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PREPARATION AND STANDARDIZATION OF LOW-CALORIC PHALSA-JAMUN MIXED FRUIT JAM DURING STORAGE

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Abstract

Consumers are now more conscious about their health and the rising prevalence of diet-related health problems has increased demand for better food options, such as low-calorie fruit products. So, the current research aimed to develop and standardize a low-calorie fruit jam utilizing two local fruits, phalsa (*Grewia asiatica*) and jamun (*Syzygium cumini*). To produce the mixed fruit jam, a systematic technique was used, which included the selection of ripe and high-quality phalsa and jamun fruits, the jam-making procedure, and adding low-calorie sweeteners to substitute conventional sugars. Preservatives were also carefully added to extend the shelf life of the jam without affecting its safety or sensory qualities. To assess the stability of the low-caloric jam during storage, samples were collected periodically and subjected to nutritional analysis, sensory evaluations, and microbial tests. Throughout the storage time, the sugar content, calorific value, and other parameters were examined. The result for the pH, TSS, and TA was highly significant during storage. The average pH was 3.87 on the first day it reduced to 2.73 significantly. The TSS of the control and other treatments varied significantly from each other. The TSS of control was 68.77 ºBrix and for low caloric jam, TSS was approximately 48.81ºBrix. Titratable Acidity increased from 0.19 to 0.55 after 90 days. Antioxidant content was reduced during the storage significantly. The sensory evaluation suggested that jam prepared with 100% stevia gives the best sensory score among all treatments.

Keywords: Phalsa; Jamun; Jam; Stevia; Sucralose.

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1. INTRODUCTION

Fruits have a significant role in human nutrition. However, because they are seasonal and perishable, they are usually processed into stable forms like juices, jams, jellies, and many other products. Jam is a fruit product that is processed and has an intermediate moisture level, prepared by boiling of homogenized pulp of fruit with sugar, pectin, and citric acid. Additional substances such as coloring compounds, preservatives, and flavorings, could also be added. Jam should be sufficiently solid to avoid flowing like a fluid and have the right consistency to allow for easy spreading. Fruit should make up at least 45% of the jam's weight and the jam should have a minimum of 68.5% of total soluble solids (TSS). Many different fruits have been used to make jams across the world. The fruit industry places a great deal of importance on the creation of new products because consumer preferences dictate food products (Garg *et al.,* 2019).

Phalsa (*Grewia asiatica L*.) is a member of the Malvaceae family and stands out among Grewia species for its edible fruit (Mehmood *et al.,* 2020). Rich in carbohydrates, acids, and vitamins A and C. Phalsa offers a nutritional profile that extends to essential amino acids and various bioactive compounds (Maurya *et al.,* 2022). Beyond its nutritional content, phalsa has been traditionally used to treat upset stomachs, skin and intestinal infections, diarrhea, and other health issues. Despite its nutritional richness, phalsa faces challenges due to its short shelf life of 3-4 days. This limitation hinders commercial applications, prompting the development of value-added products like jams to extend consumption.

Jamun (*Syzygium cumini L.*), also known as Indian blackberry, offers a distinctive flavor and substantial health benefits. The estimated worldwide production of jamun is 13.7 million tons. Jamun fruit and its leaves are good for diabetic patients. The fruit regulates blood sugar levels and aids in the conversion of starch into energy. Because jamun has a low glycemic index, sugar patients should regularly eat it during the summer. It lessens the symptoms of diabetes, such as thrusting and frequent urination (Joshi *et al.,* 2011). Other medicinal applications include treating jaundice, kidney stones, and liver disorders.

Anthocyanins and flavonoids present in Jamun act as antioxidants, fighting against bacteria, viruses, and fungi (Bukya and Madane, 2018). Jamun, being of a non-climacteric nature, presents harvesting challenges leading to post-harvest losses. The fruit is susceptible to damage during harvesting, contributing to 5-10% losses. Post-harvest storage of Jamun is typically limited to one to two days at ambient temperature, highlighting the need for innovative preservation methods (Ghosh *et al.,* 2017). While Jamun is consumed in considerable quantities, its limited processing into value-added products presents an opportunity for creating diverse and exportable products (Panda *et al.,* 2019).

Traditional jams, with 65% soluble solids, are prevalent in markets, but their high sugar content raises concerns about health implications, including weight gain and diabetes.

As consumer awareness increases about diet and health, there is a demand for convenient, high-quality, and low-calorie foods. The introduction of low-calorie

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sweeteners addresses the health concerns associated with traditional jams. Artificial sweeteners, such as xylitol, sorbitol, maltitol, aspartame, acesulfame-K, cyclamate, stevioside, sucralose, and saccharin, can replace or complement sucrose. This substitution not only reduces calorie content but also addresses the texture, structure, and taste of the product (Renard *et al.,* 2016).

Stevia, derived from the *Stevia rebaudiana* plant, offers a natural sugar substitute approximately 250 to 300 times sweeter than sucrose (Panda *et al.,* 2019). Its extracts, including steviol glycosides, have been explored for their potential health benefits, particularly in managing glucose levels in diabetes.

Sucralose, a non-caloric sweetener derived from sucrose, provides an intense sweetness profile without contributing nutrients to the body. Its stability and taste similarity to sucrose make it a popular choice in various food applications. By weight, sucralose is approximately six hundred times sweeter as compared to sucrose (Imberti *et al.,* 2019).

2. MATERIALS AND METHODS

2.1. Preparation of Jam

Fully riped and spoilage-free phalsa and jamun fruits were washed with water. Phalsa and jamun fruits were blanched individually. Then seeds and pulp were removed manually. The homogenization of pulp was done and then passed through sieves. To preserve pulp sodium benzoate, citric acid, and potassium metabisulphite were added. The jam was prepared according to the methodology given by Jribi *et al.* (2021). The low-caloric phalsa jamun mixed fruit jam was prepared by using various concentrations of stevia and sucralose.

Six treatments of jam were prepared, control treatment was prepared with sucrose. The other treatments were made with various ratios of stevia and sucralose powder. Phalsa and jamun pulp were blended in sorbitol and then filtered with a muslin cloth. Heating of phalsa and jamun pulp was done at 105 ºC along with continuous stirring. A drop test was done to check the consistency of the jam. After reaching the required consistency, sweeteners, color, citric acid, and flavor were added to the jam. After cooling to 37 ºC, the jam was stored in glass jars.

Table 1: Treatment Plan for Low-Caloric Phalsa Jamun Mixed Fruit Jam

Treatments	Sugar (%)	Stevia (%)	Polysucralose (%)
T_o	100	0	0
T_1	0	100	0
T_2	0	0	100
T_3	0	50	50
T_4	0	75	25
T_5	0	25	75

2.2. Physicochemical Analysis

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2.2.1. pH

The pH of the phalsa jamun blended jam samples was tested with a digital glass electrode pH meter. Before measuring the pH of the samples, pH 4 and pH 7 buffer solutions were used to calibrate the meter (AOAC, 2019).

2.2.2. Titratable Acidity

The titratable acidity of the samples was measured according to the method described by Nwosu *et al.* (2013). 1g of sample was taken and then diluted with distilled water to 20 ml. Then the sample was titrated with 0.1 N NaOH using phenolphthalein as an indicator. The endpoint was the appearance of a pink color, which persisted for a few seconds. The titratable acidity can be calculated as:

$$\text{Acidity (as \% anhydrous CA)} = \frac{0.0009 \times \text{volume of 0.1N NaOH used}}{\text{Weight of the sample}} \times 100$$

2.2.3. Total Soluble Solids

The total soluble solids of samples were measured according to the method described by Solebo *et al.* (2011). A digital refractometer was used to determine the total soluble solid of jam in ^{O}Brix. The samples of jam were placed on the lens of the refractometer, which was standardized to zero by using distilled water. The final average reading was noted in ^{o}Brix.

2.3. Antioxidant Analysis

Sample Extraction

Fresh pulp from phalsa and jamun fruits was homogenized, extracted in 80% of acetone for about 90 minutes at 20 degrees in a sample-to-solvent ratio of 1:10, shaken at 200 rpm, and then centrifuged at almost 3500 rpm for almost 10 minutes. Until further examination, the supernatant was taken and kept for analysis at 20 °C.

2.3.1 Ferric Reducing Antioxidant Property (FRAP)

Ferric-reducing antioxidant power of blended jam was determined by the procedure described by Saikia *et al.* (2016). 3 mL of FRAP solution was mixed with a 40 mL aliquot of appropriately diluted extracted sample. After 4 minutes of incubation at 37 °C, the absorbance of the reaction mixture was measured at 593 nm using a UV–vis spectrophotometer in comparison to a blank made with distilled water. The FRAP reagent was prepared using 2.5 mL of 10 mM 2,4,6-tripyridyl-s-triazine (TPTZ) solution in HCl, 25 mL 0.3 M sodium acetate buffer, and 2.5 mL of 20 mM ferric chloride. Utilizing ferrous sulfate aqueous solution (1–10 mM), a calibration curve was created. FRAP values were calculated as mM ferrous equivalent per 100 grams of the sample.

$$\text{FRAP value} = [(A_1 - A_0)/(A_c - A_0)] \times 2$$

Where, A_1 = absorbance of the sample

A_c = absorbance of the control

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A_0 = absorbance of the blank

2.3.2. Total Phenolic Content

TPC was calculated by the Folin-Ciocalteau methodology described by Oksuz *et al.* (2015). To determine the total phenolic content 100 µL extracted sample was taken in a conical flask, Folin-Ciocalteu reagent (750 µL) was added to the flask, and a stay time of 6 minutes was given to the flask. 750µL of sodium carbonate was then added. Each flask was filled with 12 mL distilled water, which was placed in the dark for 1.5 hours. The absorbance was taken at a wavelength of 765 nm with the help of a spectrophotometer. The standard solution (gallic acid) was run and absorbance was noted. Samples were used in triplicate for the exact measurement of TPC. The following equation was used to determine the total amount of phenolic compounds (GAE).

$$TPC = \frac{Concentration\ of\ gallic\ acid\ \left(\frac{mg}{ml}\right) \times volume\ of\ extract(ml)}{weight\ of\ jam\ sample(g)}$$

2.3.3. DPPH (2,2-diphenylpicrylhydrazyl) Assay

DPPH radical scavenging method was performed by the method described by Rababah *et al.* (2011). Approximately 2 g of each sample was extracted in triplicate with 50 mL of methanol for 60 minutes at 60°C. 500 µL of sample extracts were treated with 0.2 mL of DPPH solution. The extracting solvent was added to the mixture and made a total volume of 4.0 mL. The mixture was properly mixed and let to stay in the dark for about 30 minutes. The absorbance of the sample was then measured at 515 nm against a blank. The radical scavenging activity was shown as a percentage of inhibition using the formula

$$\text{inhibition (\%)} = \frac{A_{control} - A_{sample}}{A_{control}} \times 100$$

Where,

$A_{control}$ = absorbance of the control

A_{sample} = absorbance of the sample

2.4. Microbial Analysis of Jam

2.4.1. Total Plate Count

The Viable count of microbes was measured by total plate count method by Brandao *et al.* (2018).

Media and Glassware Sterilization

In the autoclave, glassware was sterilized at 121 ^oC for 90 minutes. The media was also sterilized in that autoclave at the same conditions.

Procedure

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The test tubes were filled with 9 ml peptone water then 1g sample was added to the first test tube. Then dilution was done as 1 ml mixer of the first test tube poured into the second test tube and this process was continued till 9 dilutions. Pouring medium was done on sterile petri dishes. 50 milliliters of sample was taken from each dilution. The samples were equally distributed in each petri dish after gently mixing with the spreader. In each petri dish, solidification took place.

Incubation Procedure

Petri plates were placed in an incubator for 24 hours at 37°C along with the condensation prevention and inversion of these dishes were also done at the same time. The incubation procedure was finished after 24 hours, and the colonies developed in petri dishes were counted using a colony counter.

Calculations

Total plate count= Total plate count dilution factor x Average number of colonies

2.5. Sensory Evaluation

Sensory evaluation of phalsa jamun blended jam was assessed for color, flavor, taste, texture, and overall acceptability by using the 9-point hedonic scale (Begum *et al.* 2018). Each sample was served to graduates from NIFSAT, UAF, who were asked to rate the blended jam based on a set of sensory qualities. The panelists were instructed to select the provided attribute based on their preferences, and scores were assigned using a 9-point hedonic scale.

2.6. Statistical Analysis

Data obtained after performing analysis was analyzed statistically by following the methods described by Montgomery (2017). The result of each parameter was statistically analyzed using the software Minitab 18, two-way ANOVA with a factorial design, and a significance level of 0.05.

3. RESULTS AND DISCUSSION

3.1. Physicochemical Analysis of Jam

3.1.1. pH

pH is an essential physiochemical parameter in jam manufacturing. The pH of jam, jellies, and marmalade is critical in the gel formation process. Its optimal level is critical in the shelf life of food products because of their acidity or basicity. The statistical variance of pH revealed that the treatment effect was highly significant. During 90 days of storage, the pH of each sample decreases. The results of treatments (Table 2) showed the mean pH values of low-caloric phalsa and jamun jam with stevia and polysucralose. The pH ranged between 3.77 to 3.98 on the first day of storage and dropped from 3.37 to 3.71 after 30 days. After 90 days of storage, the pH of T_O was reduced to 2.61, and the treatment T_5 with stevia and sucralose concentrations of 25% and 75% also showed a decrease in pH and it ranges from 3.77 to 2.53, which was the least among all the

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treatments. The pH of T_1, T_2, T_3, and T_5 was also reduced during storage days, with values decreasing from 3.78 to 2.61, 3.91 to 2.80, 3.94 to 3.83, and 3.98 to 2.9. In all treatments, pH declines while storage days increase, indicating that storage days significantly affect pH. pH is an essential physiochemical parameter in jam manufacturing. These findings were further supported by the study of Bhardwaj *et al.* (2016) who made guava and jamun mixed fruit jam and found a substantial reduction in the pH of the guava-jamun jam after three months of storage. The pH drop in blended products could be related to chemical deterioration. Bukya and Madane (2018) made jamun jam and found that the pH dropped from 3.70 to 3.55, 3.35, 3.43, and 3.02. The pH drop could be caused by the decomposition of organic acids. Ullah *et al.* (2018) found that the pH of the apple and carrot blended jam falls as storage proceeds. During the 90-day storage period, the pH of the jam dropped by up to 5.95 percent.

Table 2: Mean square for pH of Low Caloric Phalsa Jamun Jam

Treatments	Storage days				
	0	30	60	90	Mean
T_o	3.85±0.02	3.52±0.02	3.12±0.02	2.61±0.02	3.30^d
T_1	3.78±0.02	3.44±0.02	3.06±0.02	2.61±0.01	3.22^e
T_2	3.91±0.01	3.60±0.01	3.14±0.02	2.80±0.01	3.36^c
T_3	3.94±0.01	3.66±0.01	3.21±0.01	2.83±0.01	3.41^b
T_4	3.98±0.01	3.71±0.01	3.32±0.01	2.91±0.01	3.47^a
T_5	3.77±0.01	3.37±0.01	3.00±0.01	2.53±0.01	3.17^f
Mean	3.87^a	3.55^b	3.13^c	2.73^d	

T_o=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.1.2. Total Soluble Solids (TSS)

TSS stands for "Total Soluble Solids," in the context of jam, TSS refers to the total amount of soluble solids present in the jam, primarily consisting of sugars, organic acids, and other soluble compounds. Mean values of Total Soluble Solids showed that the TSS has a highly significant effect on all the treatments (Table 3). The mean values of the control and low-caloric jams were considerably different from one another. The T_o control treatment, which did not contain stevia or sucralose, had the greatest degree brix mean value of 68.77°, while T_2 had the lowest mean value of 47.38° among the other treatments, and T_1, T_3, T_4, and T_5 were 49.02°, 48.81°, 48.88°, and 47.76° individually. Garg *et al.* (2019) developed jam using Indian blackberries. He discovered that the TSS of the jam increases throughout storage. The TSS content of jam was found to be between 64.30 and 66.68 °Brix. Muhammad *et al.* (2008) found that the TSS of diet apple jam increased after storage from 11 to 25 °Brix for treatments that used artificial sweeteners instead of sugar. Javanmard and Endan (2010) developed strawberry jam and described that the TSS of the jam was increased from 66.5 to 68.7°Brix during the 60 storage days.

Table 3: Mean Square for TSS (ºBrix) of Low Caloric Phalsa Jamun Jam

Treatments	Storage days	

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	0	30	60	90	Mean
T_o	68.50±0.05	68.72±0.03	68.81±0.02	69.02±0.03	68.77^a
T_1	48.87±0.03	48.97±0.02	49.07±0.03	49.17±0.03	49.02^b
T_2	47.14±0.04	47.27±0.03	47.42±0.02	47.67±0.03	47.38^f
T_3	48.96±0.03	48.67±0.03	48.96±0.03	49.11±0.02	48.81^d
T_4	48.62±0.03	48.79±0.02	48.97±0.02	49.14±0.04	48.88^c
T_5	47.52±0.02	47.66±0.03	47.86±0.01	48.00±0.01	47.76^e
Mean	51.53^d	51.68^c	51.85^b	52.02^a	

T_o=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.1.3. Titratable Acidity

Titratable acidity is a measure of the amount of acid present in a substance that can be neutralized by a standard base solution. In the context of jam, it refers to the total amount of acid compounds (e.g., citric acid, malic acid) present in the jam. Mean values (Table 4) showed that the titratable acidity has a highly significant effect on all the treatments. Treatment and storage days interaction results were also quite significant. Similarly, storage days have a considerable effect on titratable acidity. T_5 prepared with stevia 25% and sucralose 75% has the highest mean value of 0.19, whereas T_o has the lowest mean value of 0.06 on 0 day. The results of all treatments increased after 3 months of storage. T_5 has the highest value after 3 months and T_o has the lowest value. T_5 scores increased from 0.19 to 0.55 after 90 days of storage. This increase in titratable acidity of the low-caloric jam was due to a decrease in pH during the storage period and the results suggested that the formation of acid by degradation of ascorbic acid accounted for an increase in acidity during storage. Bukya and Madane (2018) developed Jamun jam and noticed an increase in acidity with an increasing storage time of up to 90 days at room temperature. This increase in titratable acidity was due to a decrease in pH during the storage period and the results suggested that the formation of acid by degradation of ascorbic acid accounted for an increase in acidity during storage. Karanjalker *et al.* (2013) agreed with the present result and concluded that the TA increases rapidly in guava jam during storage.

Table 4: Mean Values for Acidity (%) of Low Caloric Phalsa Jamun Jam

Treatment	Storage days				
	0	30	60	90	Mean
T_o	0.06±0.02	0.20±0.01	0.29±0.01	0.48±0.03	0.26^e
T_1	0.09±0.01	0.23±0.02	0.33±0.02	0.52±0.01	0.29^d
T_2	0.14±0.02	0.26±0.01	0.35±0.01	0.53±0.01	0.32^c
T_3	0.10±0.01	0.21±0.01	0.34±0.01	0.52±0.02	0.29^d
T_4	0.16±0.01	0.30±0.02	0.39±0.02	0.53±0.02	0.34^b
T_5	0.19±0.01	0.33±0.01	0.41±0.01	0.55±0.01	0.37^a
Mean	0.12^d	0.25^c	0.35^b	0.52^a	

T_o=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.2. Antioxidant Analysis

3.2.1. Total Phenolic Content (TPC)

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Total phenolic content (TPC) refers to the total concentration of phenolic compounds present in a sample, such as a food product or plant extract. Means values of TPC of all the treatments illustrate that the TPC has a highly significant effect on the treatments (Table 5). Similarly, Total Phenolic Content (TPC) measurements show a significant impact on storage days. Total phenolic content was measured as mg gallic acid equivalent per kg FW. The treatment T_3 containing stevia and sucralose in equal amounts had the highest TPC mean value which was 149.39 GAE while the T_5 was the lowest among other treatments with mean values of 141.94 GAE. The TPC data obtained revealed that the TPC was decreased during the storage interval in each sample. Oancea and Calin (2016) prepared cherry jam and observed a 21% decrease in total phenolic content during storage. The TPC reduces during storage because the self-formation of molecules reduces the amount of hydroxyl group to react in the Folin Ciocaltrean colorimetric assay.

Table 5: Mean Values for TPC (mg/g GAE) of Low Caloric Phalsa Jamun Jam

Treatments	Storage days				
	0	30	60	90	Mean
T_o	162.43±0.41	152.55±0.57	148.42±0.40	124.18±0.19	146.89^c
T_1	163.18±0.28	155.01±0.03	150.80±0.04	126.25±0.23	148.81^b
T_2	160.21±0.26	150.84±0.24	144.98±0.50	120.17±0.25	144.05^d
T_3	164.02±0.42	155.35±0.22	151.30±0.30	126.89±0.13	149.39^a
T_4	158.13±0.43	149.75±0.26	144.05±0.05	118.47±0.45	142.60^e
T_5	157.50±0.01	148.75±0.25	143.83±0.35	117.69±0.20	141.94^f
Mean	160.91^a	152.04^b	147.23^c	122.27^d	

T_0=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.2.2. DPPH Assay

Antioxidants are compounds that can slow the deterioration of stored foods. Vitamins and phenolic compounds can act as natural antioxidants. Total antioxidant levels varied significantly among treatments, as indicated in (Table 6). Similarly, storage days had significant impacts on total antioxidant content. Table 6 displays the antioxidant mean values. Because both fruits are high in antioxidants, the average mean value for antioxidants in the treatments is very similar. The highest mean value was noted as 29.91% % by T_1 closely resembling to 29.26 % by T_3.

Maximum mean value of antioxidants was found to be 43.35% at day 0, which declined to 18.36% on the 90th day of storage. Kapoor *et al.* (2021) determined the antioxidant potential of rice-based jamun powder and it was found 44.01%. Jaiswal *et al.* (2015) prepared jamun jam and its DPPH assay was found to be 47.5%, which decreases upon storage.

Table 6: Mean Values for DPPH (%) of Low Caloric Phalsa Jamun Jam

Treatments	Storage days	

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	0	30	60	90	Mean
T_o	42.40±0.13	33.03±0.05	23.47±0.03	17.93±0.07	29.21^b
T_1	43.35±0.09	33.95±0.09	23.96±0.02	18.36±0.10	29.91^a
T_2	41.45±0.06	32.95±0.07	22.17±0.02	16.81±0.07	28.34^d
T_3	42.53±0.03	33.14±0.05	23.53±0.06	17.86±0.06	29.26^b
T_4	42.52±0.04	32.23±0.04	22.48±0.03	17.50±0.06	28.68^c
T_5	42.08±0.08	31.94±0.05	21.45±0.04	16.12±0.58	27.90^e
Mean	42.37^a	32.87^b	22.84^c	17.43^d	

T_0=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.2.3. Ferric Reducing Antioxidant Power Assay (FRAP)

The treatments and storage have a significant effect on the FRAP value, Furthermore, the FRAP value was significantly impacted by storage days. Additionally, a significant effect on the FRAP value was also shown by the interaction between treatments and storage days. The mean table 7, on the other hand, revealed a progressive reduction in the FRAP value from day zero to day 90. The highest FRAP value of T_4 was 7.36 µmol Fe/100mL at day 0, which reduced to 3.96 µmol Fe/100mL; the lowest FRAP value was T_2, which decreased from 7.29 to 3.86 during 3 months of storage. Jaiswal *et al.* (2015) made jamun jam and also concluded that the FRAP content decreased with storage. Naz *et al.* (2021) investigated the physicochemical changes in roselle-pineapple jam. The antioxidant ability of jam was tested using ferric reducing power, which declines with storage.

Table 7: Mean Values for FRAP (µmol Fe/100mL) of Low Caloric Phalsa Jamun Jam

Treatments	Storage days				
	0	30	60	90	Mean
T_o	7.36±0.03	6.60±0.05	5.35±0.04	3.96±0.02	5.82^b
T_1	7.39±0.05	6.80±0.05	5.43±0.02	4.07±0.03	5.93^a
T_2	7.29±0.03	6.50±0.05	5.25±0.03	3.86±0.03	5.72^c
T_3	7.40±0.05	6.90±0.04	5.45±0.03	4.01±0.02	5.94^a
T_4	7.40±0.02	6.92±0.06	5.50±0.05	3.92±0.02	5.94^a
T_5	7.19±0.03	6.41±0.03	5.17±0.03	3.78±0.02	5.64^d
Means	7.34^a	6.69^b	5.36^c	3.94^d	

T_0=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.3. Microbial Analysis of Jam

3.3.1. Total Plate Count

Fruit jams are susceptible to microbial deterioration due to the intermediate humidity. Jams are processed products with low water activity up to 0.86 that prevent the formation of the majority of germs. Treatments, storage days, and their interactions all had a significant effect. The mean values (Table 8) revealed that as storage days increased

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bacterial count of jams increased progressively. These findings were consistent with the findings of Aslam *et al.* (2019), who said that jamun jam may be stored for up to six months in three different packing materials: glass, plastic, and polythene. Overall means of the microbial count were noted as 4.56×10^2 CFU/g (0 days), 2.22×10^2 CFU/g (30 days), 7.81×10^2 CFU/g (60 days), and 1.09×10^4 CFU/g, at (90 days) of storage interval. Carvalho *et al.* (2013) assessed the microbiological contents of cherry jam. The findings showed that jams maintained their safety after 30 days and had an extended shelf life of up to 6 months.

Table 8: Mean Values for Total Plate Count (CFU/g) of Low Caloric Phalsa Jamun Jam

Treatments	Storage days				
	0	30	60	90	Mean
T_o	4.50±0.01	5.47±0.03	6.31±0.01	7.85±0.02	6.03^d
T_1	3.67±0.01	4.75±0.01	5.24±0.01	6.55±0.02	5.05^f
T_2	5.45±0.01	6.35±0.02	7.47±0.02	8.23±0.02	6.78^a
T_3	4.37±0.02	5.38±0.02	6.21±0.01	7.75±0.02	5.92^e
T_4	4.63±0.02	5.57±0.01	5.49±0.01	7.96±0.02	6.16^c
T_5	4.70±0.01	5.61±0.01	6.56±0.01	7.99±0.01	6.22^b
Mean	4.55^d	5.53^c	6.38^b	7.72^a	

T_0=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.4. Sensory Evaluation

Sensory evaluation is a crucial aspect of food product development and quality control, including jam production. Sensory evaluation of phalsa jamun mixed fruit jam prepared with different concentrations of stevia and polysucralose was done by a qualified panelist. Color, flavor, taste, texture, and overall acceptability were determined by using a 9-point hedonic scale.

3.4.1. Color

Color is an important attribute for the customer as it attracts the consumer towards the products. The results have shown that treatments have high significance on color and the data interpret that the days have a significant effect on the parameter and there was a significant effect between days and treatments on this attribute. The treatment T_1 was prepared with a 100% concentration of stevia and showed the best scores among all the treatments from 8.93 to 5.85. However, treatment T_2 has the lowest score of 8.32 to 5.26. After 90 days of storage, the values dropped significantly in all the treatments. The reduction in the T_o scores was caused by the degradation of ascorbic acid and browning reaction. The means values for the color score showed in table 9. Similar findings were done by Sutwal *et al.* (2019) in low-calorie apple jam. He concluded that the color score was 7.55 at zero day and reduced to 7.33 after 90 days of storage.

Table 9: Mean Values for Color of Low Caloric Phalsa Jamun Jam

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Treatments	Storage days				
	0	30	60	90	Mean
T_o	8.52±0.02	7.75±0.02	6.63±0.02	5.51±0.02	7.10[d]
T_1	8.93±0.02	8.27±0.02	6.98±0.02	5.85±0.01	7.51[a]
T_2	8.32±0.02	7.51±0.01	6.52±0.02	5.26±0.01	6.90[f]
T_3	8.51±0.01	7.69±0.01	6.74±0.01	5.52±0.02	7.11[c]
T_4	8.82±0.02	8.00±0.02	6.75±0.02	5.62±0.02	7.30[b]
T_5	8.41±0.02	7.62±0.02	6.56±0.01	5.42±0.02	7.00[e]
Mean	8.58[a]	7.81[b]	6.70[c]	5.53[d]	

T_o=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.4.2. Flavor

Flavor is one of the key sensory attributes of jam and refers to the overall taste and aroma experienced when consuming the product. It is the combination of taste and smell that creates the unique flavor profile of jam. The mean values for the flavor parameter have been shown in Table 10. The maximum mean value was found in treatment T_1 which contains 100% stevia while the minimum mean value was observed in T_2 scores 100% sucralose in the phalsa jamun jam. The data showed that in all treatments flavor score decreases as storage proceeds. Broomes and Badrie (2010) found out the flavor scores decrease upon storage in low-calorie roselle jam.

Table 10: Mean Values for Flavor of Low Caloric Phalsa Jamun Jam

Treatments	Storage days				
	0	30	60	90	Mean
T_o	8.61±0.01	7.90±0.02	6.62±0.02	5.51±0.02	7.16[c]
T_1	8.90±0.02	8.26±0.02	7.12±0.02	5.92±0.02	7.55[a]
T_2	8.41±0.02	7.62±0.02	6.60±0.01	5.53±0.01	7.03[e]
T_3	8.10±0.02	7.53±0.02	6.72±0.02	5.35±0.01	6.93[f]
T_4	8.84±0.02	7.94±0.01	6.86±0.01	5.52±0.02	7.29[b]
T_5	8.51±0.02	7.76±0.01	6.64±0.04	5.68±0.01	7.15[d]
Mean	8.56[a]	7.84[b]	6.76[c]	5.59[d]	

T_o=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.4.3. Taste

The taste of jam refers to the specific and distinctive sensory sensation experienced on the tongue when consuming the product. According to Table 11, T_1 which contains 100% stevia has the highest score of 8.97 while T_2 which is 100% sucralose with phalsa jamun-based jam has the lowest score of 8.31 on day 0. During 90 days of the storage period, there was a gradual decrease in scores for all treatments but the difference was significant. The taste score decreases because there might be changes in acidity, pH, and sugar content or sweeteners might have an after-taste on storage. The results were

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supported by Sutwal *et al.* (2019) who concluded that the low-calorie apple jam taste scores were also decreased on storage.

Table 11: Mean Values for Taste of Low Caloric Phalsa Jamun Jam

Treatment	Storage days				
	0	30	60	90	Mean
T_o	8.60±0.06	7.79±0.01	6.69±0.02	5.45±0.01	7.13^d
T_1	8.97±0.01	8.21±0.02	7.04±0.02	5.84±0.02	7.52^a
T_2	8.31±0.02	7.57±0.02	6.44±0.02	5.32±0.02	6.91^e
T_3	8.39±0.01	7.60±0.02	6.83±0.03	5.41±0.02	6.29^f
T_4	8.91±0.02	8.02±0.02	6.82±0.02	5.63±0.02	7.34^b
T_5	8.45±0.02	7.90±0.01	6.77±0.02	5.55±0.02	7.17^c
Mean	8.09^a	7.85^b	6.76^c	5.53^d	

T_0=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.4.4. Texture

Texture refers to the physical and sensory characteristics of a food product as perceived by the sense of touch and mouthfeel when consumed. In the context of jam, texture encompasses various attributes that define its consistency, smoothness, and mouthfeel. The result of the study and its mean values of phalsa jamun jam was shown in Table 12. The data in the table described that the T_2 which contains 100% sucralose had the lowest mean value of 6.57 among all the other treatments. There was a gradual decrease in the scores for all the treatments while storage. Abolila *et al.* (2015) concluded that the jamun jam texture scores were also decreased on storage.

Table 12: Mean Values for Texture of Low Caloric Phalsa Jamun Jam

Treatments	Storage days				
	0	30	60	90	Mean
T_o	8.67±0.02	7.83±0.02	6.72±0.02	5.36±0.02	7.14^c
T_1	8.93±0.02	8.32±0.02	7.24±0.02	5.95±0.02	7.61^a
T_2	8.26±0.01	7.66±0.01	6.56±0.01	5.53±0.03	7.00^f
T_3	8.35±0.01	7.52±0.02	6.79±0.01	5.54±0.04	7.05^e
T_4	8.77±0.02	7.90±0.01	6.95±0.02	5.75±0.02	7.34^b
T_5	8.42±0.02	7.80±0.02	6.51±0.01	5.71±0.02	7.11^d
Mean	8.57^a	7.84^b	6.80^c	5.64^d	

T_0=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

3.4.5. Overall Acceptability

Overall acceptability means rating the most suitable item in terms of all sensory attributes. The Table 13. Showed the mean values for the overall acceptability of phalsa jamun mixed fruit jam. The treatment T_1 which contains 100% stevia has the highest scores for overall acceptability which was 8.93 at the 0 day but the scores dropped gradually while storage. The data revealed that the T_2 has the lowest score among all the treatments.

Dropped in overall acceptability was due to the decrease in all the other organoleptic parameters like color, flavor, taste, and texture. Ali *et al.* (2018) prepared low-caloric apple jam and concluded that jam prepared with stevia had the best overall acceptance among other jams prepared with aspartame and sucralose.

Table 13: Mean Values for Overall Acceptability of Low Caloric Phalsa Jamun Jam

Treatments	Storage days				
	0	30	60	90	Mean
T_o	8.64±0.01	7.81±0.01	6.62±0.02	5.55±0.02	7.15^c
T_1	8.93±0.02	8.32±0.02	7.24±0.02	5.95±0.02	7.54^a
T_2	8.96±0.01	8.26±0.01	7.01±0.01	5.93±0.01	6.82^f
T_3	8.31±0.01	7.51±0.01	6.70±0.02	5.61±0.01	7.03^e
T_4	8.82±0.01	7.92±0.02	6.87±0.02	5.65±0.02	7.31^b
T_5	8.48±0.02	7.79±0.01	6.65±0.01	5.56±0.01	7.12^d
Mean	8.58^a	7.80^b	6.73^c	5.55^d	

T_0=100% sugar, T_1=100%stevia, T_2=100%sucralose, T_3=50%stevia+50%sucralose, T_4=75%stevia+25%sucralose, T_5=25%stevia+75%sucralose

4. CONCLUSION

The study found that increasing the storage period increased TSS, titratable acidity, and bacterial count while decreasing antioxidant activity and pH was observed in all blends. However, all of the blends maintained their acceptability after three months of storage. The jam made by blending phalsa and jamun with stevia 100% was the most preferred among all the blends, attaining the highest sensory score in overall acceptability.

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