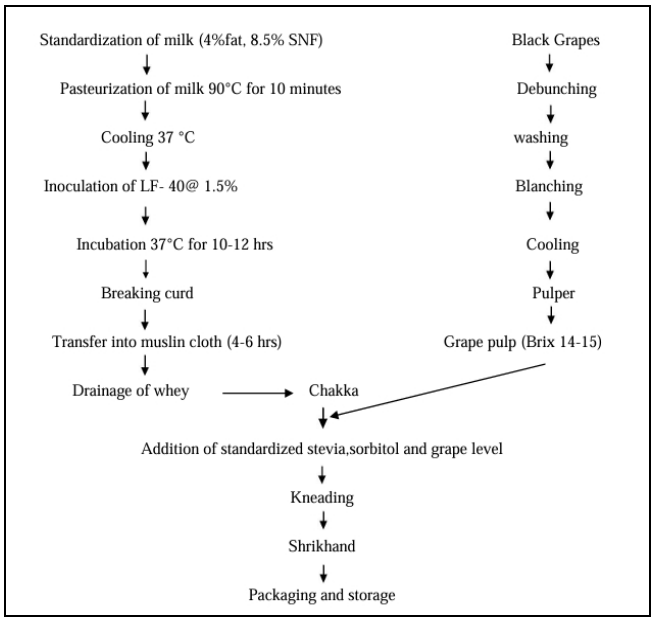

Fig 1: Flow chart of grape pulp enriched low calorie shrikhand as follows

1. Preparation and standardization of low-calorie shrikhand

Stevia was incorporated at different levels and compared with conventional shrikhand (60 g) prepared using sugar. The selected stevia level was subsequently combined with different levels of sorbitol to compensate for the loss of bulk and mouthfeel caused by complete sugar replacement. Stevia levels of 40, 80 and 120 mg per 100 g chakka were evaluated. Based on sensory and physicochemical characteristics, 80 mg was selected. Sorbitol was subsequently evaluated at 25, 30 and 35% levels, with 30% selected as the appropriate level.

2. Grape pulp incorporation

Grape pulp was incorporated into the standardized low-calorie Shrikhand at 8, 10 and 12 g per 100 g chakka. The ingredients were thoroughly mixed and the product was kneaded through a wire mesh to obtain a smooth and homogeneous consistency. The product was subsequently packed in polypropylene cups and stored under refrigerated conditions. The treatments were designated G1 (8%), G2 (10%) and G3 (12%), with the low-calorie Shrikhand without grape pulp serving as the control (Cs). Based on sensory, compositional and physicochemical characteristics, G2 (10% grape pulp) was selected for subsequent storage studies.

3. Sensory evaluation

Sensory quality was evaluated using a nine-point hedonic scale with a panel of five semi-trained judges. Flavour, colour and appearance, body and texture, and overall acceptability were assessed during product standardization and storage.

4. Physicochemical and compositional analysis

The developed products were evaluated for acidity, pH and water activity. Proximate composition included fat, protein, ash, total solids and carbohydrate content. Total carbohydrate was calculated by difference.

5. Antioxidant activity

Antioxidant activity was determined by the DPPH radical-scavenging method based on the procedure of Brand-Williams *et al*. (1995). Absorbance was measured at 517 nm following incubation of the sample extract with DPPH reagent in the dark.

Estimation of antioxidant activity Determination of antioxidant activity with 2, 2'-diphenyl- 1-picrylhydrazyl (DPPH) radical scavenging method: The total antioxidant activity of fruit extract was determined as per the DPPH method adopted by Brand-Williams *et al*.,1995. The DPPH radical scavenging activity was estimated by measuring the decrease in the absorbance of the methanolic solution of DPPH. Different volumes of fruit (50-200µl) extract were allowed to react with DPPH solution (3.3 mg of DPPH in 100 ml methanol), incubated for 30 minutes in the dark and the absorbance (A1) was read at 517 nm. The absorbance (A0) of a reaction control (methanol instead of fruit extract) was also recorded at the same wavelength. Ascorbic acid (5-50 µg/ml) was used as a standard. Scavenging ability (%) was calculated by using the DPPH radical scavenging activity (%) = [A-A] 100 0 1 A · 0 Where, A0 was the absorbance of reaction control and A1 was the absorbance of fruit extracts or standards.

Preparation of whey fraction from sample: The shrikhand is diluted with distilled water in the ratio of 1:2.5 and centrifuge for 10 minutes at 4°C.The supernatant was collected and used for measurement of antioxidant activity. 0.1 ml of sample extract or standard was added to 5 ml of DPPH reagent (0.00039 gm in 1 litre methanol) and vortex vigorously. The reaction tubes were incubated in dark for 30 min, at room temperature and the discolouration of DPPH was measured against a reagent blank at 517 nm.

6. Microbiological analysis

Coliform and yeast and mould counts were determined during storage using the methods specified in the thesis based on Indian Standards procedures.

7. Calorific value

Calorific value was calculated using energy values of 9 kcal/g for fat, 4 kcal/g for protein and carbohydrate, and 2.6 kcal/g for sorbitol. Production cost was calculated from the prevailing prices of ingredients and processing inputs used in the experiment.

Results and Discussion

1. Optimization of stevia

The initial chakka contained 33.82% total solids, 66.18% moisture and 1.59% acidity. Stevia incorporation at 40, 80 and 120 mg/100 g of chakka resulted in differences in sensory quality. The 80 mg treatment was preferred among the stevia treatments and was selected for further standardization. However, its body, texture and mouthfeel remained inferior to the sugar control, demonstrating the need for a bulking agent. The reason for lower total solids in stevia added shrikhand is because of stevia does not contribute total solids to shrikhand. The results are in confirmation with the observations made by Pon *et al*. (2015) [12] in ice cream prepared with different levels of stevia. Total solids are contributed by the addition of sugar or by bulking agent which gives essential body and texture. From the results, it is observed that the titratable acidity in control shrikhand (1.22% LA) was significantly ($P \leq 0.05$) lower than the stevia levels (1.50%LA). The minute quantity of stevia addition in the stevia added shrikhand does not decrease the acidity content in shrikhand as it was equally distributed in case of sugar added shrikhand which leads to the decrease in acidity of the product. The results are in confirmation with the Drotakalicka *et al*. (2017) [8] reported that increasing concentration of stevia the pH values of yoghurt decreased and titratable acidity increased more quickly during storage. The total solids of the sugar control were substantially higher than those of the stevia treatments. This was attributed to the contribution of sucrose to total solids and product structure, whereas the small quantity of stevia did not provide equivalent bulk.

2. Optimization of sorbitol

Sorbitol was incorporated at 25, 30 and 35% to compensate for the loss of bulk associated with sugar replacement. Increasing sorbitol level increased total solids and carbohydrate content relative to the stevia-only formulation. investigation using bulking agent like sorbitol *viz*. 25 (S1),30 (S2) and 35(S3) g for every 100 g of chakka with 80 mg of stevia powder compared with the control shrikhand prepared with 60(C) g of sugar powder. The sensory evaluation indicated that 30% sorbitol produced the most

desirable combination of flavour, body and texture and overall acceptability. Consequently, 30% sorbitol with 80 mg stevia was selected for subsequent studies. Increase in the levels of sorbitol decreases the water activity due sorbitol acts as a humectants and binds the matrix (Marques *et al*.,2016) [16] The present results are collaborated with Murlidhara (2008) [3] who reported that partially replacement of sugar with artificial sweetener in shrikhand increases the fat percentage from 10.48 to 11.68and protein percentage from 9.86 to 10.72. Sorbitol is used as a bulking agent, as it is a carbohydrates source which increases the total solids in the shrikhand. Some amount of sweetness is contributed to the shrikhand through sorbitol due to the relative sweetness of sorbitol contributes 60% of sucrose and the optimum sweetness was selected by the judges in 30% level incorporation which is slightly lower than that of control (8.46). Statistically it is supported by showing a significant (P≤0.05) difference between the sorbitol levels and control. Addition of sorbitol levels gives smooth body and texture (Marques *et al*., 2016) [16], improves the colour and appearance.

Table 1: Average sensory scores for different levels of sorbitol for low calorie shrikhand

Treatments	Flavour	Colour& appearance	Body& texture	Over all acceptability	Remarks
C	8.46 ^{a} ± 0.02	8.30 ^{a} ± 0.032	8.46 ^{a} ± 0.024	8.38 ^{a} ± 0.019	Highly consistent
S_1	7.32 ^{c} ± 0.04	7.46 ^{d} ± 0.024	6.46 ^{c} ± 0.024	7.12 ^{d} ± 0.017	Low viscous, consistent and less sweeteness
S_2	8.20 ^{b} ± 0.06	7.64 ^{c} ± 0.051	7.2 ^{b} ± 0.055	7.64 ^{b} ± 0.048	Optimum consistency acceptable sweetness
S_3	7.42 ^{c} ± 0.04	8.18 ^{b} ± 0.037	6.3 ^{d} ± 0.071	7.26 ^{c} ± 0.035	High viscous and High sweetness
C.D at 5%	0.120	0.112	0.144	0.106	Significant

Table 2: Average physicochemical values for different levels of sorbitol for low calorie shrikhand

Treatments	Acidity%	pH	Water activity
C	1.26 ^{bc} ± 0.01	4.092 ^{b} ± 0.01	0.947 ^{a} ± 0.01
S_1	1.30 ^{a} ± 0.01	4.116 ^{b} ± 0.01	0.938 ^{b} ± 0.01
S_2	1.27 ^{b} ± 0.01	4.10 ^{b} ± 0.01	0.936 ^{b} ± 0.01
S_3	1.24 ^{c} ± 0.01	4.168 ^{a} ± 0.01	0.934 ^{b} ± 0.01
C.D at 5%	0.023	0.025	0.004
Result	Significant		

Table 3: Average composition analysis (%) of low calorie shrikhand with different levels of sorbitol

Treatments	Fat	Protein	Ash	Total solids	Carbohydrates
C	8.994 ^{d} ± 0.09	9.778 ^{c} ±0.05	0.562$^{a\,b}$ ± 0.02	59.930 ^{a} ± 0.43	40.382 ^{a} ± 0.37
S_1	12.524^{a} ± 0.20	11.722 ^{a} ± 0.12	0.598 ^{a} ± 0.02	49.499 ^{d} ± 0.66	24.479 ^{d} ± 0.78
S_2	11.436^{b} ± 0.17	10.632 ^{b} ± 0.05	0.564^{ab} ± 0.02	51.310 ^{c} ± 0.57	28.460 ^{c} ± 0.66
S_3	10.416 ^{c} ± 0.21	9.954 ^{c} ± 0.05	0.528 ^{b} ± 0.02	53.701 ^{b} ± 0.47	32.735 ^{b} ± 0.64
C.D at 5%	0.344	0.591	0.041	1.618	1.598
Result	Significance				

3. Effect of grape pulp on sensory characteristics

Grape pulp was incorporated at 8, 10 and 12%. The sensory results showed that the 10% treatment (G2) provided the most favourable combination of flavour, body and texture, colour and appearance, and overall acceptability. The reported overall acceptability scores for Cs, G1, G2 and G3 were 7.68, 8.04, 8.30 and 8.09, respectively. The 10% G2 grape pulp treatment was therefore selected as the optimum level. This selection was based not only on sensory quality but also on compositional and physicochemical characteristics.

Table 4: Overall acceptability of shrikhand containing different levels of grape pulp.

Treatment	Grape pulp (%)	Overall acceptability
Cs	0	7.68
G1	8	8.04
G2	10	8.3
G3	12	8.09

4. Compositional characteristics

The incorporation of grape pulp influenced the proximate composition of the product. Fat content decreased from 11.35% in Cs to 8.39, 8.25 and 8.05% in G1, G2 and G3, respectively. Protein decreased from 10.77% in Cs to 7.70, 7.45 and 7.25%, respectively. Ash and total solids also decreased with increasing grape pulp level. The carbohydrate content of Cs was 28.82%, while values of 34.07, 32.21 and 31.01% were recorded for G1, G2 and G3, respectively. Nigam *et al*. (2009) [10] found that the fat content of papaya pulp shrikhand as 11.96 to 7.70 i.e decreasing with increasing level of papaya pulp. Nigam *et al*. (2009) [10] who found similar results i.e. decrease in protein content in papaya pulp shrikhand from 6.73 to 3.38 per centGhanbadhadur (2016) [16] observed a similar results with decrease in ash content in pomegranate juice shrikhand from0.59 to 0.25 was observed. s well as Thakur *et al*. (2014) [15] and Narayanan *et al*. (2013) also reported similar findings for decrease in the total solid content with increase level of pulp.

Table 4: Average composition percentage of different levels of grape pulp low calorie shrikhand

Treatments	Fat	Protein	Ash	Total solids	Carbohydrates
C_S	11.35^{a} ±0.06	10.774 ^{a} ±0.03	0.664 ^{a} ±0.06	51.608 ^{a} ±0.345	28.816^{d} ±0.39
G_1	8.390^{b} ±0.02	7.697^{b} ±0.18	0.550 ^{b} ±0.01	50.708 ^{a} ±0.435	34.071 ^{a} ±0.15
G_2	8.252 ^{c} ±0.03	7.445^{bc} ±0.06	0.528^{b} ±0.01	48.439 ^{b} ±0.143	32.214 ^{b} ±0.19
G_3	8.049 ^{d} ±0.08	7.250 ^{c} ±0.07	0.526 ^{b} ±0.01	46.839 ^{c} ±0.310	31.013 ^{c} ±0.22
C.D(P≤0.05)	0.125	0.290	0.047	0.962	1.175
Result	Significance				

5. Physicochemical properties and antioxidant activity

Grape pulp significantly influenced acidity, pH, water activity and DPPH inhibition. Acidity increased from 1.194% lactic acid in Cs to 1.247, 1.318 and 1.360% in G1, G2 and G3, respectively. The corresponding pH values were 4.118, 4.020, 3.852 and 3.808. The increase in acidity and reduction in pH with grape pulp incorporation were associated in the thesis with the acidic nature of the fruit

pulp. A marked increase in antioxidant activity was observed with increasing grape pulp level. DPPH inhibition increased from 33.158% in Cs to 43.386% in G1, 66.814% in G2 and 73.442% in G3. Thus, grape pulp substantially increased the radical-scavenging activity of the low-calorie product.

Table 5: Average composition percentage of different levels of grape pulp low calorie shrikhand

Treatments	Fat	Protein	Ash	Total solids	Carbohydrates
Cs	11.35[a] ±0.06	10.774[a] ±0.03	0.664[a] ±0.06	51.608[a] ±0.345	28.816[d] ±0.39
G1	8.390[b] ±0.02	7.697[b] ±0.18	0.550[b] ±0.01	50.708[a] ±0.435	34.071[a] ±0.15
G2	8.252[c] ±0.03	7.445[bc] ±0.06	0.528[b] ±0.01	48.439[b] ±0.143	32.214[b] ±0.19
G3	8.049[d] ±0.08	7.250[c] ±0.07	0.526[b] ±0.01	46.839[c] ±0.310	31.013[c] ±0.22
C.D(P≤0.05)	0.125	0.290	0.047	0.962	1.175
Result	Significance				

Table 6: Average physico- chemical analysis of different levels of grape pulp low calorie shrikhand

Treatments	Acidity%	pH	Water activity	%DPPH inhibition
Cs	1.194[c] ±0.01	4.118[a] ±0.01	0.959[a] ±0.02	33.158[d] ±0.44
G1	1.247[b] ±0.02	4.02[b] ±0.02	0.937[c] ±0.01	43.386[c] ±0.52
G2	1.318[a] ±0.02	3.852[c] ±0.01	0.947[b] ±0.01	66.814[b] ±0.51
G3	1.36[a] ±0.01	3.808[d] ±0.02	0.954[a] ±0.02	73.442[a] ±0.90
C.D(P≤0.05)	0.045	0.043	0.005	1.869
Result	Significant			

The % titratable acidity of shrikhand increase might be due to the acidic nature of grape pulp having tartaric acid (90%) and also fruits contain more acids than the milk. The results are also in accordance with Ghanbahadur (2016), Akbarpour *et al*. (2009) and Nur Hossain *et al*. (2012) [2, 11, 16] who found increase in juice level increases the titratable acidity in dairy products. The present findings were good in accordance with results of Suresh 2016 reported that increasing the level of black carrot juice decreasing the pH of the shrikhand. Increasing the level of grape pulp an increasing % of DPPH Inhibition is observed. The present results are similar with David (2015) [6] reported that highest activity was observed in 4% basil extract in shrikhand.

6. Storage stability

The optimized 10% grape pulp enriched shrikhand, the low-calorie control and the sugar-based control were evaluated during refrigerated storage. Sensory quality declined progressively with storage. The sugar control remained acceptable up to 35 days, whereas both the low-calorie control and 10% grape pulp enriched product were acceptable up to 21 days. For the 10% grape pulp product, flavour scores declined during storage as acidity increased and sourness developed. Body and texture scores also decreased progressively. The thesis reported that the grape pulp enriched product remained acceptable through 21 days, after which deterioration became evident. Yeast and mould counts increased progressively during storage, while no coliforms were detected in the samples during the reported storage period. The grape pulp enriched product showed higher yeast and mould counts than the sugar and low-calorie controls toward the later stages of storage.

Table 7: Sensory analysis of grape pulp enriched low calorie shrikhand during storage.

Storage days	Control shrikhand (60 grams of sugar)				Low calorie shrikhand (Stevia and sorbitol)				Low calorie grape enriched shrikhand			
	Flavour	Body& texture	Colour& appearance	Overall acceptability	Flavour	Body& texture	Colour& appearance	Over all acceptability	Flavour	Body& texture	Colour& appearance	Over all acceptability
0	8.38 ±0.03	8.48[a] ±0.03	8.22[a] ±0.03	8.28[a] ±0.01	8.08[a] ±0.03	7.48[a] ±0.03	8.04[a] ±0.02	7.86[a] ±0.01	8.40[a] ±0.07	8.38[a] ±0.03	8.34[a] ±0.02	8.37[a] ±0.03
7	8.14[b] ±0.05	8.34[a] ±0.05	8.08[a] ±0.03	8.16[b] ±0.021	7.72[b] ±0.03	7.24[b] ±0.05	7.64[b] ±0.09	7.53[b] ±0.03	8.24[b] ±0.05	8.16[b] ±0.02	8.22[b] ±0.03	8.21[b] ±0.02
14	8.10[b] ±0.03	7.86[b] ±0.02	7.85[b] ±0.05	7.9[c] ±0.010	7.28[c] ±0.03	6.8[c] ±0.08	7.1[c] ±0.070	7.06[c] ±0.06	7.76[c] ±0.050	7.42[c] ±0.101	7.62[c] ±0.03	7.61[c] ±0.04
21	7.72[c] ±0.07	7.52[c] ±0.03	7.71[b] ±0.05	7.6[d] ±0.03	6.46[d] ±0.05	6.28[d] ±0.08	6.16[d] ±0.05	6.30[d] ±0.03	6.36[d] ±0.04	7.06[d] ±0.06	7.22[d] ±0.05	7.21[d] ±0.03
28	7.5[d] ±0.06	7.16[d] ±0.06	7.50[c] ±0.07	7.35[e] ±0.03	5.76[e] ±0.05	5.74[e] ±0.06	5.70[e] ±0.11	5.75[e] ±0.04	5.72[e] ±0.06	6.2[e] ±0.070	6.0[e] ±0.03	5.97[e] ±0.02
35	7.2[e] ±0.05	6.82[e] ±0.08	7.28[d] ±0.04	7.01 ±0.04	-	-	-	-	-	-	--	-
CD (P≤0.05)	0.157	0.160	0.193	0.094	0.128	0.201	0.232	0.121	0.159	0.196	0.195	0.097

Average of five replications, Mean±SE and any mean two columns not followed by same superscripts are differ significantly at 5%level

Similar results were also reported by Muralidhar (2008) in dietetic shrikhand replacement of sugar with artificial sweetener and bulking agent and found that the product was spoiled after 15days of storage. Shrikhand prepared with fortification of papaya pulp (Nigam *et al*., 2009) [10] and apple pulp and Celosiaargentea (Kumar *et al*., 2011) also showed decreased in flavor score. Nigam *et al*. (2009) [10] have also reported that the texture score decreased during storage periods in papaya pulp fortified Shrikhand. Kumar *et al*. (2011) also reported a similar decline in texture score during storage when apple pulp and Celosiaargentea were added in shrikhand. The mean % DPPH inhibition of 10% grape pulp enriched shrikhand (0 to 28 days) was are in the range of 67.34 to 32.342. A linear decrease was observed in % of DPPH inhibition with increase in days of storage at 7°C due to the increasing interaction among proteins-

polyphenols and denaturation during storage time and temperature. These results are in agreement with Yadav and Dinesh Rai (2018) reported that decrease in %DPPH inhibition on increasing in the storage days of shrikhand prepared with ashwagandha, root extract up to 28day of storage. Similarly, Trigueros *et al*. (2014), Lawin and Kongbangker (2010) [7], Ashwani and Kumar & Dinesh Kumar (2016) [1] reported that antioxidant activity decreased with increasing storage days in fruit yoghurt.

Table 8: Physicochemical Analysis of grape pulp enriched shrikhand during storage

Storage days	Control shrikhand (60 grams of sugar)			Low calorie shrikhand (stevia and sorbitol)			Low calorie grape enriched shrikhand		
	Acidity	pH	Water activity	Acidity	pH	Water activity	Acidity	pH	Water activity
0	1.12^{e} ±0.009	4.33^{a} ±0.008	0.940^{a} ±0.01	1.27^{d} ±0.007	4.14^{a} ±0.008	0.922^{c} ±0.01	1.28^{c} ±0.01	4.02^{a} ±0.01	0.953^{c} ±0.01
7	1.17^{d} ±0.005	4.23^{b} ±0.014	0.9396^{a} ±0.01	1.31^{c} ±0.004	4.02^{b} ±0.04	0.925^{b} ±0.01	1.30^{c} ±0.01	3.95^{b} ±0.01	0.954^{c} ±0.01
14	1.25^{c} ±0.010	4.16^{bc} ±0.041	0.9382^{ab} ±0.01	1.33^{b} ±0.004	3.95^{c} ±0.04	0.931^{a} ±0.01	1.38^{b} ±0.01	3.91^{b} ±0.01	0.956^{b} ±0.01
21	1.29^{b} ±0.004	4.11^{cd} ±0.005	0.9376^{abc} ±0.01	1.35^{a} ±0.003	3.82^{d} ±0.04	0.932^{a} ±0.01	1.43^{a} ±0.01	3.81^{c} ±0.01	0.963^{a} ±0.01
28	1.33^{a} ±0.01	4.07^{de} ±0.005	0.9352^{bc} ±0.01	1.37^{a} ±0.003	3.80^{d} ±0.04	0.932^{a} ±0.01	1.45^{a} ±0.01	3.81^{c} ±0.01	0.9632^{a} ±0.01
35	1.35^{a} ±0.01	4.02^{e} ±0.007	0.935^{c} ±0.01	-	-	-	-	-	-
CD (P≤0.05)	0.032	0.078	0.003	0.015	0.06	0.02	0.019	0.063	0.002
Result	Significance								

7. Calorific value

The conventional sugar-based shrikhand had a calorific value of 280.91 kcal/100 g. Replacement of sugar with stevia and sorbitol reduced the value to 220.12 kcal/100 g, while incorporation of grape pulp further reduced the reported value to 187.80 kcal/100 g. Thus, the low-calorie formulation showed approximately 27% lower calorific value and the grape pulp enriched formulation approximately 33% lower calorific value than the sugar control.

Conclusion

The study demonstrated the feasibility of developing a low-calorie functional shrikhand through complete replacement of sucrose with stevia and sorbitol and enrichment with grape pulp. Stevia at 80 mg/100 g of chakka provided the preferred sweetness among the tested levels, while 30% sorbitol effectively compensated for the loss of bulk and mouthfeel associated with sugar replacement. Among the grape pulp treatments, 10% grape pulp was selected as the optimum level based on sensory, compositional and physicochemical characteristics. Grape pulp substantially enhanced antioxidant activity, with DPPH inhibition increasing from 33.158% in the low-calorie control to 66.814% in the selected 10% treatment. The optimized product had a reported calorific value of 187.80 kcal/100 g compared with 280.91 kcal/100 g for conventional sugar-based shrikhand. The optimized grape pulp enriched low-calorie shrikhand remained sensorially acceptable for 21 days under refrigerated storage conditions. Although its production cost was higher than that of conventional shrikhand, the product provided the combined attributes of reduced calorific value, acceptable sensory quality and enhanced antioxidant activity.

References

1. Kumar A, Kumar D. Development of antioxidant rich fruit supplemented probiotic yogurts using free and microencapsulated *Lactobacillus rhamnosus* culture. Journal of Food Science and Technology,2016:53(1):667–675.
2. Akbarpour V, Khodayar H, Sharifani M. Physical and chemical properties of pomegranate fruit in maturation stage. American-Eurasian Journal of Agricultural and Environmental Sciences,2009:6(4):411-416.
3. Carakostas MC, Curry LL, Boileau AC, Brusick DJ. The history, technical function and safety of rebaudioside A, a naturally occurring steviol glycoside, for use in food and beverages. Food and Chemical Toxicology,2008:46:S1–S10.
4. Chavan KD, Pawar BK, Sonawane VM. Effect of levels of strawberry pulp and sugar on sensory quality of shrikhand during storage. Journal of Maharashtra Agricultural Universities,2009:34(1):93–95.
5. Dandile UM, Pawar BK, Choudhari DM. Sensory quality of shrikhand prepared by using cardamom and saffron. Research Journal of Animal Husbandry and Dairy Science,2014:5(1):1–5.
6. David J. Preparation of herbal shrikhand prepared with basil (*Ocimum basilicum*) extract. The Pharma Innovation Journal,2015:4(8):81–84.
7. Lawin P, Kongbangkerd T. Development of probiotic yoghurt mixed with roselle syrup. KKU Research Journal,2010:15(9):803–808.
8. Kalicka D, Znamirowska A, Buniowska M, *et al*. Effect of stevia addition on selected properties of yoghurt during refrigerated storage. Polish Journal of Natural Sciences,2017:32(2):323–334.
9. Muralidhara NS. Studies on effect of non-nutritive sweeteners on quality of shrikhand. M.Tech. Thesis

submitted to National Dairy Research Institute, Karnal, 2008.
10. Nigam N, Singh R, Upadhyay PK. Incorporation of chakka by papaya pulp in the manufacture of shrikhand. Journal of Dairying, Foods and Home Science,2009:28(2):115-118.
11. Nur Hossain Md, Fakruddin Md, Nurul Islam Md. Development of fruit dahi (yoghurt) fortified with strawberry, orange and grapes juice. American Journal of Food Technology,2012:7:562–570.
12. Pon SY, Lee WJ, Chong GH. Textural and rheological properties of stevia ice cream. International Food Research Journal,2015:22(4):1544–1549.
13. Radhika GS, Moorthy SN. Sugar alcohols – A review. Trends in Carbohydrate Research,2009:1:71–79.
14. Raju PN, Pal D. Effect of bulking agents on the quality of artificially sweetened mistidahi prepared from reduced fat buffalo milk. LWT – Food Science and Technology,2011:44:1835–1843.
15. Thakur SN, Rajni Kant, Chandra R. Preparation of shrikhand by using mango pulp. Bioved,2014:25(1):79-82.
16. Marques C, Tarek R, Sara M, Brar SK. Sorbitol Production From Biomass and Its Global Market. In: Kaur Brar S, JyotiSarma S, Pakshirajan K, editors. Platform Chemical Biorefinery. Elsevier, 2016, 217–227.