



Developing Low-calorie Papaya Jam Infused with Gum Tragacanth and Chia Seed-A Comprehensive Analysis of Physicochemical Attributes and Long-Term Storage Suitability

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ABSTRACT

Background: The study focuses on developing a nutritious, low-calorie papaya jam fortified with Gum Tragacanth and Chia Seed. This innovative approach aims to enhance the physicochemical quality of the jam while addressing health concerns associated with traditional high-sugar jams. The impact of Gum Tragacanth and Chia Seed on texture, nutritional content and sensory attributes is comprehensively investigated.

Methods: Various jam samples were formulated using gum tragacanth, chia seed, stevia, grapes juice and KMS. Samples were stored in pre-sterilized glass jars at ambient temperature. Physico-chemical properties were assessed using AOAC methodology and organoleptic aspects were evaluated on a nine-point hedonic scale over six months.

Result: Over storage, total soluble solids, titratable acidity, total sugars, reducing sugars and textural attributes increased, while ascorbic acid content, pH and overall acceptability decreased. The jam sample with stevia @ 10 gm/kg + chia seeds @ 6.25%/kg + Potassium metabisulphite @ 100 mg/kg was considered the best, remaining stable for six months with minor changes.

Key Words: Fruit Jam, Low-calorie, Physicochemical properties, Total soluble solids, Value-added Products.

INTRODUCTION

In recent years, the global market for papaya (*Carica papaya* L.) has witnessed significant growth, with India emerging as a key player in its cultivation. Native to tropical America, papaya is extensively grown in tropical and subtropical regions (Anwar *et al.*, 2023) and India stands as a major contributor to its global yield, producing 48% of the total output (FAO, 2020). In India, the cultivation of this tropical fruit extends across 149,000 hectares, resulting in a substantial yield of 5,744,000 metric tons (Indian Horticulture Database, 2021). The nutritional profile of papaya includes dietary fiber, minerals (potassium, magnesium), vitamins (A, C, B and E), bioactive compounds like antioxidants, flavonoids, phytosterols, phenolic compounds, enzymes (Chymopapain and Papain), glycosides, carotenoids, pantothenic acid, folate and its exceptional medical qualities, including anti-fungal, anti-microbial, anti-fertility, anti-amoebic, anthelmintic, anti-malarial, immunomodulatory and hepatoprotective effects, make it a valuable component in the realm of natural medicine (Ugbogu *et al.*, 2023). Papaya's versatile applications extend beyond fresh consumption globally from raw green papaya in vegetable dishes to ripe fruit for candies, pickles, sauces and jams, this fruit finds its way into an array of culinary and medicinal products (Suryawanshi *et al.*, 2022). One notable application is the production of fruit jams, a popular and nutrient-rich breakfast option. The transformation of perishable fruits into jams and jellies not only aids in reducing.

Post-harvest losses but also benefits both the food processing industry and farmers (Basary *et al.*, 2022).

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Traditional jam formulations typically consist of fruits, sugar, acid, pectin, additional flavor and preservatives (Nkansah, 2022). However, concerns regarding health risks associated with high sugar intake have prompted a demand for low-calorie jams with alternative sweeteners (Basu and Singha, 2023). To address this demand, the study proposes the use of Stevia (*Stevia rebaudiana*) as a natural alternative sweetener. Stevia, known for its low-calorie or non-caloric sweeteners in its leaf extract, has gained popularity due to its resistance to heat and acid, making it suitable for jam production without compromising flavor (Basharat *et al.*, 2021). Additionally, the incorporation of grapes, rich in antioxidants and natural sugars with various health benefits, contributes to the overall nutritional value of the jam (Alqahtani *et al.*, 2022). The study further explores the use of gum tragacanth (GT) and chia seeds in jam formulations. GT, derived from *Astragalus* species and

chia seeds, known for their high water-holding capacity, emulsifying abilities and nutritional richness, serve as suspenders, stabilizers and thickeners in various foods, including jams (Adamczyk *et al.*, 2021). Beyond their technical roles, GT and chia seeds offer health benefits, like weight loss, blood sugar control and reducing inflammation (Pourashouri *et al.*, 2021). The research aims to develop a low-calorie papaya jam by substituting pectin with gum tragacanth and chia seeds, sucrose with stevia and grape juice. This innovative approach aligns with the broader objectives of supporting Sustainable Development Goals (SDGs) such as Zero Hunger and Good Health and Well-being. The study not only explores a healthier sugar substitute but also evaluates the physiochemical and organoleptic characteristics of the jam for storage stability while creating nutritious, low-calorie foods, ensuring consumer food safety and quality.

MATERIALS AND METHODS

The experiment conducted at the Laboratory of the Department of Horticulture, School of Agriculture, Lovely Professional University, Punjab, during 2022-23, aimed to prepare low-calorie papaya jam using ripe papaya (*Carica papaya* L.) fruits cultivar Pusa Delicious. The materials, including chia seeds, gum tragacanth, stevia and grape juice, were acquired from local markets. The processing equipment's were sourced from the Department of Food Technology and Nutrition.

Nineteen different treatments were applied in the preparation of papaya jam, varying in sweeteners, consistency materials and preservative (Table 1). The standard sample (T_{19}) used white cane sugar and pectin conventionally. Standard procedures were followed for sample preparation (Fig 1). Ripe papaya chunks were grind in mixer for extraction of pulp after washing, peeling and cutting. The ingredients for the jam, such as papaya pulp,

Table 1: Details of treatments comprising the various sub-treatments of sweeteners, consistency material and preservative.

Treatment symbol	Treatment combinations	Treatment symbol	Treatment combinations
T_1	S1C0P0	T_{11}	S2C1P1
T_2	S2C0P0	T_{12}	S3C1P1
T_3	S3C0P0	T_{13}	S1C2P0
T_4	S1C0P1	T_{14}	S2C2P0
T_5	S2C0P1	T_{15}	S3C2P0
T_6	S3C0P1	T_{16}	S1C2P1
T_7	S1C1P0	T_{17}	S2C2P1
T_8	S2C1P0	T_{18}	S3C2P1
T_9	S3C1P0	T_{19}	Standard
T_{10}	S1C1P1		

Note: Here, S1: No sugar; S2: Grape juice @ 30%/kg pulp, S3: Stevia @ 10 gm/kg pulp; C0: No consistency material; C1: Chia seeds @ 6.25%/kg pulp; C2: Gum tragacanth @ 15%/kg pulp; P0: No preservative; P1: Potassium metabisulphite @ 100 mg/kg pulp.

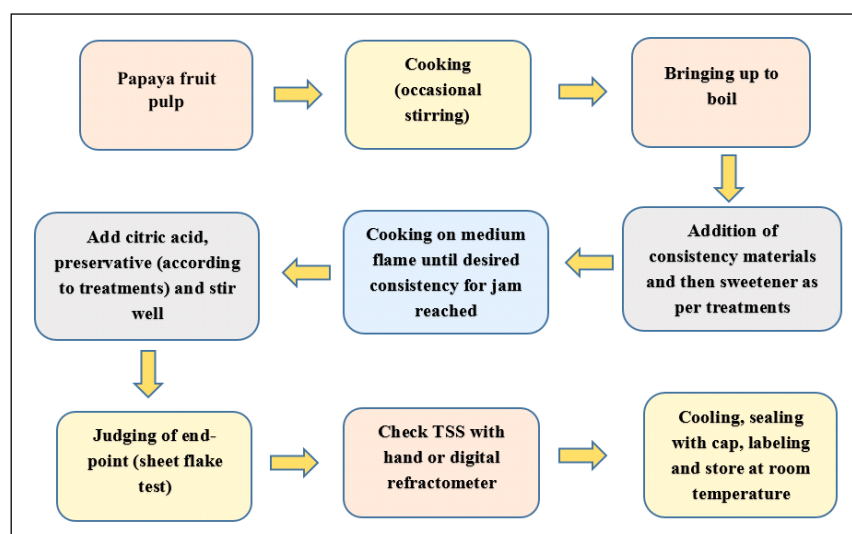


Fig 1: Preparation of low-calorie papaya jam.

Table 2: Influence on sugar content and pH of low-calorie papaya jam with gum tragacanth, chia seeds, sweeteners and preservative during extended storage.

Treatments	Total sugar (%)					Reducing sugar (%)					pH (%)					
	0 day	2 Months	4 Months	6 Months	0 day	2 Months	4 Months	6 Months	0 day	2 Months	4 Months	6 Months	0 day	2 Months	4 Months	6 Months
T ₁	12.45 ^h	12.63 ^f	14.22 ^h	16.78 ^e	5.94 ^g	6.95 ^g	7.29 ^b	8.23 ^f	3.83 ^d	3.70 ^c	3.38 ^c	3.10 ^c	3.92 ^{bcd}	3.84 ^{abc}	3.44 ^{abc}	3.30 ^{abc}
T ₂	12.51 ^{gh}	12.71 ^f	14.31 ^{gh}	16.89 ^e	6.00 ^{efg}	7.03 ^g	8.09 ^b	8.98 ^{ef}	3.92 ^{bcd}	3.84 ^{abc}	3.44 ^{abc}	3.30 ^{abc}	4.03 ^{abcd}	3.90 ^{abc}	3.58 ^{abc}	3.30 ^{abc}
T ₃	15.48 ^{gh}	15.60 ^{ef}	17.36 ^{gh}	19.41 ^e	8.11 ^{defg}	9.16 ^{defg}	10.01 ^b	11.29 ^{cdef}	4.03 ^{abcd}	3.90 ^{abc}	3.58 ^{abc}	3.30 ^{abc}	4.03 ^{abcd}	3.90 ^{abc}	3.58 ^{abc}	3.30 ^{abc}
T ₄	12.60 ^h	12.80 ^f	14.50 ^h	16.82 ^e	5.97 ^g	6.92 ^g	7.92 ^b	8.33 ^f	3.89 ^{cd}	3.76 ^{abc}	3.44 ^{bc}	3.16 ^{bc}	3.89 ^{cd}	3.76 ^{abc}	3.44 ^{bc}	3.16 ^{bc}
T ₅	12.64 ^{gh}	12.84 ^f	14.62 ^{gh}	16.92 ^e	6.04 ^{efg}	7.12 ^{efg}	8.45 ^b	9.40 ^{ef}	3.99 ^{abcd}	3.86 ^{abc}	3.54 ^{abc}	3.26 ^{abc}	3.99 ^{abcd}	3.86 ^{abc}	3.54 ^{abc}	3.26 ^{abc}
T ₆	15.54 ^{efgh}	15.65 ^{ef}	17.42 ^{efgh}	19.53 ^e	8.18 ^{cdefg}	9.19 ^{cdefg}	10.10 ^b	11.47 ^{bcd}	4.07 ^{abcd}	3.94 ^{abc}	3.62 ^{abc}	3.34 ^{abc}	4.07 ^{abcd}	3.94 ^{abc}	3.62 ^{abc}	3.34 ^{abc}
T ₇	12.75 ^{deh}	12.95 ^d	14.97 ^{deh}	16.85 ^d	6.28 ^{bcd}	7.29 ^{bcd}	8.69 ^b	9.57 ^{bcd}	4.15 ^{abcd}	4.02 ^{abc}	3.70 ^{abc}	3.42 ^{abc}	4.15 ^{abcd}	4.02 ^{abc}	3.70 ^{abc}	3.42 ^{abc}
T ₈	12.81 ^{bde}	13.01 ^{bcd}	15.07 ^{bde}	17.34 ^{bcd}	6.44 ^{bcd}	7.45 ^{bcd}	8.64 ^b	9.52 ^{bcd}	4.29 ^{abcd}	4.14 ^{abc}	3.82 ^{abc}	3.54 ^{abc}	4.29 ^{abcd}	4.14 ^{abc}	3.82 ^{abc}	3.54 ^{abc}
T ₉	15.76 ^b	15.81 ^b	17.77 ^b	19.66 ^{bc}	8.41 ^{bc}	9.75 ^{bc}	10.47 ^b	11.78 ^b	4.53 ^{ab}	4.4 ^{ab}	4.08 ^a	3.80 ^a	4.53 ^{ab}	4.4 ^{ab}	4.08 ^a	3.80 ^a
T ₁₀	13.63 ^{cdefgh}	13.83 ^{cdef}	15.04 ^b	17.59 ^d	6.23 ^{cdefg}	7.24 ^{cdefg}	8.88 ^b	9.76 ^{bcd}	4.11 ^{abcd}	3.98 ^{abc}	3.66 ^{abc}	3.38 ^{abc}	4.11 ^{abcd}	3.98 ^{abc}	3.66 ^{abc}	3.38 ^{abc}
T ₁₁	13.70 ^{bcd}	13.88 ^{bc}	15.11 ^{bcd}	17.71 ^{bcd}	6.47 ^{bcd}	7.55 ^{bcd}	8.91 ^b	9.83 ^{bcd}	4.33 ^{abcd}	4.20 ^{abc}	3.88 ^{abc}	3.60 ^{abc}	4.33 ^{abcd}	4.20 ^{abc}	3.88 ^{abc}	3.60 ^{abc}
T ₁₂	15.82 ^b	15.88 ^b	17.85 ^b	19.79 ^b	8.50 ^b	9.84 ^b	10.59 ^b	11.88 ^b	4.56 ^a	4.43 ^a	4.11 ^a	3.83 ^a	4.56 ^a	4.43 ^a	4.11 ^a	3.83 ^a
T ₁₃	12.91 ^{bcd}	13.11 ^{bcd}	15.17 ^{bcd}	17.41 ^d	6.32 ^{bcd}	7.33 ^{bcd}	8.73 ^b	9.61 ^{bcd}	4.19 ^{abcd}	4.06 ^{abc}	3.74 ^{abc}	3.46 ^{abc}	4.19 ^{abcd}	4.06 ^{abc}	3.74 ^{abc}	3.46 ^{abc}
T ₁₄	13.54 ^{bcd}	13.74 ^{bc}	15.80 ^{bc}	17.48 ^d	7.16 ^{bcd}	8.38 ^{bcd}	8.78 ^b	9.66 ^{bcd}	4.37 ^{abcd}	4.24 ^{abc}	3.92 ^{abc}	3.64 ^{abc}	4.37 ^{abcd}	4.24 ^{abc}	3.92 ^{abc}	3.64 ^{abc}
T ₁₅	15.60 ^b	15.71 ^b	17.51 ^b	19.53 ^d	8.26 ^{bcd}	9.63 ^{bcd}	10.23 ^b	11.61 ^{bc}	4.45 ^{abc}	4.32 ^{abc}	4.00 ^{abc}	3.72 ^{abc}	4.45 ^{abc}	4.32 ^{abc}	4.00 ^{abc}	3.72 ^{abc}
T ₁₆	13.75 ^{bcd}	13.95 ^{bcd}	15.86 ^{bcd}	17.83 ^d	6.37 ^{bcd}	7.58 ^{bcd}	8.96 ^b	9.86 ^{bcd}	4.23 ^{abcd}	4.10 ^{abc}	3.78 ^{abc}	3.50 ^{abc}	4.23 ^{abcd}	4.10 ^{abc}	3.78 ^{abc}	3.50 ^{abc}
T ₁₇	14.48 ^{bc}	14.68 ^b	16.00 ^b	18.28 ^{cd}	7.19 ^{bcd}	8.45 ^{bcd}	8.85 ^b	9.73 ^{bcd}	4.41 ^{abcd}	4.28 ^{abc}	3.96 ^{abc}	3.68 ^{abc}	4.41 ^{abcd}	4.28 ^{abc}	3.96 ^{abc}	3.68 ^{abc}
T ₁₈	15.65 ^b	15.75 ^b	17.64 ^b	19.60 ^{cd}	8.32 ^{bcd}	9.68 ^{bcd}	10.35 ^b	11.67 ^b	4.49 ^{ab}	4.36 ^{abc}	4.04 ^{ab}	3.76 ^{ab}	4.49 ^{ab}	4.36 ^{abc}	4.04 ^{ab}	3.76 ^{ab}
T ₁₉	63.19 ^a	63.41 ^a	65.45 ^a	67.78 ^a	21.77 ^a	22.11 ^a	23.57 ^a	24.89 ^a	3.95 ^d	3.82 ^{bc}	3.50 ^{bc}	3.22 ^{bc}	4.49 ^{ab}	4.36 ^{abc}	4.04 ^{ab}	3.76 ^{ab}

*Means in the same column with different letters are significantly different (p<0.05).

sweeteners, thickening agents, citric acid and potassium metabisulphite, were accurately measured. Different treatments received varied concentrations of thickening agents and sweeteners based on the experimental design. Cooking was performed until the desired consistency (sheet flake test) reached and TSS was checked by using hand refractometer. KMS was then added, the final product was cooled, poured into sterilized glass jars and stored at ambient temperature for analysis.

Physicochemical characteristics of the jam samples were analysed using AOAC (2000) methodology. The pH, TSS and sugar content (total and reducing) were determined using digital instruments and established methodologies (Nduko *et al.*, 2018). Texture analysis (firmness and cohesiveness) employed a Texture analyser (Sharma *et al.*, 2022) and organoleptic evaluation (overall acceptability was evaluated on the basis of all parameters which include taste, aroma, flavour and color) was conducted with a 9-point hedonic scale by five trained panellists at ambient temperature (Meilgaard *et al.*, 1999). Triplicate analyses were performed at two-month intervals over six months and statistical analysis was carried out using one-way ANOVA in OPSTAT software ($p < 0.05$ significance level).

RESULTS AND DISCUSSION

Physicochemical analysis

Total sugars (%)

In this explored investigation, our attention is drawn to the indispensable role of sugars in fruit products, specifically influencing flavor development and preservation. The examination delves into the dynamics of total sugar concentration (%) in diverse jam samples over the storage period. The standard jam commences with an initial total sugar content of 63.19%, culminating at 67.78% during storage. Among fresh samples, T_{12} manifests the highest mean total sugar content (15.82%), while T_1 registers the lowest (12.45%) (Table 2). Noteworthy increments occur during storage, with T_1 and T_{12} reaching 16.78% and 19.79%, respectively. The incorporation of gum tragacanth and chia seeds in low-calorie papaya jam induces significant alterations in total sugar content ($p < 0.05$) during treatment and storage. Naturally, the standard jam, enriched with sucrose, attains the highest mean total sugar level. The escalation in total sugar content is ascribed to the conversion of starch and other insoluble carbohydrates into sugars, aligning with prior studies by Sutwal *et al.* (2019), Pinandoyo and Masnar (2020) and

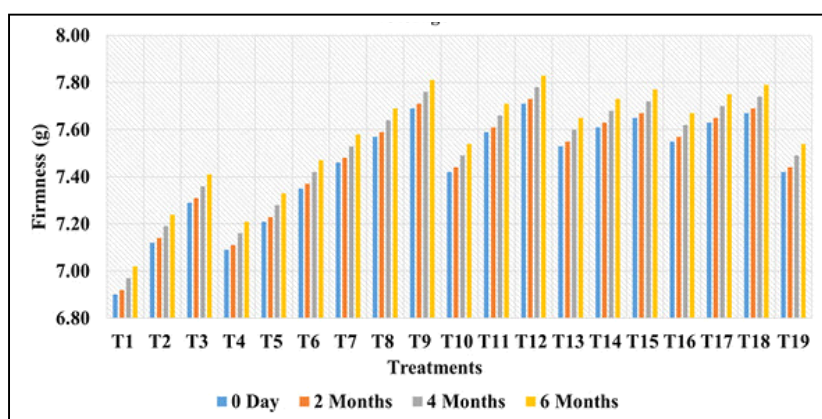


Fig 2: Texture (firmness) of low calorie papaya jam infused with gum tragacanth and chia seed.

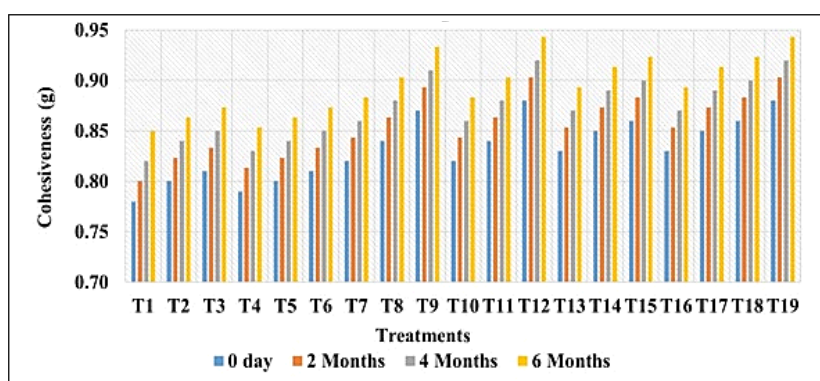


Fig 3: Texture (cohesiveness) of low calorie papaya jam supplemented with gum tragacanth and chia seeds.

Kumar *et al.* (2020) focusing on apple and papaya jams, respectively.

Reducing sugar (%)

In this investigation, a noteworthy increase ($p < 0.05$) in reducing sugars (%) was evident in all jam samples over time (Table 2). Notably, the mean reducing sugar content for the standard sample, T_{19} , elevated from 21.77% to 24.89%. Particularly, sample T_1 exhibited an increase from 5.94% to 8.50% and sample T_{12} from 7.50% to 11.88% during storage. The rise in reducing sugars in standard jam is attributed to sucrose inversion in an acidic environment, where sucrose transforms into glucose and fructose due to acidity and prolonged storage. This observation aligns with Sutwal *et al.* (2019), who noted a significant increase in apple jam's reducing sugar content during storage. Similar findings were reported by Pinandoyo and Masnar (2020) and Kosiorowska *et al.* (2022) in papaya jam fortified with soya protein and cranberry jams with added gold flax and chia seeds, respectively. These consistent results underscore the impact of storage conditions on jam composition and align with existing literature.

pH

In the investigation of pH's impact on gel formation in papaya jam, the addition of chia seeds and gum tragacanth significantly influenced pH levels throughout treatments and storage ($p < 0.05$). Initial pH for the standard

sample was 3.95%, gradually decreased to 3.22% over six-month storage. All samples exhibited a decline in pH over time, with initial readings for T_1 and T_{12} at 3.83% and 4.56%, respectively. During storage, these values decreased to 3.10% and 3.83%, indicating an average pH drop. The acidic content increase, possibly due to sugar breakdown or polysaccharide hydrolysis, contributed to this decline. Anwar *et al.* (2023) and Basu and Singha (2023) reported similar pH reductions in papaya jam during storage, reinforcing the findings. This underscores the importance of pH control for optimal jam quality (Table 2).

Ascorbic acid (mg/100 g)

The incorporation of gum tragacanth and chia seeds exhibited a significant impact ($p < 0.05$) on preserving ascorbic acid (mg/100 g) in papaya jam during treatments and storage. The mean ascorbic acid content for the standard sample (T_{19}) decreased from 26.95 mg/100 g to 22.44 mg/100 g over the storage. As evidenced in Table 3, initial ascorbic acid content in samples T_1 and T_{12} was 26.10 mg/100 g and 33.47 mg/100 g, gradually decreasing to 21.70 mg/100 g and 28.96 mg/100 g, respectively during storage. This decline may result from ascorbic acid oxidation, leading to dehydroascorbic acid and subsequent degradation into 2, 3-diketo-L-gulonic acid and furfural compounds. The results align with the findings of Kumar *et al.* (2020) and Pourashouri *et al.* (2021) who observed reductions in ascorbic acid content in guava-papaya jam

Table 3: Influence on ascorbic acid content, titratable acidity and TSS of low-calorie papaya jam with gum tragacanth, chia seeds, sweeteners and preservative during extended storage.

Treatments	Ascorbic acid (mg/100 g)				Titratable acidity (%)				Total soluble solids TSS (°Brix)			
	0 day	2 Months	4 Months	6 Months	0 day	2 Months	4 Months	6 Months	0 day	2 Months	4 Months	6 Months
T_1	26.10 ^j	24.86 ⁱ	23.70 ^h	21.70 ^h	0.65 ^a	0.66 ^a	0.68 ^a	0.69 ^a	15.28 ^e	17.37 ^e	19.09 ^e	21.15 ^e
T_2	26.95 ^{gh}	25.72 ^g	24.47 ^g	22.44 ^g	0.59 ^{ab}	0.60 ^{ab}	0.62 ^{ab}	0.63 ^{ab}	18.53 ^d	20.70 ^d	22.77 ^d	24.89 ^d
T_3	28.05 ^f	26.82 ^f	25.55 ^f	23.54 ^f	0.55 ^{ab}	0.56 ^{ab}	0.58 ^{ab}	0.59 ^{ab}	21.53 ^c	23.70 ^c	25.73 ^c	27.89 ^c
T_4	26.61 ^{hi}	25.38 ^{gh}	24.11 ^{gh}	22.10 ^{gh}	0.60 ^{ab}	0.61 ^{ab}	0.63 ^{ab}	0.64 ^{ab}	15.37 ^e	17.41 ^e	19.12 ^e	21.24 ^e
T_5	27.04 ^g	25.81 ^g	24.54 ^g	22.53 ^g	0.57 ^{ab}	0.58 ^{ab}	0.60 ^{ab}	0.61 ^{ab}	18.53 ^d	20.70 ^d	22.77 ^d	24.89 ^d
T_6	28.12 ^f	26.89 ^f	25.62 ^f	23.61 ^f	0.54 ^{ab}	0.55 ^{ab}	0.57 ^{ab}	0.58 ^{ab}	21.57 ^c	23.74 ^c	25.81 ^c	27.93 ^c
T_7	29.35 ^e	28.12 ^e	26.85 ^e	24.84 ^e	0.51 ^{ab}	0.52 ^{ab}	0.54 ^{ab}	0.55 ^{ab}	15.71 ^c	17.84 ^c	19.36 ^c	21.48 ^c
T_8	31.25 ^c	30.02 ^c	28.75 ^c	26.74 ^c	0.43 ^{ab}	0.44 ^{ab}	0.47 ^{ab}	0.48 ^{ab}	20.43 ^b	22.60 ^b	24.67 ^b	26.79 ^b
T_9	33.40 ^a	32.17 ^a	30.90 ^a	28.89 ^a	0.32 ^b	0.33 ^b	0.35 ^b	0.36 ^b	21.70 ^b	23.87 ^b	25.94 ^b	27.06 ^b
T_{10}	29.29 ^e	28.06 ^e	26.79 ^e	24.78 ^e	0.55 ^{ab}	0.56 ^{ab}	0.58 ^{ab}	0.57 ^{ab}	15.78 ^c	17.95 ^c	19.41 ^c	21.55 ^c
T_{11}	31.32 ^c	30.09 ^c	28.82 ^c	26.81 ^c	0.42 ^{ab}	0.43 ^{ab}	0.45 ^{ab}	0.46 ^{ab}	20.48 ^b	22.65 ^b	24.72 ^b	26.84 ^b
T_{12}	33.47 ^a	32.24 ^a	30.97 ^a	28.96 ^a	0.30 ^b	0.31 ^b	0.33 ^b	0.34 ^b	21.73 ^b	23.90 ^b	25.97 ^b	27.10 ^b
T_{13}	30.17 ^d	28.94 ^d	27.67 ^d	25.66 ^d	0.49 ^{ab}	0.50 ^{ab}	0.52 ^{ab}	0.53 ^{ab}	15.53 ^c	17.69 ^c	19.18 ^c	21.26 ^c
T_{14}	32.38 ^b	31.15 ^b	29.88 ^b	27.87 ^b	0.39 ^{ab}	0.40 ^{ab}	0.43 ^{ab}	0.44 ^{ab}	20.54 ^b	22.71 ^b	24.78 ^b	26.90 ^b
T_{15}	33.26 ^a	32.03 ^a	30.76 ^a	28.75 ^a	0.37 ^{ab}	0.38 ^{ab}	0.40 ^{ab}	0.41 ^{ab}	21.63 ^b	23.80 ^b	25.87 ^b	27.06 ^b
T_{16}	30.21 ^d	28.98 ^d	27.71 ^d	25.70 ^d	0.47 ^{ab}	0.48 ^{ab}	0.50 ^{ab}	0.51 ^{ab}	15.62 ^c	17.76 ^c	19.27 ^c	21.33 ^c
T_{17}	32.46 ^b	31.23 ^b	29.96 ^b	27.95 ^b	0.38 ^{ab}	0.39 ^{ab}	0.41 ^{ab}	0.42 ^{ab}	20.57 ^b	22.74 ^b	24.81 ^b	26.93 ^b
T_{18}	33.33 ^a	32.10 ^a	30.83 ^a	28.82 ^a	0.34 ^{ab}	0.35 ^{ab}	0.37 ^{ab}	0.38 ^{ab}	21.67 ^b	23.84 ^b	25.91 ^b	27.03 ^b
T_{19}	26.95 ^{ij}	25.72 ^{hi}	24.47 ^h	22.44 ^h	0.59 ^{ab}	0.60 ^{ab}	0.62 ^{ab}	0.63 ^{ab}	68.05 ^a	69.34 ^a	70.72 ^a	72.32 ^a

*Means in the same column with different letters are significantly different ($p < 0.05$).

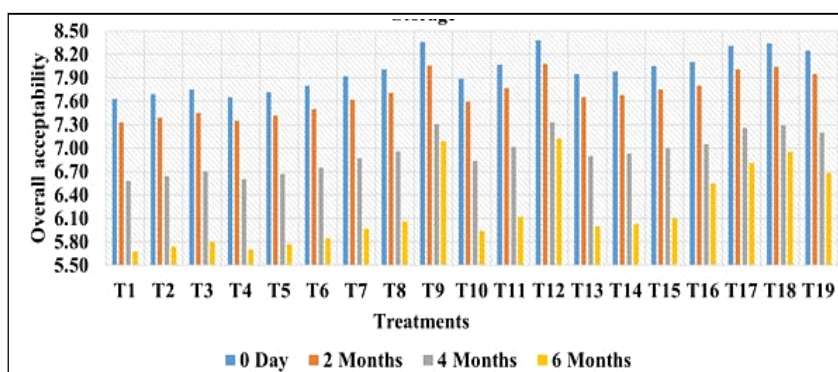


Fig 4: Overall acceptability of low calorie papaya jam infused with gum tragacanth and chia seed.

over time and low-calorie fruit nectars incorporating stevioside as a natural sweetener.

Titrateable acidity (%)

In Table 3, the impact of gum tragacanth and chia seeds on titrateable acidity (%) in low-calorie papaya jam is detailed. The addition of chia seeds and gum tragacanth significantly altered acidity ($p < 0.05$) during storage and treatments. Initial acidity levels of T_1 and T_{12} samples were 0.65% and 0.30%, respectively, gradually rising to 0.69% and 0.34%, respectively. This rise may stem from organic acids formed through polysaccharide breakdown, aligning with Sutwal *et al.* (2019), who observed increased acidity in apple jam over 28 days and similar trends in strawberry marmalade (Özbek *et al.*, 2019) and sugar-free sea buckthorn marmalades (Nistor *et al.*, 2021).

Total soluble solid (TSS) (°B)

Incorporating gum tragacanth and chia seeds into papaya jam significantly altered the TSS content during treatment and storage ($p < 0.05$) (Table 3). The total soluble solids (TSS) data indicated minor alterations during room temperature storage, with an overall increase in TSS over time. The total soluble solids (TSS) of the standard jam were recorded as 68.05°B. The sample T_{12} exhibited the highest mean value (27.10°B) compared to T_1 (21.15°B), attributed to the higher sugar concentration in standard jam. The rise in total soluble solids may result from acid-induced polysaccharide breakdown into simple sugars during storage, releasing soluble sugars in the product. These findings align with previous studies on pineapple jam, strawberry marmalade and sour cherry jam, highlighting the impact of added components on TSS dynamics during storage (Nduko *et al.*, 2018; Özbek *et al.*, 2019; Nourmohammadi *et al.*, 2021).

Texture analysis

Firmness and cohesiveness

In the investigation of low-calorie papaya jam, the incorporation of gum tragacanth and chia seeds significantly influenced ($p < 0.05$) firmness and cohesiveness, as

illustrated in Fig 2 and Fig 3. The firmness of fresh samples (6.90 N–7.71 N) increased to 7.02 N–7.83 N over the storage period, aligning with the findings of Shokrane *et al.* (2023), indicating improved structure with fiber substitution. Cohesiveness, ranging from 0.78 N–0.85 N initially, increased to 0.88 N–0.95 N during storage due to incorporation of gum tragacanth and chia seeds. Similar findings were reported by Nejatian *et al.* (2019) and Özbek *et al.* (2019) in low-calorie dairy desserts and strawberry marmalade, respectively. These results highlight the positive impact of fiber on texture attributes, echoing similar findings in related studies (Ghasemi *et al.*, 2017).

Organoleptic analysis

Overall acceptability

During the six-month storage period, the overall acceptability of all jam samples declined significantly ($p < 0.05$). The overall acceptability of standard sample decreased from 8.25 to 6.68 during storage period. For the samples, T_1 had an initial acceptability of 7.63, decreasing to 5.68 and T_{12} had 8.38, declining to 7.12 over time (Fig 4). The reduction in organoleptic quality parameter which includes color, aroma, flavor and taste with prolonged storage reflected the decline in overall acceptability, consistent with the findings of Sutwal *et al.* (2019) and Kumar *et al.* (2020) who observed similar trends in apple jam and guava-papaya jam, respectively.

CONCLUSION

This study provided a comprehensive analysis of how gum tragacanth and chia seeds influences the physicochemical and sensory attributes of low-calorie papaya jam over six-month storage. The findings highlight substantial improvement in the physicochemical characteristics of the low-calorie papaya jam through the incorporation of gum tragacanth and chia seeds. Notably, the organoleptic assessments reveal sustained texture and overall acceptability throughout the storage duration. T_{12} (S3C1P1) (stevia @ 10 gm/kg + chia seeds @ 6.25%/kg + potassium metabisulphite @ 100 mg/kg) emerged as the optimal treatment, excelling in both physicochemical and sensory

aspects. This research highlights the potential of gum tragacanth and chia seeds as viable alternatives to traditional thickening agents, presenting a health-conscious option without associated health concerns. The study's significance lies in its contribution to formulating high-quality, low-calorie jam, by utilizing gum tragacanth and chia seeds for enhanced quality and disease protection. Moreover, the investigation aligns with Sustainable Development Goals (SDGs), particularly Zero Hunger by preserving fruits through jam production, ensuring accessibility for an extended period. Additionally, it contributes to Good Health and Well-being by exploring gum tragacanth and chia seeds as healthful substitutes for pectin, fostering the creation of nutritious, low-calorie food choices while upholding food safety and quality through comprehensive assessments of storage stability, compositional changes and sensory properties.

Conflict of interest

The authors declare no conflict of interest among them.

REFERENCES

- Adamczyk, G., Ivanišová, E., Kaszuba, J., Bobel, I., Khvostenko, K., Chmiel, M. and Falendysh, N. (2021). Quality assessment of wheat bread incorporating chia seeds. *Foods*. 10(10): 2376. doi: 10.3390/foods10102376.
- Alqahtani, N.K., Alnemr, T.M., Ahmed, A.R. and Ali, S. (2022). Effect of inclusion of date press cake on texture, color, sensory, micro structure and functional properties of date jam. *Processes*. 10(11): 2442. doi: 10.3390/pr10112442.
- Anwar, S., Saleem, A., Razzaq, A., Nasir, M. A., Hussain, A., Tariq, M.R., Ali, S.W., Intisar, A., Safdar, W., Umer, Z., Basharat, Z., Ali, U., Mehmood, H. and Masood, S. (2023). Nutritional probing and storage stability of papaya jam supplemented with date pit powder. *Heliyon*. 9(5) doi: 10.1016/j.heliyon.2023.e15912.
- AOAC, (2000). Official Methods of Analysis. In: The Association of Official Analytical Chemists, fifteenth ed., (Arlington, USA).
- Basary, M.R.H., Premakumar, K. and Afreen, S.M.M.S. (2022). Development and storage study of mixed fruit jams from papaya and pineapple incorporated with Aloe vera. *Asian Journal of Dairy and Food Research*. 41(3): 351-355. doi: 10.18805/ajdfr.DRF-255.
- Basharat, S., Huang, Z., Gong, M., Lv, X., Ahmed, A., Hussain, I. and Liu, L. (2021). A review on current conventional and biotechnical approaches to enhance biosynthesis of steviol glycosides in *Stevia rebaudiana*. *Chinese Journal of Chemical Engineering*. 30: 92-104.
- Basu, S. and Singha, S. (2023). Influence of sugar substitutes in rheology of fruit gel. In *Advances in food rheology and its applications*. Woodhead Publishing. pp. 385-411.
- FAO Faostat, (2020). Date, the food and agriculture organization of the United Nations [Last accessed on 2020 Jun10], <http://www.faostat.fao.org/faostat/en/#data/QC>, 2018.
- Ghasemi, A., Shahedi Baghe Khandan, M. and Yasini Ardakani, S. A. (2017). The Effect of Persian Gums and Tragacanth on Texture and Sensory Characteristics of Non-gluten Cakes. *Journal of Nutrition and Food Security*. 2(3): 221-230.
- Indian Horticulture Database. (2021). National Horticulture Board, Ministry of Agriculture, Government of India, Gurugram, Haryana, India.
- Kosiorowska, A., Pietrzyk, S., Pajak, P. and Socha, R. (2022). The effect of the addition of gold flax (*Linum usitatissimum* L.) and chia seeds (*Salvia hispanica* L.) on the physicochemical and antioxidant properties of cranberry jams. *European Food Research and Technology*. 248(11): 2865-2876. doi: 10.1007/s00217-022-04096-7.
- Kumar, S., Gehlot, R., Sindhu, R. and Malik, T. (2020). Changes in chemical constituents and overall acceptability of guava-papaya jam during storage. *Journal of Pharmacognosy and Phytochemistry*. 9(3): 1278-1281.
- Meilgaard, M.C., Carr, B.T. and Civille, G.V. (1999). *Sensory Evaluation Techniques*. CRC Press.
- Nduko, J.M., Maina, R.W., Muchina, R.K. and Kibitok, S.K. (2018). Application of chia (*Salvia hispanica*) seeds as a functional component in the fortification of pineapple jam. *Food Science and Nutrition*. 6(8): 2344-2349.
- Nejatian, M., Jonaidi-Jafari, N., Abbaszadeh, S., Saberian, H., Darabzadeh, N. and Ghanizadeh, G. (2019). Using the mixture design approach to predict the rheological properties of low-calorie dairy desserts containing gum tragacanth exuded by three Iranian *Astragalus* species. *Food Science and Biotechnology*. 28(2): 405-412. doi: 10.1007/s10068-018-0496-9.
- Nistor, O.V., Bolea, C.A., Andronoiu, D.G., Cotârle, M. and Stănciuc, N. (2021). Attempts for developing novel sugar-based and sugar-free sea buckthorn marmalades. *Molecules*. 26(11): 3073. doi:10.3390/molecules26113073.
- Nkansah, A.M. (2022). Quality characteristics and acceptability of jam produced from pineapple (*Ananas comosus*) and carrot (*Daucus carota* L.) blends. *Asian Journal of Dairy and Food Research*. 41(4): 431-437. doi: 10.18805/ajdfr.DRF-268.
- Nourmohammadi, A., Ahmadi, E. and Heshmati, A. (2021). Optimization of physicochemical, textural and rheological properties of sour cherry jam containing stevioside by using response surface methodology. *Food Science and Nutrition*. 9(5): 2483-2496. doi: 10.52547/fsct.18.118.363
- Özbek, T., Sahin-Yeşilçubuk, N. and Demirel, B. (2019). Quality and nutritional value of functional strawberry marmalade enriched with chia seed (*Salvia hispanica* L.). *Journal of Food Quality*. doi: 10.1155/2019/2391931.
- Pinandoyo, D.B. and Masnar, A. (2020). Changes in chemical constituents and overall acceptability of papaya jam fortified with soya protein during storage. *Menara Perkebunan*. 88(1). <https://doi.org/10.22302/iribb.jur.mp.v88i1.361>.
- Pourashouri, P., Shabanpour, B., Heydari, S. and Raeisi, S. (2021). Encapsulation of fish oil by carrageenan and gum tragacanth as wall materials and its application to the enrichment of chicken nuggets. *LWT*. 137(2): 110-334. doi: 10.1016/j.lwt.2020.110334.
- Sharma, M., Pondicherry, K.S. and Duizer, L. (2022). Understanding relations between rheology, tribology and sensory perception of modified texture foods. *Journal of Texture Studies*. 53(3): 327-344.

- Shokraneh, N., Alimi, M., Shahidi, S.A., Mizani, M., Bameni Moghadam, M. and Rafe, A. (2023). Textural and rheological properties of sliceable ketchup. *Gels*. 9(3): 222. doi: 10.3390/gels9030222.
- Suryawanshi, N.A., Patil, Y.N., Ramod, S.S. and Terde, S.H. (2022). Effect of prebiotics on physico-chemical and sensory properties of synbiotic Shrikhand blended with Papaya pulp. *Asian Journal of Dairy and Food Research*. 41(2): 178-182. doi: 10.18805/ajdfr.DR-1746.
- Sutwal, R., Dhankhar, J., Kindu, P., Mehla, R. (2019). Development of low calorie jam by replacement of sugar with natural sweetener stevia. *Int J. Cur. Res. Rev*. 11(04): 10. doi: 10.31782/IJCRR.2019.11402.
- Ugbogu, E.A., Dike, E.D., Uche, M.E., Etumnu, L.R., Okoro, B.C., Ugbogu, O.C., *et al.* (2023). Ethnomedicinal uses, nutritional composition, phytochemistry and potential health benefits of carica papaya. *Pharmacological Research- Modern Chinese Medicine*. 7(2): 100-266. doi: 10.1016/j.prmcm.2023.100266.