

Development of a Mixed Fruit Preserve with Added Chia Seeds

Research Article

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Abstract

Increasing consumer demand for nutritious preserves is necessitating the need for development of value-added low sugar products. In the present study a mixed fruit preserve was prepared with added chia seeds sweetened with sugar and a non-nutritive sweetener. Chia seeds were either used whole or in grounded state which were either raw or pressure cooked. Sensory evaluation was carried out using the 5-point hedonic scale. Variation 10 which had 25% of sugar, 5% of sucralose, 3% of intact pressure-cooked black chia seeds had the highest overall acceptability score (4.22±0.71) and the total score (33.25±4.49). The accepted variation had 28.2% moisture, 0.98% titratable acidity and 66.9 degree brix total soluble solids (TSS). Analysis indicated the total fat, protein, crude fiber, dietary fiber, carbohydrate, ascorbic acid, vitamin A, Omega-3 and omega-6 content was 2.08 g, 0.77 g, 0.97 g, 3.51 g, 48.37 g, 4.95 mg and 15 ug, 1.12g and 0.41g per 100 g of the final product respectively. Accelerated shelf-life and Real time shelf-life analysis found product to be microbiologically safe for twenty-eight days and three hundred sixty-five days respectively. Overall, the product was very well received and can be introduced in the market.

Keywords: Novel ingredient; Functional food; Shelf-life, Proximate analysis, Preserve, Poly-unsaturated fatty acids, New food product development

Introduction

Chia seeds are obtained from an annual herb, also known as *Salvia Hispanica*. The chia plant is sensitive to day light and produces black or white seeds. Black coloured chia seeds are more common [1]. Chia seeds are a good source of omega-3 (18%) and omega-6 (6%) fatty acids, soluble dietary fibre (7%) and they also provide proteins (23%) and antioxidants in appreciable amounts [2]. Chia contains about 5 per cent mucilage, 23 per cent cellulose and 2.5 per cent gums. The insoluble dietary fiber of chia is capable of retaining water several times of its weight during hydration and thus provides bulk and prolongs the gastro-intestinal transit time [3]. Several studies have demonstrated the benefits of consuming chia seeds on human health. It is beneficial for digestive system and helps in management of weight, Diabetes, Dyslipidaemia and hypertension. In view of its

composition, it has been reported to act as an anti-inflammatory, antioxidant, anti-blood clotting, laxative, antidepressant, antianxiety, analgesic, vision and immunity improver [4-9].

Chia seeds can be used as whole or in grounded form [2]. Chia seeds have the unique property of forming a gelatinous mass when soaked in water. This is due to the presence of high amount of mucilage and gums. Due to the presence of high amount of mucilage and gums, chia seeds form a gelatinous mass when soaked in water. Chia seeds can absorb water up to 12 times their weight. These seeds do not have any flavour and odour of their own therefore they can be easily incorporated in any food or dish [3].

Fruit preserves are usually produced by mixing the fruit with sugar, pectin and acid and then cooking to a desired temperature and concentration. Preserves are mainly of two types-sweet preserves

and savoury preserves. Sweet preserves include foods such as jams, jellies, and marmalades whereas savoury preserves include chutney, ketchups, etc. [10]. Traditional sweet preserves being energy dense, rich in simple sugars but low in fiber and several other nutrients are losing customer demand. The customers are now looking for lesser energy dense, high fiber sweet preserves [11].

In the present study, attempts have been made towards the development of a mixed fruit preserve with added chia seeds to augment omega-3 and omega-6 fatty acid content, fiber and protein in the existing recipe used for preparing mixed fruit jam. Attempts have also been made to develop a low caloric sweet product by partially replacing sugar with an artificial sweetener. It can be used as a bread-spread and can be incorporated in bakery products such as cakes, biscuits, pastries etc. or used as an accessory or ingredient in numerous ways.

Materials and Methods

The basic formulation of standard mixed fruit jam has been shown in Table 1. Figure 1 shows brief flow chart of the method of preparation of mixed fruit preserve employed during the study. Fruits which were used are well known for their low-calorie content, low glycaemic index (apple-38, papaya-34, guava-32 and grapes-46 on an average all below glycaemic index of 55) and high vitamin and mineral content. One standard and ten variants were developed and evaluated for their consumer preferences and physiochemical parameters.

Table 1: Formulation used for making Standard Mixed Fruit Preserve (per 250 g).

S. No.	Ingredients	Amount (g)
1.	Apple	100
2.	Papaya	100
3.	Guava	25
4.	Grapes	25
5.	Sugar	250
6.	Pectin powder	10
7.	Citric acid	2.5
8.	Water	100

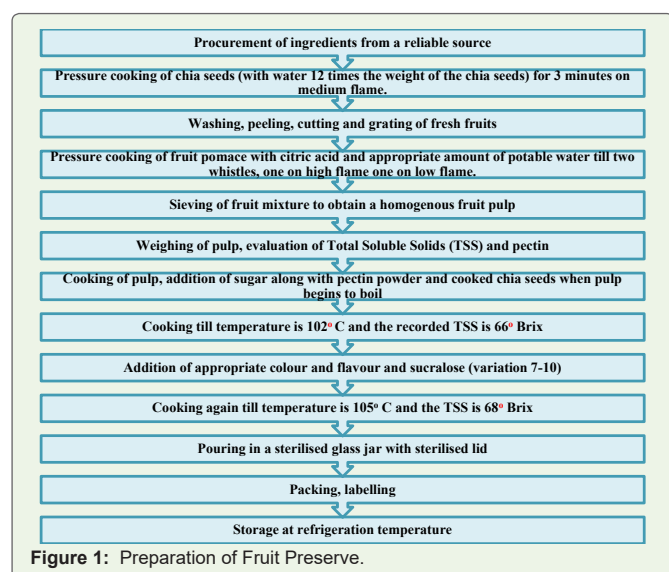


Figure 1: Preparation of Fruit Preserve.

Procurement and processing of ingredients

Fresh and cavity/disease free fruits were procured from a reliable source. Black variety chia seeds, pectin powder, citric acid, sugar and other ingredients were used after evaluating the major information available through their food label. All the ingredients were weighed on an electronic weighing balance having an accuracy of $\pm 0.1g$.

Preparation of Chia Seeds

When whole chia seeds are hydrated at 200°C for 2 hours in the 1:40 seed and water ratio they form a gelatinous solution. Solubility of chia mucilage's has been found to be 100% when examined at different concentrations i.e. (0.15, 0.25 and 0.5%) and at temperatures (30, 60, 70 and 900°C respectively) and also in different centrifugation (800 and 2000g) conditions. Chia seeds are high in mucilage and soluble fibers specifically gums. Therefore, it can be substituted as a natural thickening agent in food products instead of using chemical form of pectin or other additives. It has added nutritional and clinical benefits [3]. Therefore, in the present study, chia seeds were either used intact or in grounded state. Chia seeds have pointed edge. Thus, in the present study, they were added to the preserve as raw intact, raw pressure cooked and raw grounded. In case of pressure cooking, the seeds were cooked with water twelve times the weight of the chia seeds (for e.g., if 5 grams of raw chia was used, 60 ml of water was taken for pressure cooking the seeds). The cooking was done for five minutes, After that the seeds were cooled down, they were weighed on an electronic balance and the cooked weight was noted carefully.

Preparation of fruit pulp

The fruits were cleaned under running water, rinsed in distilled water, peeled, cut and edible portion was weighed on an electronic balance. The fruits were deseeded, juice extracted and pomace was put in the pressure cooker along with pectin powder, citric acid and appropriate amount of potable water and all the ingredients were mixed properly. The mixture was then pressure cooked to two whistles, one on high flame one on low flame. The contents were then allowed to cool down and subjected to sieving. A plastic sieve was used and a uniform fruit pulp was obtained. The fruit pulp was then weighed on an electronic balance and was evaluated for Total Soluble Solids (TSS) using a digital refractometer. The pectin content of the pulp was assessed by using alcohol test [12].

Preparation of fruit preserve

The obtained fruit pulp was poured into a heavy bottom container and thereafter subjected to heat. A glass thermometer was suspended into the fruit pulp and the continuous temperature change associated with heat was observed carefully. When the mixture started to boil, sugar along with pectin powder and chia seeds (only in variations) were added and the mixture was again allowed to cook. A digital refractometer was used to evaluate the TSS of the pulp during cooking at an interval of 5-8 minutes. The flow diagram depicting the process flow of its preparation has been presented in Figure 1.

Towards the end of the preparation, when the temperature of the pulp reached 102°C and the recorded TSS was about 66° Brix, appropriate food colour, flavour and citric acid were added to the pulp and mixed properly. In variations 7 to 10 prepared as shown in Table 2 where artificial sweetener was used, it was added at this step

Table 2: Variations of the Mixed Fruit Preserve (per 250 g).

Variation	Fruit pulp (pomace)	Sugar (g)	Sucralose (g)	Chia seeds (g)	Form in which chia seeds was used	Method of incorporation
Standard	250	250	0	0	-	-
Variation 1	250	250	0	0.5	Whole	Pressure Cooked
Variation 2	250	250	0	1	Whole	Pressure Cooked
Variation 3	250	250	0	1.5	Whole	Pressure Cooked
Variation 4	250	250	0	2	Whole	Pressure Cooked
Variation 5	250	250	0	2.5	Whole	Pressure Cooked
Variation 6	250	187.5(75%)	6.25	2.5	Whole	Pressure Cooked
Variation 7	250	187.5(75%)	6.25	5	Grounded	Raw
Variation 8	250	125(50%)	9.4	2.5	Whole	Pressure Cooked
Variation 9	250	112.5(25%)	12.5	7.5(Mixed)	Whole	Pressure Cooked
Variation 10	250	112.5(25%)	12.5	7.5	Whole	Pressure Cooked

along with colour and flavour. The amount of sucralose to be added increased proportionately from 3% to 5% and by proportionately reducing sugar content from 100% to 75% to 50% to 25% respectively. When the end point for the fruit preserve was reached i.e. when the temperature of the preserves was 105°C and the TSS was 68° Brix, the gas was turned off and the preserve was prepared for packaging. A sheet test was also done to ensure the proper cooking of the preserve.

Packaging

500 ml sterilised glass jars with sterilised lids were used for packaging of the preserve. While still hot the preserve was poured in the glass jar. The mixture was then allowed to cool down and then the lid of the jar was closed after some time. The preserve was allowed to remain at the room temperature for about 20-24 hours for cooling purpose.

Labelling

After the preserve had cooled down properly, it was securely closed with the lid and the prepared food label with code was put on the jar. The final product was used for further analysis.

Sensory Evaluation

The acceptability of the product by the target population is an important factor in determining its success and market viability [13]. Consumer preference trials were conducted for the mixed fruit preserve by 30 trained panel lists. Evaluation was done using the 5-point hedonic scale. Parameters rated were colour, texture, flavour, taste, appearance, spread ability, mouth feel and overall acceptability. The panel lists were asked to express their degree for liking the sensory attributes using a 5-point hedonic scale for each parameter, where 5 (excellent) was the highest and 1 (poor) was the lowest score. Thus, 1= poor, 2= average, 3= good, 4= very good, 5= excellent. Standard protocols for sensory evaluation were followed [14]. Panel lists did not consume food half an hour prior to sensory evaluation. Each panel list was given a glass of water to rinse their mouth after each taste to avoid being biased or influenced. The panel lists were served on a white plate with small amount of preserve by applying it uniformly on a slice of white bread. The room was well illuminated and ventilated. A written consent to participate in the study was obtained from the panel lists. Ethical clearance was obtained from the internal Institutional Ethical Body Committee.

Chemical Analysis

As per specifications given by national surveillance body - Food Safety and Standards Authority of India (FSSAI) in 2011 [10], All the variations and standard were checked for their TSS, titratable acidity and moisture content. Titratable acidity is the total amount of acid present in the food matrix which is determined using a standard titrant i.e. sodium hydroxide. This is important for assessing the keeping quality of the product. Total soluble solids content gives us a measure of the total soluble solids in a food matrix. It is usually measured to estimate the sucrose content in food matrices [12].

The final accepted variation i.e. number 10 based on results of sensory evaluation was analyzed for its total fat content as per AOAC 922.06 method [15], protein content as per IS: 7219:1973 method [16], crude fiber content as per IS 10226: 1982 method [17], total dietary fiber content as per AOAC 985.29 method [18], total carbohydrates content as per IS: 1656: 2007 method [19], vitamin C content as per IS: 5883: 1970 method [20], Omega-3 and Omega-6 content as per AOAC 2012.13 method and vitamin A content as per AOAC 992.06 method [21,22]. The chemicals used were of analytical grade and were manufactured by Merck Limited, Mumbai, India. All the analysis was carried out in duplicate.

Shelf-Life Analysis

Shelf-life prediction is increasingly becoming an important part of any new product development and because of improved controlled storage testing facilities in more recent times. Accelerated Shelf-Life Testing (ASLT) aims to accelerate the rate of deterioration of the product without altering the mechanisms or order of changes seen in the product under normal storage conditions [23]. The most accepted variation i.e. variation 10 of the mixed fruit preserve was subjected to shelf analysis as well. ASLT was done at 40±2°C and 75% relative humidity (RH) ± 5% for seven, fifteen, twenty-two and thirty days. Total plate count, mould count and yeast count in terms of colony forming units per gram (cfu / g) were assessed as per FSSAI approved methods [10]. Real time shelf-life testing was also done for which the preserve was stored at 5±2°C at 75% relative humidity (RH) ± 5% for zero, thirty, sixty, ninety, one hundred twenty, two hundred forty, two hundred and seventy and three hundred sixty-five days respectively. Total plate count, mould count and yeast count (cfu / g) were assessed for these many days.

Statistical Analysis

All data were entered in Microsoft Excel 2016. Mean, standard deviation and range was reported for all the parameters estimated using STATA Version 12.

Results and Discussion

Physical parameters

The acceptability of the product by the target population is an important factor in determining its success and market viability. Consumer preference trials were conducted for the mixed fruit preserve. Sensory evaluation was done using the 5-point hedonic scale [13]. Parameters rated were colour, texture, flavour, taste, appearance, spread ability, mouth feel and overall acceptability. The results have been presented in Table 3 and Table 4. Qualitative data indicated that the novel ingredient used - chia seed was widely accepted and appreciated. Overall, no significant difference was seen across the variations viz. a viz. standard mixed fruit preserve for all the parameters (F-Value: 1.356; p-value: 0.201). Variation 10 had the highest overall acceptability score and the total score. It was well received by the panel list (n=30).

Colour: The colour of the preserve prepared was magenta. Significant difference ($p < 0.05$) was seen in colour for variation 10 when compared with the standard as shown in Table III because of the addition of chia seeds. Significant difference ($p < 0.05$) was seen in colour for variation 10 when compared with variation 1 as shown in Table IV. This could be because of the gradual addition of chia to the variants, the maximum 5% being used in variation 10.

Texture: The amount and the form of chia seeds added to the preserve influenced its texture. Significant difference ($p < 0.05$) was seen in texture for variation 7, 9 and 10 when compared with the standard composition as shown in Table 3 because of the addition of chia seeds in grounded raw form. Significant difference ($p < 0.05$) was seen in texture for variation 10 when compared with variation 1 as shown in Table IV because of increasing amount of chia seed in variation 10.

Flavour: Significant difference ($p < 0.05$) was seen in flavour for variation 5, 9 and 10 when compared with the standard composition as shown in Table 3. The partial substitution of sugar with sucralose could have influenced the flavour. Grinding as done in variation 7 did not impact the flavour score significantly when compared with the most accepted variation and the standard preserve.

Taste: No significant difference ($p > 0.05$) was seen for taste across standard and any variation. Substitution of sugar with sucralose in variations 7 to 10 did not impact the taste score significantly. Indeed it was better than the variations and standard preserve prepared using only sugar.

Appearance: Significant difference ($p < 0.05$) was seen in appearance for variation 10 when compared with the standard (Table 3). Increased presence of whole chia seeds seemed to attract panel lists.

Spread ability: No significant difference ($p < 0.05$) was seen in spread ability for any variation when compared with the standard composition as shown in Table 3. In fact, the scores received were higher with gradual addition of chia in the variations.

Table 3: Sensory Results of Preserves (n=30 trained panellist).

Sample	Colour	Texture	Flavour	Taste	Appearance	Spread ability	Mouthfeel	Overall Acceptability	Total Score (40)
Standard	3.56±0.88	3.64±0.69	3.66±0.82	3.81±0.79	3.79±0.74	4.04±0.82	3.81±0.85	3.75±0.85	30.74±5.05
Variation 1	3.54±0.78	3.43±0.71	3.69±0.81	3.48±0.79	3.63±0.81	3.52±0.85	3.69±0.78	3.69±0.85	28.96±5.05
Variation 2	3.95±0.90	3.52±0.79	3.69±0.78	3.59±0.94	3.67±0.97	3.67±0.70	3.59±0.97	3.56±0.88	28.93±5.13
Variation 3	3.79±0.67	3.75±0.53	3.86±0.54	3.84±0.78	3.91±0.67	3.68±0.69	3.93±0.79	3.82±0.73	30.64±3.96
Variation 4	3.91±0.67	3.73±0.83	3.98±0.87	4.00±0.67	3.86±0.69	3.79±0.59	4.02±0.76	3.91±0.77	31.05±4.81
Variation 5	3.62±0.78	3.74±0.66	4.00±0.76**	3.82±0.88	3.82±0.72	3.68±0.71	3.88±0.74	3.88±0.77	29.94±4.99
Variation 6	3.54±0.64	3.72±0.66	3.63±0.70	3.70±0.78	3.70±0.65	3.70±0.68	3.82±0.66	3.90±0.78	30.01±3.73
Variation 7	3.96±0.91	4.04±0.74**	3.94±0.74	4.02±0.80	3.77±0.98	4.23±0.59	4.02±0.68	3.96±0.67	31.94±4.85
Variation 8	3.85±0.74	3.98±0.69	3.81±0.70	3.92±0.72	4.00±0.72	4.17±0.70	4.04±0.71	4.08±0.67	31.85±4.20
Variation 9	3.76±0.96	4.10±0.65**	4.10±0.69**	3.84±0.92	3.80±0.85	3.84±0.89	4.14±0.82	4.09±0.86	31.67±5.18
Variation 10	4.18±0.75**	4.24±0.72**	4.06±0.68**	4.15±0.73	4.18±0.85**	4.14±0.60	4.08±0.83	4.22±0.71**	33.25±4.49**

Table 4: Comparison of Most Acceptable Variation with Standard and Other Variations - Sensory Characteristics and Total Score.

Sensory Characteristics	Variation 10	Standard vs. Variation 10	Variation 1 vs. Variation 10	Variation 2 vs. Variation 10	Variation 3 vs. Variation 10	Variation 4 vs. Variation 10	Variation 5 vs. Variation 10	Variation 6 vs. Variation 10	Variation 7 vs. Variation 10	Variation 8 vs. Variation 10	Variation 9 vs. Variation 10
Colour	4.18±0.75	3.56±0.88 (0.047)*	3.54±0.78 (0.047)*	3.95±0.90 (0.089)	3.79±0.67 (0.082)	3.91±0.67 (0.092)	3.62±0.78 (0.052)	3.54±0.64 (0.048)	3.96±0.91 (0.091)	3.85±0.74 (0.081)	3.76±0.96 (0.071)
Texture	4.24±0.72	3.54±0.69 (0.046)*	3.43±0.71 (0.035)*	3.52±0.79 (0.052)	3.75±0.53 (0.073)	3.73±0.83 (0.081)	3.74±0.66 (0.061)	3.72±0.66 (0.065)	4.04±0.74 (0.075)	3.98±0.69 (0.098)	4.10±0.65 (0.123)
Flavour	4.06±0.68	3.66±0.82 (0.042)	3.69±0.81 (0.053)	3.69±0.78 (0.056)	3.86±0.54 (0.087)	3.98±0.87 (0.094)	4.00±0.76 (0.097)	3.63±0.70 (0.058)	3.94±0.74 (0.091)	3.81±0.70 (0.081)	4.10±0.69 (0.211)
Taste	4.15±0.73	3.71±0.79 (0.079)	3.48±0.79 (0.045)	3.59±0.94 (0.062)	3.84±0.78 (0.091)	4.00±0.67 (0.123)	3.82±0.88 (0.095)	3.70±0.78 (0.089)	4.02±0.80 (0.201)	3.92±0.72 (0.098)	3.84±0.92 (0.081)
Appearance	4.18±0.85	3.69±0.74 (0.049)*	3.63±0.81 (0.058)	3.67±0.97 (0.062)	3.91±0.67 (0.092)	3.86±0.69 (0.095)	3.82±0.72 (0.073)	3.70±0.65 (0.067)	3.77±0.98 (0.068)	4.00±0.72 (0.716)	3.80±0.85 (0.067)
Spread ability	4.14±0.60	4.04±0.82 (0.121)	3.52±0.85 (0.059)	3.67±0.70 (0.072)	3.68±0.69 (0.069)	3.79±0.59 (0.078)	3.68±0.71 (0.062)	3.70±0.68 (0.068)	4.23±0.59 (0.067)	4.17±0.70 (0.912)	3.84±0.89 (0.098)
Mouthfeel	4.08±0.83	3.71±0.85 (0.097)	3.69±0.78 (0.081)	3.59±0.97 (0.054)	3.93±0.79 (0.093)	4.02±0.76 (0.112)	3.88±0.74 (0.085)	3.82±0.66 (0.075)	4.02±0.68 (0.567)	4.04±0.71 (0.781)	4.14±0.82 (0.087)
Overall Acceptability	4.22±0.71	3.65±0.85 (0.047)*	3.69±0.85 (0.062)	3.56±0.88 (0.049)*	3.82±0.73 (0.090)	3.91±0.77 (0.095)	3.88±0.77 (0.085)	3.90±0.78 (0.081)	3.96±0.67 (0.231)	4.08±0.67 (0.456)	4.09±0.86 (0.234)
Total Score	33.25±4.49	30.74±5.05 (0.047)*	28.96±5.05 (0.041)*	28.93±5.13 (0.041)*	30.64±3.96 (0.055)	31.05±4.81 (0.092)	29.94±4.99 (0.049)*	30.01±3.73 (0.054)	31.94±4.85 (0.078)	31.85±4.20 (0.671)	31.67±5.18 (0.121)

Mouthfeel: No significant difference ($p > 0.05$) was seen for mouth feel across standard and all variations. The addition of chia was well received by the panellists and did not impact the scores for mouthfeel.

Overall Acceptability: Significant difference ($p < 0.05$) was seen in overall acceptability for variation 10 when compared with the standard composition as shown in Table 3 because of the increasing addition of whole chia seeds and gradual substitution of sugar with sucralose. Significant difference ($p < 0.05$) was seen in overall acceptability for variation 10 when compared with variation 2 as shown in Table 4. This could be due to gradual increase in amount of chia in whole form. Indeed reduction of sugar in variation 10 to 25% was very well received by the panel lists.

Total Score: Significant difference ($p < 0.05$) was seen in total score for variation 10 when compared with the standard composition as shown in Table 3. Significant difference ($p < 0.05$) was seen in total score for variation 10 when compared with variation 1, 2 and 5 as shown in Table 4.

Overall, variation 10 with 7.5g of intact black pressure-cooked chia seeds with 25% sugar and 5% sucralose was found to be the most acceptable variation by the trained panel lists.

Chemical parameters

The physico-chemical properties of the mixed fruit preserve for standard and other variations has been presented in Table 5. For all variations except for variation 6, 7 and 9 the moisture content exceeded the cut-off of 29.8% as given by Food and Agriculture Organization (FAO) [24]. This could be due to the variation in the variety of chia seed used, its nature and the method of cooking employed. Use of pressure-cooked seeds could have contributed to increased incorporation of moisture. Also, chia seeds are good source of soluble hygroscopic fibre. Thus, increasing the amount of chia enhances the water absorption and hence higher amount of moisture gets retained in the final product. This however was a concern because higher the moisture content, greater is the water activity and shorter the shelf-life. Shelf-life analysis was also carried out and is discussed later.

The TSS of variations except 6, 7, 8 and 9 had values below 65% degree brix; in compliance with FSSAI (2011) standards [10]. The

titratable acidity expressed as malic acid for all the variations prepared was meeting the cut off criteria of minimum 0.7% as per FAO [24].

The proximate analysis was carried out for the most accepted variation prepared i.e. variation 10 as per standard methods. The total fat, protein, crude fiber, dietary fiber and carbohydrate content were found out as 2.08 g, 0.77 g, 0.97 g, 3.51 g and 48.37 g respectively per 100 g. The ascorbic acid content was found out as 4.95 mg/ 100g of the final product. Vitamin A content was below 15 ug/ 100g which is the detection limit. Omega-3 and omega-6 content were also estimated which were found out to be 1.12 g/ 100g and 0.41 g/ 100g respectively of the final product.

According to Garg and others [25], the proximate analysis done for 100g of mixed fruit jam shows that the fat, protein, crude fiber and carbohydrate content was 1.28 g, 2.12 g, 0.4 g and 67.08 g respectively. The vitamin C content was reported to be 0.04 mg. This shows that the values for fat, crude fiber and vitamin C for the value added innovative mixed fruit preserve prepared in the study is higher than that prepared by Garg and others [25]. When compared with commonly available mixed fruit jams in the Indian market, the nutritive value of our product was higher while the energy density was 27 per cent lower.

Shelf-life Analysis

After packing and sealing of the preserve, ASLT at $40 \pm 2^\circ\text{C}$ and 75% relative humidity (RH) $\pm 5\%$ indicated that the product had microbiological acceptability for only twenty-eight days. The results have been presented in Table 6.

As per FSSAI (2011), the total plate count, mould count and yeast count for preserves should be less than 40,000 cfu/g and 125 cfu/g respectively to declare any product microbiologically safe [10]. Therefore, the limits were exceeded only when the product was subjected to similar conditions for thirty days.

Real time shelf-life testing was also done as shown in Table 7 where the preserve was subjected to $5 \pm 2^\circ\text{C}$ and 75% relative humidity (RH) $\pm 5\%$ for zero, thirty, sixty, ninety, one hundred twenty, two hundred forty, two hundred and seventy and three hundred sixty-five days respectively. Total plate count, mould count and yeast count (cfu / g) were assessed for above mentioned days.

Table 5: Physico-Chemical Attributes of Mixed Fruit Preserve.

Sample Code	Fruit Pulp Taken (g)	Sugar(g)	Amount of Chia Seeds Added (g)	Grounded/ Intact	PressureCooked /Raw	Amount of Sucralose Added (g)	Cooked weight(g)	TSS of Pulp (% Degree Brix)	Acidity of Pulp(% malic acid)	TSS of Product (Degree Brix)	Acidity (% malic acid)	Moisture(%)Oven Drying Method
1	250	250	0.5	Intact	Pressure Cooked	0	317.7	10.6	0.95	68	0.92	18.1
2	250	250	1	Intact	Pressure Cooked	0	361.12	10.5	0.95	68	0.91	24.5
3	250	250	1.5	Intact	Pressure Cooked	0	305.92	10.8	0.96	68	0.92	25.6
4	250	250	2	Intact	Pressure Cooked	0	347.09	10.7	0.95	68	0.93	25.8
5	250	250	2.5	Intact	Pressure Cooked	0	346.94	10.6	0.95	68	0.91	28.9
6	250	187.5(75%)	2.5	Intact	Pressure Cooked	6.25	281.15	10.5	1.05	61	0.96	29.9
7	250	187.5(75%)	5	Grounded	Raw	6.25	333.05	10.5	1.01	53.9	0.95	30.1
8	250	125(50%)	2.5	Intact	Pressure Cooked	9.4	323.33	10.4	0.98	61	0.94	29.3
9	250	112.5(25%)	7.5(Mixed)	Intact	Pressure Cooked	12.5	280.36	9.6	0.93	58	0.85	30.1
10	250	112.5(25%)	7.5	Intact	Pressure Cooked	12.5	310	10.2	1.03	66.9	0.98	28.2
11 (Standard)	250	250	0	0	-	0	289.51	6.4	1.01	68	0.96	11

Table 6: Accelerated Shelf-life testing for Mixed Fruit Preserve.

Parameters	0 Days	7 Days	15 Days	22 Days	30 Days
Total Plate Count, cfu/g	ND(DL-10)	301	405	567	690
Mould, cfu/g	ND(DL-10)	75	94	121	185
Yeast, cfu/g	ND(DL-10)	74	73	89	118

ND-Not detectable; DL-Detection Limit.

Table 7: Real Time Shelf-life testing for Mixed Fruit Preserve.

Parameters	0 Days	30 Days	60 Days	90 Days	120 Days	240 Days	270 Days	365 Days
Total Plate Count, cfu/g	ND(DL-10)	ND	ND	ND	ND	ND	ND	ND
Mould, cfu/g	ND(DL-10)	ND	ND	ND	ND	ND	ND	ND
Yeast, cfu/g	ND(DL-10)	ND	ND	ND	ND	ND	ND	ND

As per FSSAI (2011) [10], the total plate count, mould count and yeast count for preserves should be less than 40,000 cfu/g and 125 cfu/g to declare any product microbiologically safe. The product was found to be microbiologically safe when assessed for three hundred and sixty-five days if stored refrigerated at $5\pm 2^{\circ}\text{C}$ at 75% relative humidity (RH) $\pm 5\%$.

Conclusion

In the present study mixed fruit preserve was prepared with added chia seeds and substitution of sugar with non-nutritive sweetener i.e. sucralose. Chia seeds were either used whole or in grounded state and were used in raw state or were pressure cooked. The acceptability of the product by the target population is an important factor in determining its success and market viability. Consumer preference trials were conducted for the mixed fruit preserve. Sensory evaluation was done using the 5-point hedonic scale. Parameters rated were colour, texture, flavour, taste, appearance, spread ability, mouthfeel and overall acceptability. The novel ingredient used-chia seeds were widely accepted and appreciated. Substitution of sugar with non-nutritive sweetener enhanced the sensory appeal. Variation 10 which had 25% of sugar, 5% of sucralose, 4% of intact pressure-cooked black chia seeds had the highest overall acceptability score and the total score. The physico-chemical properties for the accepted variation had moisture, titratable acidity and TSS as per the standards given by FSSAI [10].

The proximate analysis was also done for the accepted variation prepared i.e. variation 10 as per standard methods. The total fat, protein, crude fiber, dietary fiber and carbohydrate content were found out as 2.08 g, 0.77 g, 0.97 g, 3.51 g and 48.37 g respectively per 100 g. The ascorbic acid content was found out as 4.95 mg/ 100g of the final product. Vitamin A content was below the detection limit of 15 ug/ 100g. Omega-3 and omega-6 content were also estimated which were found out to be 1.12 g/ 100g and 0.41 g/ 100g respectively of the final product.

ASLT at $40\pm 2^{\circ}\text{C}$ and 75% relative humidity (RH) $\pm 5\%$ indicated that the product had microbiological acceptability for only twenty-eight days. Real time shelf-life analysis showed that the product was microbiologically safe when assessed for three hundred and sixty-five days. This product had low energy density but higher amount of protein, fiber and omega-3 and omega-6 fatty acids as compared to

commonly available mixed fruit preserves. This nutritious innovative product thus holds a promising future in healthier processed food market.

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