



## RESEARCH ARTICLE

# Physiochemical and Sensory Properties of Pumpkin and Strawberry Jams Fortified with Chia Seed (*Salvia hispanica* L)

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**ABSTRACT**

Supplementation of jams with functional ingredients is one of the methods to develop healthier jams. The aim of this research was therefore to develop functional jams supplemented with chia seed (CS). Five formulations of two types of jams were selected (pumpkin jam [PJ] and strawberry jam [SJ]) with different levels (0, 1.5, 3, 4.5, and 6%) of CS were added. The jams were assessed chemically, sensorial, and nutritionally using inductively coupled plasma optical emission spectrometry. The results showed that the introduction of CS into PJ significantly increased protein, ash, and cellulose content from 0.35%, 0.55 and 46.43 of the control to 0.77%, 1.01 and 54.18 of the sample containing 6% CS, respectively. However, pH, acidity, and moisture decreased. Similarly, protein, ash, and cellulose in SJ jam increased from 0.44%, 0.58 and 14.55 in the control sample to 0.93%, 0.93 and 16.75 in the sample containing 6% CS, respectively. Unlike PJ, pH and moisture increased with the addition of CS. The antioxidant and total phenol content were not noticeably changed. The sensory data discovered that the addition of CS adversely affected all sensory attributes, parallel with CS addition in both jams, but appearance, color, and taste were more influenced, particularly in PJ. The addition of CS in PJ increased the content of calcium, iron, and zinc from <0.05 mg/kg (control) to 1121, 6.74, and 2.36, respectively. In conclusion, the data of this study showed that PJ and SJ can be produced by the addition of as high as 6% CS, with improved nutritional value and acceptable sensorial properties.

**Keywords:** Chia seed, strawberry, pumpkin, functional ingredient, jams, physiochemical

**INTRODUCTION**

Functional foods are defined as food despite having basic nutrients; it offers additional physiological benefits to the body. Furthermore, due to the increasing consumers demand for healthy foods due to the current situation of diseases.<sup>[1,2]</sup> Thus, researchers have continuously developing various functional foods, from beverages<sup>[3]</sup> to cereals.<sup>[4]</sup>

Jam is one of the most consumed food products as throughout the years a part of daily meals. It is basically made of fruits with added sugar and some thickening agents (gums). It is prepared by mixing sliced fruits with the aforementioned components and cooking them until the required texture is attained. It can be packaged in cleaned cans and/or jars.

Despite their popular use in different cultures, Jams can be unhealthy food choices, particularly when it is high in sugar and low in other nutrients. Especially if less nutritious ingredients are used. The carbohydrate level in jams can reach up to 77.5% with <1% protein and at most 2% fiber.<sup>[5]</sup> Thus, the demand for healthier and functional foods is increasing every day. This can be achieved by using more nutritious components.

One of the nutritional approaches to enrich jams with nutrients is adding novel functional nutrient-dense seeds into jams. A number of previous studies have mentioned using various functional ingredients into jams in order improve the quality and functionality of jams such as dietary fiber,<sup>[6]</sup> flaxseed and plant raw material,<sup>[7]</sup> cur cumin,<sup>[8]</sup> and tea extract.<sup>[9]</sup> Consequently, Jams can be enriched with functional ingredients as a carrier and vehicle. Among these novel functional ingredients are seeds such as chia seed (CS).

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CS (*Salvia hispanica*) is an unrefined seed with possessing almost 40% of oil with largest amount of omega-3 of  $\alpha$ -linolenic acid reaching more than 65%, dietary fiber up to 30% and, proteins up to 25% as well as rich in antioxidant (considered as gallic acid) and minerals including calcium.<sup>[10]</sup> These nutrients can exert health benefits against cardiovascular disease, diabetes, and scavenge free radicals.<sup>[11]</sup> Moreover, CS is free from cholesterol and trans fats, and no side effects have been found.<sup>[12]</sup> Thus, due to health benefits and increasing incidences of non-communicable diseases (i.e., diabetes, cancer, and cardiovascular disease), CS is getting popularity and has been widely used in different processed foods, in cereals and salads, fruit juices, and jams.

Strawberry and pumpkin jam (PJ) are very healthy that are high in nutritious components, including antioxidants (Vit C, anthocyanin, and phenolic compounds)<sup>[13,14]</sup> and possess several health benefits, including lowering the risks of cardiovascular diseases, anti-inflammatory and ant mutagenic properties.<sup>[15]</sup> That makes it very suitable for jams particularly if used with novel functional ingredients. However, the fortification of jams with novel functional ingredients, particularly seeds, might change the chemical composition, texture, mouth-feel, consistency, and texture as well as general acceptability.

Therefore, the overall aim of this project is to develop different mixtures of low carbohydrate functional strawberry and PJ jams through fortifying with CS and assess nutritional aspects through chemical composition and organoleptic characteristics. The study also substituted sugar with stevia in order to make it less carbohydrate.

## MATERIALS AND METHODS

### Materials

Fresh strawberries and PJ with good quality CSs, sugar, and glucose syrup were purchased from local markets in Erbil. All chemicals used in the study were of food analytical grade.

### Methods

#### Preparation of jam

Jam samples were prepared by washing the fresh strawberry fruit thoroughly, sorting them, and cutting them into two halves. For PJ it was washed, peeled, and the flesh chopped into cubic pieces. For every 1 kg of the pieces, 0.4 kg of sugar, 0.2 kg of glucose syrup, and 0.125 kg of water were added (Table 1). The mixture was boiled to concentrate the soluble solids to about 68% and obtained the favorite consistency. Then, the jam was cooled down to room temperature and filled into previously sterilized bottles, and CSs was added in concentrations of 1.5, 3, 4.5, and 5% 6. The glass bottles were sealed and stored in a cool, dry place for further assessment.

### Chemical Analysis

#### Moisture

Moisture content was analyzed following a standard method (AOAC, 2006) using the direct oven method.

#### Total soluble solids

Total soluble solids were determined by measurement of the refraction index with a refractometer at 20°C. The obtained reading was expressed as Brix, or percentage of total soluble solids, which was used as an indicator for the end of heating time.

#### Titrateable acidity

Titrateable acidity was determined by titrating the samples with NaOH, in which its required volume was changed to percentages of citric acid.<sup>[16]</sup>

#### pH determination

The pH values of the samples were determined according to the official method of.<sup>[17]</sup>

#### Determination of ash

Ash content was analyzed by the dry ashing method used by.<sup>[17]</sup>

#### Determination of crude fiber

Crude fiber was analyzed by the Weende method with a dosi-fiber extractor for the determination of cellulose and fiber-Lab plant-England according to.<sup>[17]</sup> Approximately 2 g of jam samples were weighed in fiber analyzer tubes (W0). Boiling with 100 mL of acid ( $H_2SO_4$  0.128M) at 80°C for 40–45 min. It was then washed with distilled water 2–3 times. Again boiling with 100 mL KOH 0.223M at 80°C for 40–45 min, then washed with Acetone 2–3 times. The samples were dried in a hot-air oven at 150°C for 2 h, cooled, and weighed (W1). The samples were dried, then turned to ash using a muffle furnace at 550°C for 3 h, then cooled and weighed (W2). Crude fiber was calculated by the following formula:

$$\text{Crude fiber\%} = \frac{W1 - W2}{W0} \times 100$$

#### Mineral analysis

Calcium (Ca), iron (Fe), and zinc (Zn) were analyzed using inductively coupled plasma optical emission spectrometry (ICP-OES) (Perkin Elmer, USA). An amount of sample (3 g) was digested using the dry ashing method (AOAC, 2006). The ash result was then dissolved in concentrated HCL (7 mL) before being diluted to 100 mL with deionized water. The solution was then filtered, and the mineral content was determined using ICP-OES.

#### Determination of total phenolic content (TPC)

TPC content was determined using the Folin-Ciocalteu method described by.<sup>[18]</sup> Five grams of each jam sample were dissolved in 50 mL of deionized water. The samples were centrifuged at 3000 rpm for 10 min in a test tube, 0.5 mL of sample, 2.5 mL of 0.2 N of Folin-Ciocalteu reagent, and 2 mL of (7.5%) sodium carbonate ( $Na_2CO_3$ ) were added, then mixed by vortex for 20 s. The samples were kept in a dark place for 90 min at room temperature. The absorbance of the reaction mixture was then measured at 760 nm against empty distilled water (SHIMADZU CORP. 03531 photometer, model: UV-1280, and serial number: A120655). Gallic acid (5–250 mg/L, R2 = 9982) was used as the standard to produce the titration curve. The TPC content of samples was measured in milligrams of gallic acid equivalents (GAE) per 100 g of jam sample.

### Determination of antioxidant activity

The antioxidant activity of jam samples was measured using a modified version of the method reported by Bermúdez-Soto and Tomás-Barberán (2004). Jam's anti-radical action was measured using the 2, 2-diphenyl-1-picrylhydryl radical (DPPH). The jam sample (10 g) was diluted up to 100 mL with deionized water. Then, 0.1 mL of the sample solution was combined with 3.9 mL of a DPPH solution (0.0025 mg/mL) diluted using 100% pure methanol. After 60 min of incubation in a dark place at room temperature, the absorbance of the mixture was measured using a spectrophotometer. (SHIMADZU CORP. 03531 spectrophotometer, Model: UV-1280, Serial No. A120655). Instead of jam, methanol was utilized as a control. The equation was used to quantify radical scavenging activity as (DPPH%) discoloration:

$$\text{Antioxidant activity\%} = \frac{A_{\text{control}} - A_{\text{test}}}{A_{\text{control}}} \times 100 \lim_{x \rightarrow \infty}$$

### Sensory evaluation of jam

Sensory evaluation was conducted in the Food Technology Laboratory by 31 semi-trained panelists. The panelists were staff and students of the Food Technology Department at Salahaddin University. The samples were evaluated for sensory attributes (appearance, color, taste, texture, flavor, spreadability, and overall acceptability) on a nine hedonic scale (1 considered as less liked and 9 highly liked).

### Statistical Analysis

Statistical analysis was done to analyze the data utilizing SPSS (Statistical Package for the Social Sciences v. 21.0, IBM). A complete randomized design (Duncan test) test was done to compare variables from different categories. A statistically significant level was set at a level of  $P < 0.05$ .

## RESULTS

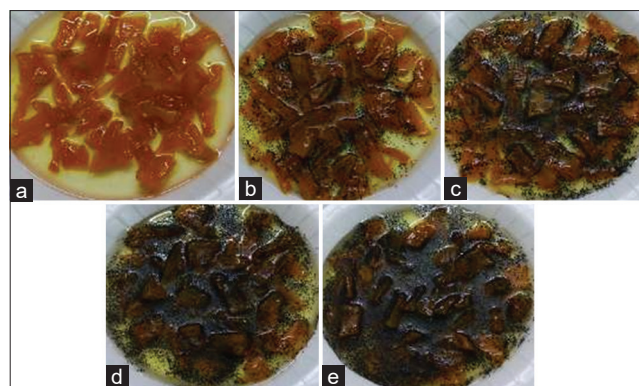
### Jam Composition

The photos of both PJ and strawberry jams (SJ) made with and without CS are presented in [Figures 1 and 2], which turned darker with the addition of CSs with a Brix value of around  $65 \pm 1$ .

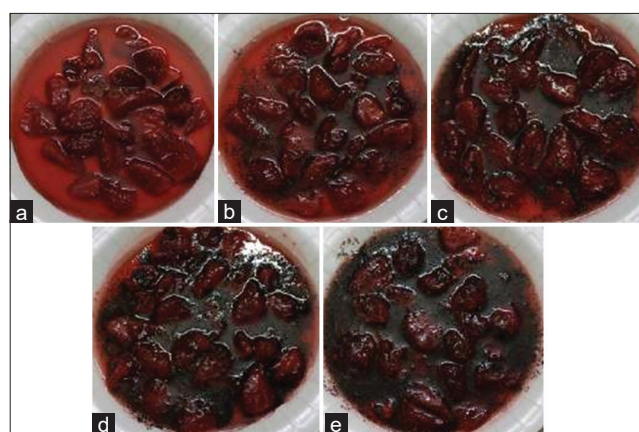
### Proximate Chemical Analysis

To find out the statistical differences between the control and other treatments, a complete randomized design and Duncan's test were applied and the  $P$ -value was lower than 0.05, which indicated statistical differences between the control and the treatments. The statistical analysis showed that the percentage of protein in both jams is significantly increasing with the addition of CS. The results showed that the protein content of the controls, PJ and SJ, were 0.35% and 44%, respectively [Tables 2 and 3]. With the addition of CS, the protein content was between 0.58 and 0.93 for PJ and 0.44 and 0.93 for SJ.

The statistical analysis also showed that pH and acidity were significantly affected by the addition of CS. The results showed that the addition of CS to PJ increased the pH of the control (5.95) to 5.5 (CS 6%) and decreased the acidity from



**Figure 1:** Pictures of pumpkin jams supplemented with and with chia seed (a) Control (no chia seed), (b) 1.5%, (c) 3%, (d) 4.5% and (e) 6%



**Figure 2:** Strawberry jams supplemented with and with chia seed (a) Control (no chia seed), (b) 1.5%, (c) 3%, (d) 4.5%, and (e) 6%

0.7 to 0.5. Furthermore, the addition of CS increased the pH of SJ from 3.5 (control) to 3.6 (CS 6%).

The data analysis showed that the moisture content is differently affected in PJ and SJ with the addition of CS. The moisture content of PJ (35.9) was decreased to 30.2 with the addition of CS (6%) whereas in SJ the moisture was slightly but significantly increased from 33.1 to 33.5. On the other hand, the cellulose content (dietary fiber) and ash content seem to be significantly increasing with the addition of CS. The data showed that the cellulose of PJ (control) was 46.43% and that of CS (6%) was 54.18%. Moreover, the cellulose content of SJ (control) increased to 14.55 and that of CS (6%) to 16.77%.

The ash content of PJ and SJ (control) significantly ( $P < 0.05$ ) increased from 0.55, 0.58 to 0.76 and 0.93 (CS%6), respectively

Total antioxidant and total phenolic in both types of PJ and SJ seem to be significantly different between the controls and the treatments, but it still seems they are close to control.

The mineral content of the jams was also assessed using ICP-OES, and the results are presented in [Table 6]. It can be seen that the addition of CS in PJ increased the content of calcium, iron, and zinc from  $<0.05$  mg/kg (control) to 1121, 6.74, and 2.36, respectively. On the other hand, the addition

**Table 1:** The quantity of row material of pumpkin and strawberry jams

Treatment	Pumpkin (g)	Sugar (g)	Glucose syrup (g)	Water (g)	Percentage Chia seed/100 g jam at 65% Brix	Brix (%)
Control	600	300	150	300	0	65
1.5%CS	600	300	150	300	1.5	65
3%CS	600	300	150	300	3	65
4.5%CS	600	300	150	300	4.5	65
6%CS	600	300	150	300	6	65
Treatment	Strawberry (g)	Sugar (g)	Glucose (g) syrup	Water (g)	Percentage Chia seed/100 g jam at 65% Brix	Brix (%)
Control	750	300	150	100	0	65
1.5% CS	750	300	150	100	1.5	65
3%CS	750	300	150	100	3	65
4.5% CS	750	300	150	100	4.5	65
6% CS	750	300	150	100	6	65

**Table 2:** Proximate chemical analysis of pumpkin

Chemical composition	Control	1.5CS	3%CS	4.5%CS	6% CS	P<0.05
Protein (%dry weight)	0.35 <sup>e</sup>	0.47 <sup>d</sup>	0.63 <sup>c</sup>	0.77 <sup>b</sup>	0.89 <sup>a</sup>	0.000
Ash %	0.55 <sup>e</sup>	0.82 <sup>c</sup>	0.93 <sup>b</sup>	1.01 <sup>a</sup>	0.76 <sup>d</sup>	0.000
Moisture %	35.9 <sup>a</sup>	34.0 <sup>b</sup>	32.5 <sup>c</sup>	30.5 <sup>d</sup>	30.2 <sup>de</sup>	0.000
PH	5.9 <sup>a</sup>	5.6 <sup>b</sup>	5.5 <sup>e</sup>	5.5 <sup>d</sup>	5.5 <sup>c</sup>	0.000
Acidity g/100g	0.07 <sup>b</sup>	0.06 <sup>bc</sup>	0.09 <sup>a</sup>	0.06 <sup>bcd</sup>	0.05 <sup>de</sup>	0.004
Cellulose (%dry weight)	46.43 <sup>c</sup>	29.86 <sup>d</sup>	49.15 <sup>b</sup>	28.25 <sup>e</sup>	54.18 <sup>a</sup>	0.000
Antioxidant*	85.5 <sup>b</sup>	82.0 <sup>e</sup>	86.1 <sup>a</sup>	84.8 <sup>d</sup>	83.8 <sup>c</sup>	0.268
Total phenol*	269.3 <sup>a</sup>	248.4 <sup>b</sup>	212.1 <sup>c</sup>	208.4 <sup>d</sup>	193.8 <sup>e</sup>	0.003
Brix (°)	65±1	65±1	65±1	65±1	65±1	P>0.05

\*mg GAE [gallic acid equivalent]/g, CS: chia seed, Numbers are mean values±MSD, Dissimilar alphabetic superscript in one row refers to statistically significant differences among means according to the Duncan test ( $P<0.05$ ).

**Table 3:** Proximate chemical analysis of strawberry

Chemical composition	Control	1.5CS	3%CS	4.5%CS	6%CS	P<0.05
Protein (%dry weight)	0.44 <sup>e</sup>	0.58 <sup>d</sup>	0.69 <sup>c</sup>	0.81 <sup>b</sup>	0.93 <sup>a</sup>	0.000
Ash %	0.58 <sup>e</sup>	0.94 <sup>a</sup>	0.84 <sup>c</sup>	0.61 <sup>cd</sup>	0.93 <sup>ab</sup>	0.000
Moisture %	33.1 <sup>ab</sup>	32.5 <sup>bc</sup>	32.1 <sup>cd</sup>	31.2 <sup>e</sup>	33.5 <sup>a</sup>	0.001
PH	3.5 <sup>cd</sup>	3.5 <sup>c</sup>	3.6 <sup>b</sup>	3.3 <sup>e</sup>	3.6 <sup>a</sup>	0.000
Acidity (g/100 g)	0.8136 <sup>d</sup>	0.8175 <sup>c</sup>	0.8024 <sup>b</sup>	0.8283 <sup>a</sup>	0.7864 <sup>e</sup>	0.723
Cellulose (%dry weight)	14.55 <sup>e</sup>	15.66 <sup>d</sup>	26.16 <sup>b</sup>	15.89 <sup>c</sup>	16.75 <sup>b</sup>	0.000
Antioxidant*	98.12 <sup>abcd</sup>	97.68 <sup>abc</sup>	98.35 <sup>ab</sup>	98.55 <sup>a</sup>	98.53 <sup>df</sup>	0.008
Total phenol*	1374.5 <sup>a</sup>	1321.6 <sup>abc</sup>	1322.6 <sup>ab</sup>	1241.2 <sup>abcd</sup>	1309.3 <sup>df</sup>	0.020
Brix (°)	65±1	65±1	65±1	65±1	65±1	P>0.05

\*mg GAE [gallic acid equivalent]/g, CS: chia seed, Numbers are mean values±MSD, Dissimilar alphabetic superscript in one row refers to statistically significant differences among means according to the Duncan test ( $P<0.05$ ).

of CS to SJ did not change mineral content. It has been stated that CS is a suitable source of minerals.

## Sensory Analysis

The results of the sensory evaluation revealed that the addition of CS to jams significantly changed some PJ sensory attributes

assessed by the panelists [Tables 4 and 5]. The results showed that there is an adverse correlation between sensory attribute scores and the addition of the CS level. The addition of the CS significantly ( $P < 0.05$ ) reduced the sensory scores of appearance, color, and taste from ( $7.2 \pm 1.8$ ), ( $8.0 \pm 1.0$ ), and ( $6.2 \pm 1.7$ ) to ( $4.3 \pm 1.8$ ), ( $4.4 \pm 1.9$ ), and ( $4.5 \pm 2.0$ ), respectively. Moreover, all other attributes scores the accepted

**Table 4:** Sensory attributes of pumpkin Jam supplemented with CS

Attributes	Control	1.5CS	3%CS	4.5%CS	6%CS	P<0.05
Appearance	7.2±1.8*	6.6±1.7	5.7±1.9	5.1±1.6	4.3±1.8	0.000
Color	8.0±1.0	6.7±1.9	6.2±1.7	5.3±1.6	4.4±1.9	0.000
Texture	6.6±1.6	6.2±2.0	6.1±1.7	5.7±2.0	5.2±2.0	0.107
Taste	6.2±1.7	6.1±2.4	5.7±2.0	5.2±2.2	4.5±2.0	0.013
Flavor	6.03±1.6	6.03±2.2	5.3±2.1	5.3±1.9	5.3±2.01	0.363
Spreadability	5.8±2.0	6.1±1.8	6.2±1.7	6.5±1.4	6.1±1.6	0.653
Overall acceptability	7.03±1.5	6.7±1.6	6.1±1.6	5.7±1.7	5.0±1.7	0.000

CS: chia seed, Numbers are mean±MSD

**Table 5:** Sensory attributes of strawberry jam supplemented with different levels CS

Attributes	Control	1.5CS	3%CS	4.5%CS	6%CS	P<0.05
Appearance	7.45±1.3	7.13±1.2	6.58±1.4	5.87±1.5	5.45±1.7	0.000
Color	7.71±1.1	7.16±1.3	6.94±1.3	5.55±1.4	5.10±1.7	0.000
Texture	7.39±1.0	6.9±1.2	6.35±1.3	5.81±1.5	5.61±1.6	0.000
Taste	7.42±1.3	6.84±1.4	6.45±1.7	6.29±1.7	6.16±1.8	0.021
Flavor	7.39±1.3	6.87±1.5	6.74±1.7	6.52±1.3	5.94±2.1	0.015
Spreadability	7.1±1.4	6.84±1.2	6.68±1.2	6.10±1.2	6.1±1.3	0.022
Overall acceptability	7.61±1.0	7.23±1.0	6.94±1.2	6.26±1.3	5.48±1.8	0.000

CS: chia seed

**Table 6:** Mineral composition of Pumpkin and strawberry jams supplemented with chia seed

Minerals	Pumpkin jams					Strawberry jam				
	Control	1.5CS	3%CS	4.5%CS	6%CS	Control	1.5CS	3%CS	4.5%CS	6%CS
Calcium mg/kg	<0.05	658.7	330.8	345.1	1121	<0.05	<0.05	<0.05	<0.05	<0.05
Iron mg/kg	<0.05	2.586	0.697	0.987	6.743	<0.05	<0.05	<0.05	<0.05	<0.05
Zinc mg/kg	<0.05	1.415	0.616	0.528	2.364	<0.05	<0.05	<0.05	<0.05	<0.05

CS: chia seed

score of (5) and seemed to be acceptable. Furthermore, the sensory attributes of SJ assessed by the panelists were also significantly ( $P < 0.05$ ) scored lower on the scale but scored a passing score of (5). However, they were also recorded a better score, and they were higher than PJ. This may indicate that the sensory attributes of SJ were less adversely affected by the introduction of CS in comparison to PJ.

## DISCUSSION

Jams are one of the most consumed foods that are preferred by many consumers, particularly for breakfast. Many fruits and, even sometimes, vegetables are used in jam preparation. This is attributed to their affordability, availability, and sensorial properties.<sup>[19]</sup> However, the chemical and nutritional aspects of jam are of concern due to the high level of carbohydrates and relatively low level of nutrients. Therefore, enriching jams with nutrients dense seeds could be a reasonable way to increase nutrients without compromising their quality.

The protein content of the control jams seems to be low (0.35-0.44%) and very close to previous studies who reported protein content in jackfruit<sup>[5]</sup> and pineapple.<sup>[20]</sup> This is due to the fact that the basic components of jam (fruit and/or

vegetables, sugar, acid, and hydrocolloids) are not the main source of protein. The data showed that the introduction of SC increased protein content parallel to the addition level. CS is a reasonable source of protein, with more than 16% of protein, which makes it richer than most cereals, including barley and wheat. Furthermore, CS also contains both non-essential and essential amino acids. Consequently, it possesses high-quality protein<sup>[21]</sup> and can be utilized to enrich low-protein products like jams.

Due to the high dietary fiber content, the addition of CS to any product can increase the dietary fiber content. It has been reported that carbohydrate content in CS reaches around 42%, with around 82% of which is dietary fiber,<sup>[20]</sup> and leads to fiber content in PJ and SJ. CS contains soluble and insoluble dietary fiber; the first one can be fermented once it arrives in the colon, produces short-chain fatty acids, and serves several benefits; the latter one builds bulk in the colon.<sup>[4]</sup> Thus, adding CS to products like jam can increase nutritional value and extend several fiber-related benefits. Furthermore, CS also contains several fatty acids, including a substantial amount of  $\alpha$ -linolenic and linoleic acids (63.79%) and (18.89%), respectively. Therefore, the presence of essential fatty acids,

particularly  $\alpha$ -linolenic, with that amount can confer health-related benefits, including coronary heart disease, and adding to PJ and SJ can back-up and improve health benefits.

The pH and acidity of the jams were very close to their control despite being statistically significantly different. This indicates that the addition of CS did not radically change the taste and rheology of the jams (gel). Furthermore, the concentration of sugar (Brix) in the jams was similar to the controls, if not better. Even the panelists confirmed the result and recorder that the spreadability of the supplemented jams recorded a high liking score, which in PJ was better than the control (control recorded 5.8 and 6% CS recorded 6.1). The spreadability and rheology (viscosity) of jams are two of the main factors to assess the quality.<sup>[22,23]</sup>

The results of the sensory attributes of both jams indicated that the chia addition affected the sensory attributes of the jams. The results of PJ showed that the addition of 6% significantly changed the sensory attribute liking score, particularly appearance, color, and taste. Other sensory attributes, including spreadability, texture, and overall acceptability, were less affected, and all scored a passing score of (5). On the other hand, the SJ treatment seems to have a better liking score compared to the control. All the sensory attributes, even after the addition of CS, scored as high as 6% of passing scores.

Texture and color are two main factors that are of concern by the consumers. Only color in PJ was adversely affected by the addition of 6% CS, which could mean that more than this amount cannot be tolerated. Appearance and taste, like color, were also adversely affected. This might be attributed to the addition of whole black CS. CS flour could have less effects. The effects of CS on flavor could be attributed to the perception of consumers toward the addition of novel ingredients to jams since CS has a bland flavor and does not significantly change the jam's original flavor. These results are in agreement with a previous study that found CS-affected pineapple jams supplemented with CS.<sup>[20]</sup>

The spreadability is crucially important in jams for consumers since it can affect their performance during eating. The results showed that spreadability seems to be less affected and accepted by consumers, despite adding CS as high as 6%. This can be attributed to the fact that CS contains gums and can form a gelly-like structure when mixed with moisture, which can improve jam spreadability.<sup>[24]</sup>

Last but not least, the overall acceptability of the jams was proportional to the addition of CS. Thus, control had the highest overall acceptability, and the addition of CS had the lowest but an acceptable and passing score. This could mean that, despite adding even 6% can be acceptable. A previous study also indicated that the addition of 6% of CS had little effect on sensorial properties of pineapple jam.<sup>[20]</sup>

The data also unexpectedly indicated that the addition of CS increased the mineral content of the PJ but not the SJ. Previous research has stated that CS is a rich source of many minerals, commonly calcium, iron, and zinc, with 631, 7.72, and 4.58 mg/100 of CS, respectively.<sup>[25]</sup> It has also been reported that the presence of several healthy nutrients, including fibers, minerals, proteins, lipids (omega-3), and

antioxidants, provides nutritious benefits and exerts several metabolic health benefits.<sup>[26]</sup>

It could be expected that adding novel ingredients to food formulas might impact on acceptability by consumers. Particularly, the addition of novel CS into jams has been very recently focused on, and people are not very familiar with. However, it is expected that some undesirable impacts of CS can be accepted due to the nutritional value of CS, which can be used in the food industry and in creating functional and nutraceutical products.

## CONCLUSION

The study was conducted in order to develop and fortify two types of jams with novel functional ingredients like CS. The results of the study referred that the supplementation of CS with PJ and SJ improved the nutritional value, particularly protein, cellulose, and ash. Also, the outcome of the research indicated that, despite adding a new ingredient to the jam's formula, they were still accepted sensorial by a number of panelists. The results may indicate that although CS delivers several health benefits, but addition of CS might change the preferences of the products, particularly their appearance, color, and taste, as well as their increased mineral content. However, this is less seen in strawberry than in pumpkin and seemed to be more acceptable. This indicates that increasing the amount by 6% might increase nutritional value but compromise quality, sensory, and consumer perception.

## CONFLICT OF INTEREST

The authors declare that there is no conflict of interest.

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