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Lactulose fortification in guava preserves: Effect on nutritional quality

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ABSTRACT

This study examined the lactulose-fortified low-calorie guava preserves. The results showed that sucrose, used as a sweetener in guava preserves, could be partially substituted by lactulose without significantly affecting the overall quality of the preserves. The physicochemical properties, antioxidant activity, and sensory evaluation of guava preserves with substitute lactulose were evaluated. The main aim of this study was to develop prebiotic guava preserves from two guava cultivars, namely, Safeda and Chittidar. The guava preserves without lactulose were used as control samples which contained 50% w/w sucrose of pulp, while lactulose-treated preserves replaced sucrose with 25%, 50%, and 75% w/w of lactulose. The finding showed that prebiotics did not significantly differ between control and treated samples. The range of ascorbic acid content of guava preserves was 98.2-102.6 mg/100g. Lactulose did not show a statistically significant effect on the level of ascorbic acid in guava preserves. The mineral content and antioxidant properties of guava preserves supplemented with lactulose were higher than those not supplemented with lactulose. The guava preserves with 50% lactulose were most accepted.

Keywords: Antioxidant activity, Ascorbic acid, Lactulose, Physicochemical properties, Prebiotics, Preserve

Introduction

Besides that, guava is a seasonal fruit with a short shelf life. This fresh produce of fruit is more susceptible to disease organisms because of the high respiration rate after harvesting. Guava is a seasonal fruit and having a short shelf life. Therefore, to make it available throughout the year, we can develop some functional food using guava, like guava preserve, etc. The traditional method to increase the nutritional quality of fruit products is to incorporate dietary ingredients which enhance the nutritional quality of products. New functional components such as probiotics and prebiotics like lactulose and fructooligosaccharides are being used in this direction (Renuka *et al.,* 2009). Prebiotic materials aid the growth and activity of bacterial species, especially probiotics in the gut. Prebiotics cherish the favorable gut microbes, stimulate their proliferation, and increases their action, such as *Lactobacillus* and *Bifidobacterium* (Juskiewicz and Zdunczyk, 2002; Rastall, 2010). Lactulose has all the above prebiotic properties, and it is a non-digestible disaccharide widely used in the pharmaceutical industry to make medicine for acute and chronic constipation. It is sweet in taste, which is very similar to sucrose. They help to prevent cardiovascular disease by decreasing total cholesterol and lipid in the serum (Renuka *et al.,* 2009). Prebiotics maintain the colon's health because they consist of dietary fiber, which is not absorbed by the intestine and increases fecal matter, and intestinal transit time, which relieves constipation and improves the general health of humans. It absorbs carcinogenic matter, which reduces the risk of colorectal cancer. Lactulose fermentation occurs by colonic bacteria, which produces small-chain fatty acids (SCFA) such as Acetate, Propionate, and Butyrate. These SCFA, especially butyrate, slow the growth of cancer cells and activate apoptosis in colon cancer cells. This process occurs through secondary chemoprevention. Which reduces the burden of carcinogens and decreases the number of mutations, thereby reducing cancer risk (Roy *et al.,* 2009; Scharlau *et al.,* 2009).

Thus, this study aims to develop the guava preserve by two guava cultivars pulp with prebiotic lactulose, to meet new consumer demand and maintain good colon health. This work also evaluates the proximate composition and antioxidant properties of guava preservation.

Materials and Methods

Development of Guava Preserve with Lactulose

Two selected guava cultivars were "Safeda and Chittidar" procured from Allahabad local market. Conventional guava preserve was prepared according to the procedures described by Menezes et al. (2009) to be used as a control for comparing guava preserves with lactulose in Table 1. While in treatments, sugar was replaced with lactulose at different concentration labels (11.25-33.5%).

Table 1. Formulation of conventional guava preserves and prebiotic guava preserves with lactulose.

Treatments		Ingredients (%)
Safeda	Chittidar	
ST_0	CT_0	50% guava pulp, 45% sugar, and 5% pectin
ST_1	CT_1	50% guava pulp, 33.75% sugar, 11.25% lactulose and 5% pectin
ST_2	CT_2	50% guava pulp, 22.5% sugar, 22.5% lactulose and 5% pectin
ST_3	CT_3	50% guava pulp, 11.25% sugar, 33.75% lactulose and 5% pectin

S=Safeda, C=Chittidar

The guava fruits were washed in running water and then sanitized in a 1% sodium hypochlorite solution for 2 min. The peel was removed using a peeler and cut into small pieces for blanching at 100°C. The Inalsa mixer grinder was used to make the pulp and pass it through a 6 mm mesh sieve. For conventional guava preserves, guava pulp and sugar were processed in an open pan, and the cooking was interrupted when it reached 75% soluble solid on the refractometer scale. To formulate the prebiotic guava preserves, guava pulp and sugar were cooked in an open pan. Until it reached 45% soluble solids, the lactulose and pectin were added at 80°C under constant stirring. The citric acid was added to the mixture at the end of the cooking process in all the treatments (Figure 1). Then all guavas preserve formulations were spread on a plate, cut into equal sizes, and dried in a tray dryer at 60°C for 4 hrs., then wrapped into a transparent film of polypropylene (Figure 2).

Physicochemical Analysis

The analysis of the levels of moisture, protein, ash, fat, and crude fiber was done according to the guidelines of the Association of Official Analytical Chemists (AOAC, 2016). The percentage of carbohydrate content was determined by the formula method and titratable acidity by the titrimetric method and expressed as percent citric acid (AOAC, 2016). Estimating minerals like Ca, Fe, and P were performed according to Rangana 2005 by titration and spectroscopic method, respectively.

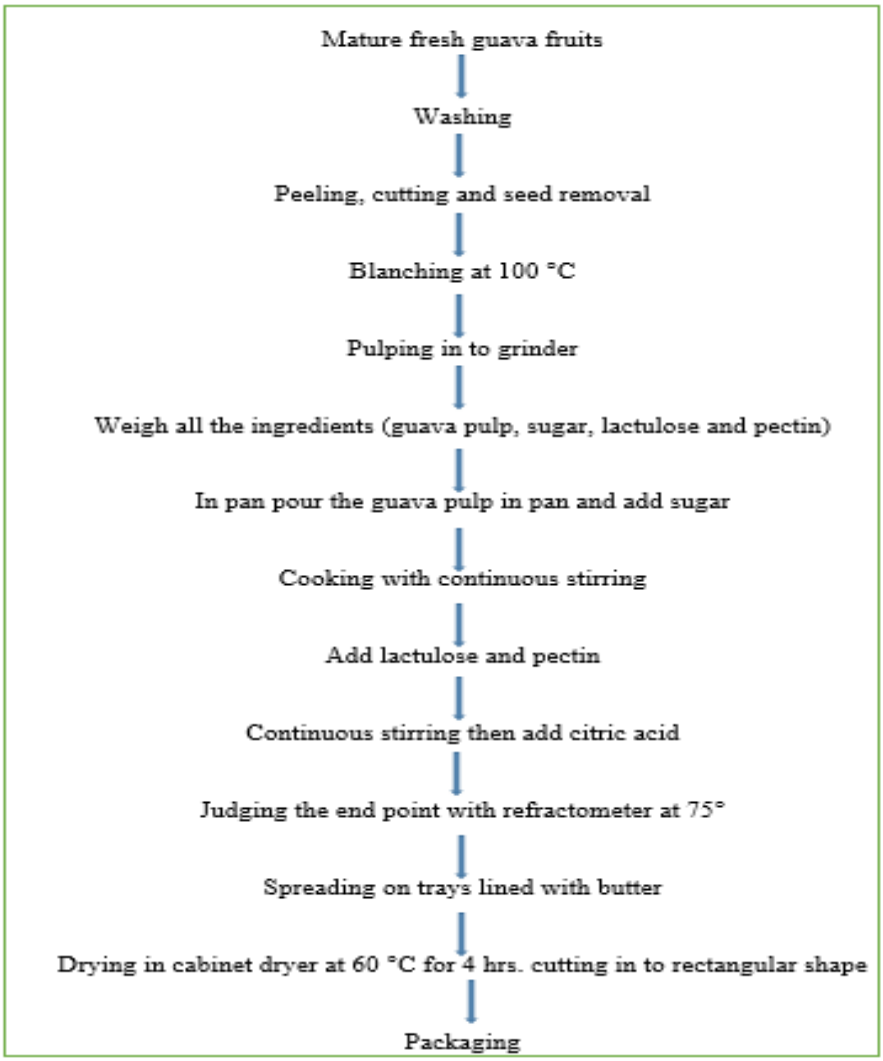
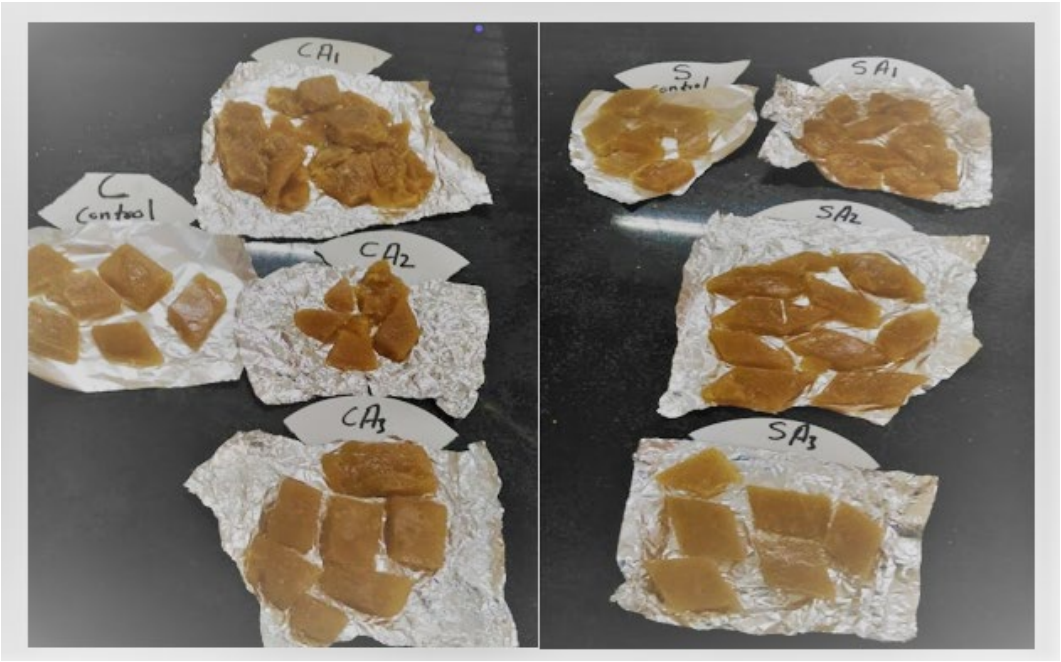


Figure 1. Flow chart of Preparation of Guava Preserve



S=Safeda, C=Chittidar, (T_0=50% guava pulp, 45% sugar, T_1= 50% guava pulp, 33.75% sugar, 11.25% lactulose, T_2=50% guava pulp, 22.5% sugar, 22.5% lactulose, T_3= 50% guava pulp, 11.25% sugar, 33.75% lactulose)

Figure 2. Guava preserve fortified with lactulose

Ascorbic Acid

Ascorbic acid was estimated by a 2, 6 dichlorophenol indophenol titration method. A 10 g sample was prepared in 3% (w/v) metaphosphoric acid, and the volume was made up to 100 mL with metaphosphoric acid. A filtered aliquot (5 mL) of the sample was titrated against standard 2, 6 dichlorophenol indophenol (2, 6 DCIP) dye solution until the pink color developed completely.

mg ascorbic acid/mL = (X - B) X (F/E) X (V /Y)

where:

X = mL for sample titration

B = average mL for sample blank titration

F = titer of dye (= mg ascorbic acid equivalent to 1.0 mL indophenol standard solution)

E = mL assayed

V = volume of the initial assay solution

Y = volume of sample aliquot titrated

Sample Preparation for Antioxidant Analysis

The extracted solution of guava preserves for phenolic content and antioxidant analysis was prepared in 80% methanol. The extraction procedure was conducted with (0.5 g) samples and 10 mL extracting solvent using an orbital shaker for 1 hour at 300 rpm, and further antioxidant analysis (TPC, DPPH, FRAP, and ABTS) were performed with this extraction.

Total Phenolic Content (TPC)

TPC was determined by Folin–Ciocalteu method (ISO 14502:2005). 1 ml of extracted solution was mixed with 5 ml of Folin–Ciocalteu reagent, followed by the addition of 4 ml of sodium carbonate solution after 3 minutes but before 8 minutes. Subsequently, the mixture was incubated for 60 minutes in the dark, and its absorbance was measured at 765 nm. Gallic acid was used as the standard for the calibration curve. Results were expressed as milligrams of gallic acid equivalents per 100 g of sample (mg GAE/100 g of sample).

Antioxidants Properties

Percent (%) antiradical activity

The antiradical activity was determined by using the DPPH (1, 1- diphenyl 2- picrylhydrazyl) radical, according to Aquino *et al.,* (2001). The antioxidant capacity of the solvent extracts was determined through the evaluation of the free radical scavenging effect on the DPPH radical. An aliquot (100 µL) of the sample extract was mixed with 150 µL of DPPH methanolic solution. The mixture was kept in the dark for 15 minutes to incubate the mixture. Absorbance was measured later at 515 nm against a blank of methanol, and the control sample was prepared the same as above without the test sample. The percent antiradical activity was calculated using the following formula:

% Antiradical activity =

$$\frac{contol\ Absorbance - Sample\ absobance}{Control\ Absorbance} \times 100$$

Ferric-reducing antioxidant power (FRAP)

FRAP value of guava preserve was determined by using TPTZ (2,4,6-Tris (2-pyridyl)-s-triazine) reagent according to Pulido *et al.*, (2000), and the result was expressed mmol of Fe (II) equivalent/g of sample.

Iron (Fe2+) chelating activity (%) =

{1- (Abs. of sample / Abs. of control)} × 100

Antioxidant capacity determined by radical cations (ABTS)

A modified procedure was used to determine free radical scavenging activity as described by Re *et al.,* 1999. The ABTS+ stock solution (7 mM) was prepared through a reaction of 7 mM ABTS and 2.45 mM of potassium persulphate as the oxidizing agent. The working solution of ABTS+ was obtained by diluting the stock solution in ethanol to give an absorption of 0.70 ±0.02 at 734 nm. Sample extracts (10 µL) were added to 90 µL of ABTS+ solution, and absorbance was read at 734 nm at 30°C exactly 10 min after initial mixing. The percentage inhibition of ABTS+ of the test sample and known solutions of Trolox was calculated using the following formula:

% Inhibition = 100(A0–A)/A0

Where A0 is the first absorbance at 734 nm, obtained by measuring the same volume of solvent, and A is the final absorbance of the test sample at 734 nm.

Color Measurement & Analysis

The color of the preserves was measured using X-rite (Grandville, MI, USA). The color attributes, i.e., Hunter lightness (L^*), redness (a^*), and yellowness (b^*), were recorded 3 times for each sample (n=3). Additional color attributes, such as chroma, redness, whiteness value, and ΔE (total color change), were calculated with L^*, a^*, and b^*values.

$\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$

Chroma = $(a^{*2} + b^{*2})^{1/2}$

Whiteness Value = $100-[(100-L^*)^2 + a^{*2} + b^{*2}]^{1/2}$

Redness Value= a^*/ b^*

Sensory Evaluation

The sensory evaluation of guava preserves was done by 9 points hedonic rate scale, which includes color, texture, taste, flavor, and overall acceptability. The semi-trained judge's panel was selected from the Center of Food Technology, Allahabad University. They rated guava preserves from zero to nine on the scale for the above parameters.

Statistical Analysis

The incorporation of prebiotics as lactulose in guava preserve and its effect on nutritional and antioxidant properties of guava preserve were analyzed using analysis of variance (ANOVA). All the experiments were carried out in triplicate.

Results and Discussion

Physicochemical Analysis

All Guava preserves (CT0, CT1, CT2, CT3 & ST0, ST1, ST2, and ST3) (S=Safeda, C=Chittidar, (T_0=50% guava pulp, 45% sugar, T_1= 50% guava pulp, 33.75% sugar, 11.25% lactulose, T_2=50% guava pulp, 22.5% sugar, 22.5% lactulose, T_3= 50% guava pulp, 11.25% sugar, 33.75% lactulose) were analyzed for proximate composition using AOAC 2016 standard methods and results are shown in Table 2. No significant difference was observed in fat, protein, and titratable acidity of guava preserves after treatment with prebiotics. Menezes *et al.,* (2012) reported the proximate value of low-calorie guava to preserve with three different percentages of lactulose that is 16%, 19.5%, and 23% and observed no significant difference in crude fiber, protein, and fat content of guava preserves after treatment with lactulose.

Table 2. Proximate composition of guava preserves

S.No.	Treatments	Moisture (%)	Ash (%)	Tritrable acidity g/100g (as citric acid)	Fat %	Crude fiber %	Protein %	Carbo-hydrate %	Energy Kcal
1	C T0	24.76^{cd} ±4.33	0.95^{a} ±0.20	2.33^{a} ±1.2	1.84^{a} ±0.437	2.53^{a} ±0.0611	2.65^{a} ±0.116	67.27^{e} ±0.99	296.24^{g} ±1.22
2	C T1	37.53^{d} ±1.18	1.89^{abc} ±0.96	2.14^{a} ±0.94	1.75^{a} ±0.141	2.75^{ab} ±0.094	2.63^{a} ±0.105	53.45^{bc} ±0.85	240.07^{c} ±1.39
3	C T2	39.73^{bc} ±1.11	2.05^{bc} ±0.71	1.94^{a} ±0.92	1.68^{a} ±0.095	2.98^{b} ±0.125	2.67^{a} ±0.047	50.89^{a} ±0.52	229.36^{b} ±0.73
4	C T3	32.68^{ab} ±1.46	1.22^{ab} ±0.23	2.19^{a} ±1.00	1.58^{a} ±0.095	2.52^{a} ±0.375	2.68^{a} ±0.127	59.32^{d} ±1.08	262.44^{d} ±1.23
5	S T0	25.70^{ab} ±0.32	0.97^{a} ±0.013	2.01^{a} ±0.53	1.69^{a} ±0.319	2.48^{a} ±0.080	2.59^{a} ±0.082	66.59^{e} ±1.15	291.93^{f} 0.97
6	S T1	41.52^{abc} ±1.29	2.37^{c} ±0.56	2.11^{a} ±0.75	1.44^{a} ±0.362	2.61^{a} ±0.090	2.64^{a} ±0.176	49.09^{a} ±0.83	219.79^{a} ±1.31
7	S T2	39.80^{a} ±0.90	2.46^{c} ±0.45	1.95^{a} ±0.71	1.55^{a} ±0.182	2.86^{a} ±0.176	2.65^{a} ±0.075	51.45^{ab} ±0.62	227.27^{b} ±1.04
8	S T3	35.56^{a} ±0.88	1.97^{bc} ±0.49	2.17^{a} ±0.92	1.65^{a} ±0.105	2.42^{a} ±0.375	2.68^{a} ±0.152	55.72^{c} ±0.54	272.45^{e} ±2.00

Values expressed are mean ± standard deviation of the three experiments. Means in the same column with different letters were significantly different at $p<0.05$.

S=Safeda, C=Chittidar, (T_0=50% guava pulp, 45% sugar, T_1= 50% guava pulp, 33.75% sugar, 11.25% lactulose, T_2=50% guava pulp, 22.5% sugar, 22.5% lactulose, T_3= 50% guava pulp, 11.25% sugar, 33.75% lactulose)

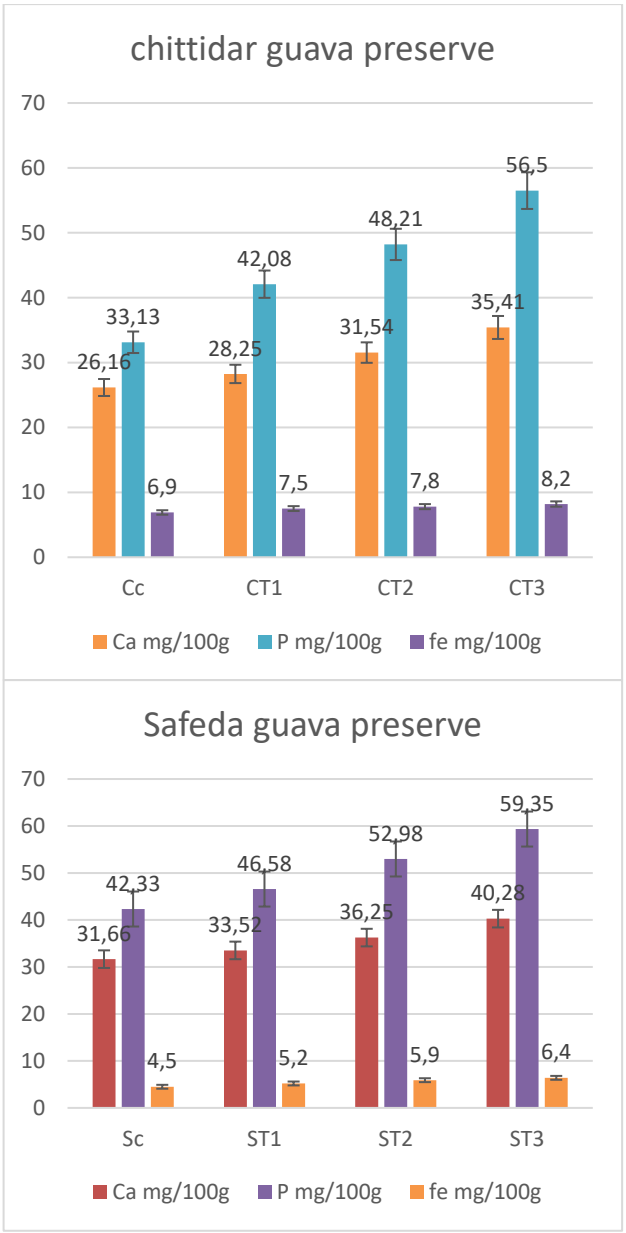
Ash content first increased and then decreased with a higher percentage of lactulose. Menezes *et al.,* (2012) also reported a decrease in the ash content of guava preserves with increased lactulose added. Kourany *et al.,* (2017) developed the protein-fortified guava bar, estimated its proximate composition, and found that the bar had 12.52%, 5.55%, 1.25%, 3.29% moisture, crude fiber, ash, and fat, respectively. Kumar *et al.,* (2017) prepared a bar with different blending ratios of papaya and guava. They found that a 50% blending ratio was best with proximate analysis of 15%, 1%, and 0.98% moisture, protein, and titrable acidity. The Carbohydrate and calorie content of guava preserves decreased after replacing sugar with lactulose in both the chittidar and safeda cultivars. The reduction in carbohydrates and calories of chittidar guava preserve ranges between 11.81-20.54 % and 11.41-18.96, respectively, by the decrease of sucrose from 11.25-33.25% w/w. This reduction range in safeda guava preserve lies between 16.32-26.28% and 6.67-24.71%, respectively. Menezes *et al.,* (2012) also reported that lactulose addition in guava preserve reduced its caloric value.

Mineral Content of Guava Preserve

The calcium, phosphorus, and iron content of guava preserves increases with an increase in the concentration of lactulose in both cultivars of guava preserves (Figure 3). The maximum increase in calcium and phosphorus was found in the chittidar cultivar, i.e., 9.25 and 23.37 mg/100g, respectively. Still, the highest increase in iron was found in the safeda cultivar with 1.9 mg/100g. There are no supportive studies to increase mineral content after incorporating lactulose. Still, in some studies, there are pieces of evidence to increase the absorption of minerals after digestion contained with lactulose. Scholz-Ahrens *et al.,* (2001) reported that prebiotics could induce the absorption and retention of many minerals like calcium, iron, and magnesium. Sekhi *et al.,* (2007) found that lactulose enhances the absorption of calcium and magnesium, and this enhancement is due to organic acids produced by the catabolization of lactulose in the large intestine.

Total Phenolic Content

Polyphenolic compounds are very important fruit constituents due to their antioxidant activities. These compounds help to neutralize free radicals, which are responsible for many degenerative diseases like cardiovascular diseases, cancer, and gastrointestinal disease (Bendary *et al.,* 2013). Patel *et al.,* (2016) reported that fresh guava extract contains 415.69 mg/100g total phenolic content (TPC). The total phenolic content in 8 samples of guava preserves was measured using the Folin-Ciocalteu method, as shown in Figure 4. The total phenolic content of these guava preserves ranged from 136.67 to 145.01 mg/100g, and this also indicates that the concentration of TPC increases with lactulose percentage increment. Correa *et al.,* (2011) reported 140.92 mg/100g TPC in guava jam for the standard formulation. They also reported 194.77 mg/100g TPC of zero sugar formulation of guava jam. Jahanzeb *et al.,* (2016) developed a cereal bar incorporated with guava pulp (15%) and reported 134.44 mg/100g total phenolic content.



S=Safeda, C=Chittidar, (T_0=50% guava pulp, 45% sugar, T_1= 50% guava pulp, 33.75% sugar, 11.25% lactulose, T_2=50% guava pulp, 22.5% sugar, 22.5% lactulose, T_3= 50% guava pulp, 11.25% sugar, 33.75% lactulose)

Figure 3. Minerals content of guava preserve

Ascorbic Acid

Ascorbic acid, or vitamin C, is a water-soluble vitamin and cannot be produced by the human body, so it is important to incorporate vitamin C through dietary sources to meet the recommended dietary allowances. The high content of vitamin C in guava makes it a super fruit. Jawaheer *et al.,* 2003 reported average ascorbic acid content of guava is 201.1 mg/100g. In making jam, guava retains only 37% of ascorbic acid due to severe heat treatment. Cooking time and cooking temperature are both factors involved in the degradation of vitamin C. Figure 3 shows a range of ascorbic acid between 98.2-102.6 mg/100g in guava preserves. This graph also represents that the ascorbic acid content increases with an increase in the concentration of lactulose. The maximum increase for both cultivars was found in the T3 treatment.

Antioxidants Properties

DPPH is a free stable radical that adopts an electron or hydrogen ion to transfer in a stable free radical in methanol or an aqueous solution and accepts an electron or hydrogen radical to turn into a stable atom or molecule (Kanwal *et al.,* 2017). The effect of all the treatments on the percent of antiradical activity of guava preserve is shown in Figure 4. The graph shows an increase in DPPH activity with a high percentage of lactulose. Correa *et al.,* 2013 reported a 65.88% DPPH value of guava jam of standard formulation. According to Correa *et al.,* 2013 DPPH determines the activity of a sample or composition that protects a lipid substrate from oxidation; the inhibition of the DPPH radical is based on the transfer of electrons from an antioxidant compound to an oxidant. The metal chelating activity, ABTS activity, and ferric reducing antioxidant power (FRAP) show similar effects to DPPH that increase with increasing lactulose percentage in the preserves. Pisoschi *et al.,* 2011 reported ABTS value of guava extract ranged between 22.3 ±0.9and 37.9 ±3.4 µM TE/ fresh mass, and the FRAP value ranged between 14.4 and 104.5mg/100 of fruit. Chen *et al.,* 2011 proposed that lactulose is an indirect antioxidant that mobilizes endogenous hydrogen production, which in turn can reduce oxidative stress in human beings.

S=Safeda, C=Chittidar, (T_0=50% guava pulp, 45% sugar, T_1= 50% guava pulp, 33.75% sugar, 11.25% lactulose, T_2=50% guava pulp, 22.5% sugar, 22.5% lactulose, T_3= 50% guava pulp, 11.25% sugar, 33.75% lactulose)

Figure 4. Ascorbic acid, Total phenolic content, and antioxidant properties of Guava preserves

Color Analysis

The lightness (L*), redness (a*) and yellowness (b*) characteristics of guava preserve samples with different percentages of lactulose are presented in Table 3. samples of guava preserves containing lactulose had significantly ($p<0.05$) higher L*values than control samples for both the guava cultivars. As we increase lactulose concentration L* value increases in both the cultivars, which reveals that the brightness of samples increases when lactulose concentration is higher. a* value (redness) was observed to be lower in control samples and higher in the T1 sample for Chittidar and Safeda cultivar control samples which also had the lowest a* value. In contrast, T2 had the highest a* value. Total color change (E) was highest in T3 for Chittidar, i.e., 8.46, and T2 for Safeda, i.e., 5.15. These guava preserves of both cultivars have the highest whiteness value, which ranges between 30-34, and the lowest redness value, which ranges between 0.46-0.47 for all the samples; these results subsequently showed that guava preserves are brighter and white in color, which is acceptable by sensorial panelists.

Sensory Evaluation

The sensorial preference scores given by the panelists to the guavas are shown in Table 4. We found a significant difference between control and treatment samples in color texture, flavor, taste, and overall acceptability. This table also reveals no significant differences between T1 and T2 along the full sensorial scale in the Chittidar cultivar. In overall acceptability, Safeda T2 received the highest score among overall treatments, 8.43 ±0.06.

Table 3. Color, Chroma value whiteness, and redness value of guava preserves

Sample	L*	+a*	+b*	E	Chroma	Whiteness value	Redness value
Control (C)	36.09±0.060^{a}	8.61±0.046 ^{a}	18.63±0.040 ^{a}	-	20.52±0.85^{a}	32.87±1.84^{ab}	0.46±0.036^{a}
CT1	37.13±0.025^{d}	12.27±0.020^{g}	25.83±0.026 ^{g}	8.14±0.44^{d}	28.59±0.73^{c}	30.93±2.46^{a}	0.47±0.020^{a}
CT2	37.18±0.025^{d}	10.97±0.055^{e}	22.92±0.035^{d}	5.01±0.44^{c}	25.41±1.10^{b}	32.23±1.94^{ab}	0.47±0.020^{a}
CT3	39.84±0.045^{f}	11.45±0.040^{f}	25.67±0.142^{f}	8.46±0.62^{d}	28.11±0.52^{c}	33.60±2.11^{ab}	0.44±0.036^{a}
Control (S)	36.11±0.051^{a}	8.60±0.085 ^{a}	18.61±0.025 ^{a}	-	20.50±0.60^{a}	32.90±0.99^{ab}	0.46±0.264^{a}
ST1	36.31±0.057^{b}	8.72±0.032 ^{b}	18.78± 0.070 ^{b}	0.28±0.07^{a}	20.71±0.74^{a}	33.03±1.10^{ab}	0.46±0.040^{a}
ST2	36.67±0.060^{c}	10.38±0.042^{d}	23.42±0.044^{e}	5.15±0.41^{c}	25.62±0.85^{b}	31.68±2.14^{ab}	0.44±0.065^{a}
ST3	38.60±0.076^{e}	9.38±0.035 ^{c}	20.01±0.045 ^{c}	2.96±0.37^{b}	22.09±0.96^{a}	34.74±1.96^{b}	0.46±0.055^{a}

Values expressed are mean ± standard deviation of the three experiments. Means in the same column with different letters were significantly different at $p<0.05$

S=Safeda, C=Chittidar, (T_0=50% guava pulp, 45% sugar, T_1= 50% guava pulp, 33.75% sugar, 11.25% lactulose, T_2=50% guava pulp, 22.5% sugar, 22.5% lactulose, T_3= 50% guava

Table 4. Sensory evaluation of guava preserve

Sample	Color	Texture	Flavor	Taste	Overall acceptability
Control (C)	7.20±0.17^{a}	7.20±0.17^{a}	7.57±0.12^{b}	7.90±0.001^{a}	7.40±0.06^{a}
CT1	8.07±0.12^{c}	8.03±0.06^{c}	8.03±0.06^{c}	7.20±0.001^{d}	8.07±0.12^{de}
CT2	8.07±0.06^{c}	8.13±0.06^{c}	7.48±0.06^{e}	7.70±0.001^{e}	8.12±0.03^{de}
CT3	7.73±0.13^{b}	7.63±0.29^{b}	7.52±0.03^{c}	7.70±0.001^{b}	7.83±0.06^{c}
Control (S)	8.20±0.17^{c}	8.07±0.12^{c}	7.91±0.03^{c}	8.43±0.001^{c}	8.17±0.06^{e}
ST1	8.58±0.14^{d}	7.77±0.06^{b}	8.12±0.01^{d}	8.03±0.001^{c}	8.03±0.06^{d}
ST2	8.65±0.09^{d}	7.52±0.04^{b}	7.23±0.03^{e}	7.73±0.06^{g}	8.43±0.06^{f}
ST3	7.20±0.17^{a}	7.27±0.12^{a}	7.65±0.06^{a}	7.43±0.06^{f}	7.70±0.001^{b}

Hedonic values (color, texture, flavor, taste, and overall acceptance)1- dislike very much; 9 - like very much

Values expressed are mean ± standard deviation of the three experiments. Means in the same column with different letters were significantly different at $p<0.05$. S=Safeda, C=Chittidar, (T_0=50% guava pulp, 45% sugar, T_1= 50% guava pulp, 33.75% sugar, 11.25% lactulose, T_2=50% guava pulp, 22.5% sugar, 22.5% lactulose, T_3= 50% guava pulp, 11.25% sugar, 33.75% lactulose)

Conclusion

The study demonstrated that guava preserved with prebiotic properties could be developed while maintaining good sensorial qualities. Prebiotics maintain good gut and colon health, and guava are high in antioxidants and vitamin C, which fight free radicals. This study reveals that when sucrose is replaced with prebiotic lactulose, carbohydrate content and calories are reduced. The development of guava preserves also minimizes post-harvest loss of fresh guava and makes it available throughout the year. Guava preserves with 22.5% w/w sucrose and 22.5% w/w have high nutritional value and higher overall acceptability. Therefore, this study represents an important contribution to the future development of healthier fruit products.

Compliance with Ethical Standards

Conflict of interests: The author declares that for this article, they have no actual, potential, or perceived conflict of interest.

Ethics committee approval: Authors declare that this study does not include any experiments with human or animal subjects.

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Disclosure: -

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