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Influence of Sucrose Substitution with Stevioside on Quality Attributes of Sour Orange Jam

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ABSTRACT
A key objective nowadays is to develop food products that are high in nutritional value, low in calories, and highly acceptable to consumers. The goal of this study was to substitute sucrose with stevioside (0, 25, 50, 75, and 100%) in the manufacture of sour orange jams. The findings indicated that substitution of stevioside for sucrose at various levels significantly ($p< 0.05$) affected the physical, chemical, and organoleptic characteristics of prepared jams. The amount of total carbohydrates, and calories significantly decreased as the stevioside content increased. Conversely, there was a rise in the dry weight basis content of protein, crude fat, ash, and crude fiber. This study is considered to be the cornerstone for developing orange jam to accommodate various healthy diets.

INTRODUCTION

Citrus aurantium L. (*Rutaceae*) is also known as bitter orange, sour orange, and seville orange (Suntar *et al*., 2018). In many cultures, sour oranges have been used as a traditional food. In Egypt, is usually used as jam and/or juice (Ersus & Cam, 2007; Lim, 2012), India utilized it in yoghurt products and used it as a flavoring agent with hot pepper (Zhang *et al*., 2007). Moreover, it is used in traditional Chinese medicine (Stohs & Shara, 2007). One of the most important active components in sour orange is synephrine alkaloids, which are used to cure gastrointestinal irritation (Ghassem & Fatemeh, 2011), reduce obesity (Bent *et al*., 2004; Haaz *et al*., 2006), have anti-amnesic properties, and anti-osteoporotic effects (Farag *et al*., 2020).

Jam manufacturing is based on the correct formation of "sugar-pectin-acid" gels (Watson, 1966). The jam products were manufactured with high amounts of soluble solids to increase shelf life. However, sugar and pectin alone are insufficient for product forming. Equally important is the fruit, which results in a definite equilibrium in the “pectin-acid-sugar” system (Breverman, 1963). Pectin is used as a functional food in low-calorie foods as fat or sugar substitute (Lobato-Calleros *et al* 2006). It is estimated most of commercial pectin production is used in the production of jellies and jams (Thakur *et al*, 1997). Reduced calories are nutritionally altered products that contain 25% less nutrients or calories than a reference food (Abdullah & Cheng, 2001).

In traditional jams, the total soluble solid content ranged 60-65% or greater, and the product should contain at least 45% fruit (CODEX, 2009). Because of their high sugar content, the consumption of jams contributes to hyperglycemia in diabetics. For diabetics who suffer from hyperglycemia, alternative jams containing artificial sweeteners should be available (Gajar & Badrie 2002). Low-calorie sweeteners have been widely used for a long time by consumers who are concerned about their health and calories in their daily diet (Choi & Chung, 2015). Steviol glycosides (steviosides) are highly sweet natural compounds from *Stevia rebaudiana* Bertoni leaves, which have recently been approved as sweeteners for a range of foods (Zahn *et al*., 2013). Stevioside, an abundant component of *Stevia rebaudiana* leaves, is known for its intense sweetness (250-450 times sweeter than sucrose) and is used as a non-caloric sweetener in several countries. (Chatsudthipong & Muanprasat, 2009). The major components of the leaf are stevioside (5-10% of total dry weight), rebaudioside A (2-4%), dulcoside A (0.4-0.7%) and rebaudioside C (1-2%), (Wood *et al*., 1955).

Manufacturers, commercial businesses, and the general public are drawn to the growing need for fruit preserves with fewer calories and sugar. Sucrose, on the other hand, interacts with pectin to enable gel formation; therefore, it is impossible to reduce or eliminate sucrose in traditional jam making methods without negatively impacting the quality of the final product (Popel et al., 2013). The aim of this work was to develop reduced-sugar jams from sour oranges that included stevioside and to investigate their chemical, physicochemical, and sensory properties.

MATERIAL AND METHODS

2.1. Materials:

All chemicals used in this study were of analytical grade. Citrus aurantium - sour orange - fruits were purchased from the citrus farm in Om-elreda, Damietta Governorate, Egypt in January 2022. The fruits were identified at the Botany Department, Faculty of Agriculture, Damietta University. Sugar and jars were purchased from Damietta Hypermarkets.

2.2. Jam formulation and manufacturing

After cleaning the sorted fruits, the fruits are scraped into the crust to decrease the bitterness of the compounds in the peel. The peel was cut to a small size (0.5 Cm X 3 Cm) and soaked in water for 24 h. in accordance with the traditional method used in Egypt. These slices softening by soaking in hot water, and heating until tender; the water is replaced twice at least during process (Vibhakara & Bawa 2010). The juice and peel were then mixed using the jam formulation shown in Table 1.

Table 1. The formula used for the manufacturing of jam from sour orange fruits

Treats		Sucrose %	Steviosides g/kg	Pectin g/kg	Gelatin g/kg	Peels %	Juice %	CMC g/kg	Sodium benzoate %
Control		50	-	-	-	30	20	-	-
Pectin+ Gelatin	PG1	35	0.15	1.2	1	40	25	0.05	0.1
	PG2	25	0.35	2.4	2	45	30	0.1	0.1
	PG3	15	0.50	3.6	3	50	35	0.2	0.1
	PG4	-	1.02	4.8	4	60	40	0.3	0.1
Pectin	P1	35	0.15	1.2	-	40	25	0.05	0.1
	P2	25	0.35	2.4	-	45	30	0.1	0.1
	P3	15	0.50	3.6	-	50	35	0.2	0.1
	P4	-	1.02	4.8	-	60	40	0.3	0.1

Control: 100% sucrose, PG1: 75% sucrose +25%stevioside + pectin + Gelatin, PG2: 50% sucrose + 50%stevioside + pectin + Gelatin, PG3: 25% sucrose + 75%stevioside + pectin + Gelatin, PG4: 100%stevioside + pectin + Gelatin, P1: 75% sucrose + 25%stevioside + pectin, P2: 50% sucrose+50%stevioside + pectin, PG3: 25% sucrose+75%stevioside + pectin, PG4: 100% stevioside + pectin (The percentage of sucrose and stevioside was calculated according to its sweetness)

2.3. Analytical methods

2.3.1. Physical analysis:

A pH meter (3510 Jenway, England) was used to measure pH values of fresh fruit and prepared jams**.** Total soluble solids (TSS %) was determined using a hand-refractometer (Atago, Japan) at room temperature (AOAC, 2012). TSS/Acidity was used to measure the sucrose to acid ratio (Lacey *et al.*, 2001). Color was determined instrumentally, the **(**L*a*b*) by a colorimeter (Konica Minolta CM3600A, Osaka, Japan) (CIE, 2004).

2.3.2. Chemical analysis:

Moisture, protein, fat, fiber, ash, carbohydrate, and titratable acidity (as citric acid % w/v) were determined following the A.O.A.C (2012). The calorific value was calculated according to (FAO/WHO, 1970) as following 1g fat equal 9 Cal and 1 g for protein and carbohydrate equal 4 cal.

2.4. Texture profile

Texture properties of jam were determined (Brookfield CT3-texture analyzer) using cylindrical prop with 12.5 mm * 20 mm depth. Test speed was 10 mm and trigger force 10 g, (Mahmoud *et al.*, 2021).

2.5. Sensory evaluation

A group of 10 panelists assessed the prepared sour orange jams according to sensory criteria such as color, texture, odor, taste, and overall acceptability. The panelists were asked to rank the sensory characteristics (very dislike (1), dislike (2-4), fair (5-6), like (7-8), and highly like (9-10)), the mean ratings for the three assessments were determined. All sensory studies were carried out under the guidance of the Food-Industries Department at Damietta University, Egypt (Mahmoud *et al.*, 2021).

2.6. Statistical analysis

The results were presented as means of triplicates. One-way analysis of variance (ANOVA) was performed using SAS software (Ver. 9.4) to test significance variations between sample means at $p < 0.05$.

RESULTS AND DISCUSSION

3.1. Physical indices

3.1.1. pH value and titratable acidity

It is known gel formation in the jam industry occurs only within a certain range of pH, that the optimum pH around 3.0 (Vibhakara & Bawa. 2010). Lopez (1981) noted that the optimum pH for gel formation must be occurring between 3.2 and 3.6. Higher than pH 4, gel formation does not occur in the usual soluble solid range (Vibhakara & Bawa, 2010). As shown in Table 2, there were significant differences in pH values of the prepared sour orange jam as a result of replacing sucrose with stevioside among the studied treatments. The pH of the studied sour orange jam samples ranged from 3.37-3.58. A decrease in pH value of the sour orange jam was observed as the amount of sucrose decreased. In this respect, Jribi et al. (2021) found that partial substitution with steviosides decreased pH of the studied samples. They added that a decrease in pH value might be due to the increase in the amount of sour orange used in the recipes as the sucrose content decreased. Concerning the titratable acidity of sour orange jam, one of the distinguishing features of sour orange is the distinctive acidity taste, which was clearly evident in the high acidity of the samples. Data in the same table indicated that replacing sucrose with stevioside had a significant effect on titratable acidity of sour orange jam among the studied treatments. The titratable acidity value of the control jam (2.81) increased to 4.49 (PG4) and 4.93 (P4). The increase in acidity may be due to the increases in the amount of sour orange used in the recipes as the sucrose content decreased. The ability to preserve jams increases with increasing acidity (Vibhakara & Bawa, 2010).

3.1.2. Total Soluble Solids% (TSS %) and TSS/Acid ratio

The results in Table 2 show that there were significant differences ($p<0.05$) in total soluble solids% of sour orange jam among the different treatments. TSS% values for sour orange jam among the studied different treatments ranged from 10.73 to 68.92°Br. The highest value (68.92ºBr.) of TSS% was noted for the control jam sample, which usually occurs within the jam ranges of 65-70 ºBr (Joseph and Havighorst, 1952). The lowest TSS% values were found in PG4 and P4, 11.06°and 10.73°Br, respectively, which contained stevioside as a sweetening agent and substitute for sucrose. There was a positive relationship between sucrose content and TSS% value of sour orange jam among the studied treatments, where the highest value of sucrose content was the highest in TSS% value for sour orange jam. TSS% of sour orange jam is primarily represented by sucrose, with acids and minerals contributing according to the Codex Alimentarius standard (CODEX, 2009). A decrease in soluble solids in low-sucrose jams has been previously reported (Sutwal *et al*., 2019; Stamatovska *et al*., 2017). The obtained values of <60°Brix would imply storing the jam below 5 °C after opening (Ferreira *et al*., 2004).

Table 2. Effect of replacing sucrose by stevioside at different rates on physical indices of prepared sour orange jam.

Treats.	pH value	Titratable acidity*	TSS (Brix)	TSS/Acidity
Raw Juice	3.08^{h}	1.78^{h}	10.03^{g}	5.63^{h}
Control	3.52^{bc}	2.81^{g}	68.92^{a}	24.52^{a}
PG1	3.54^{b}	3.01^{f}	57.03^{b}	18.90^{b}
PG2	3.54^{b}	3.05^{f}	44.06^{d}	14.44^{d}
PG3	3.48^{cd}	3.90^{d}	30.50^{e}	7.80^{f}
PG4	3.40^{fg}	4.49^{b}	11.06^{g}	2.46^{i}
P1	3.58^{a}	2.78^{g}	49.30^{c}	17.73^{c}
P2	3.46^{de}	3.24^{e}	42.90^{d}	13.24^{e}
P3	3.43^{ef}	4.05^{c}	29.03^{f}	7.16^{g}
P4	3.37^{g}	4.93^{a}	10.73^{g}	2.17^{i}
LSD	0.040	0.054	1.184	0.313

*(as citric acid %w/v), Means in a column that are not followed by the same letter are significantly different ($p <0.05$).Control: 100% sucrose, PG1: 75% sucrose +25%stevioside + pectin + Gelatin, PG2: 50% sucrose + 50%stevioside + pectin + Gelatin, PG3: 25% sucrose + 75%stevioside + pectin + Gelatin, PG4: 100%stevioside + pectin + Gelatin, P1: 75% sucrose + 25%stevioside+pectin,P2: 50% sucrose+50%stevioside+pectin, PG3:25% sucrose+75%stevioside + pectin, PG4: 100% stevioside + pectin

The replacing sucrose with stevioside had a significant effect on the TSS/acid ratio of sour orange jam among the studied treatments (Table 2). The lowest value of TSS/Acid ratio indicates an increase in the sour taste of sour orange jam, and the highest value indicates an increase in the amount of sucrose and thus an increase in the sweet taste. The highest value of TSS/acid was found in control 24.52 and it decreased gradually with sucrose content. The lowest TSS/acid ratio (2.46 and 2.17) was found in PG4 and P4, respectively. Singh *et al*. (2009) reported that the TSS/acid ratio ranged from to 12-60 for different fruit pulp combinations. TSS/acidity ratio is also a better indicator of consumer acceptability than either sucrose or acid alone (Coombe *et al.*, 1980).

3.2. Chemical composition of sour orange jam

The chemical composition of sour orange jam treated by replacing sucrose with stevioside at different ratios (crude fiber, crude protein, ash, crude fat, and total carbohydrate) is displayed in Table 3.

Table 3. Effect of replacing sucrose by stevioside at different ratios on chemical composition of prepared sour orange jam.

Treats.		Moisture %	Protein %	Fat %	Fiber %	Ash %	Carbs %
Con.	ww	17.82^{h}	1.07^{de}	4.25^{b}	7.25^{b}	0.652^{cd}	67.9^{a}
	dw	-	1.30^{F}	5.17^{H}	8.83^{F}	0.79^{G}	82.63^{A}
PG1	ww	37.68^{g}	1.67^{a}	3.92^{c}	5.98^{d}	0.662^{c}	49.72^{b}
	dw	-	2.69^{D}	6.29^{F}	9.59^{F}	1.06^{F}	79.79^{A}
PG2	ww	46.21^{e}	1.56^{ab}	3.92^{c}	6.50^{c}	0.654^{cd}	39.14^{d}
	dw	-	2.90^{CD}	7.30^{E}	12.09^{E}	1.21^{E}	72.79^{B}
PG3	ww	57.52^{c}	$1.41b^{c}$	6.01^{a}	9.81^{a}	0.802^{ab}	26.64^{f}
	dw	-	3.33^{C}	14.15^{C}	23.10^{C}	1.88^{D}	62.74^{D}
PG4	ww	82.13^{a}	0.89^{ef}	2.86^{f}	5.35^{e}	0.694^{c}	9.66^{g}
	dw	-	5.01^{A}	16.05^{B}	29.99^{A}	3.88^{B}	52.64^{E}
P1	ww	40.56^{f}	1.25^{cd}	3.29^{e}	5.84^{d}	0.62^{d}	48.29^{c}
	dw	-	2.11^{E}	5.54^{G}	9.82^{F}	1.01^{F}	81.25^{A}
P2	ww	51.46^{d}	1.21^{d}	3.66^{d}	6.24^{cd}	0.643^{cd}	35.79^{e}
	dw	-	2.50^{DE}	7.55^{E}	12.87^{E}	1.32^{E}	73.75^{B}
P3	ww	60.57^{b}	1.24^{cd}	4.12^{b}	7.64^{b}	0.836^{a}	26.29^{f}
	dw	-	3.15^{C}	10.45^{D}	19.39^{D}	2.12^{C}	66.68^{C}
P4	ww	81.72^{a}	0.73^{f}	3.14^{e}	5.21^{e}	0.751^{b}	9.40^{g}
	dw	-	4.04^{B}	17.18^{A}	28.57^{B}	4.11^{A}	52.90^{E}

ww :wet weight, **dw**: dry weight. Means in a column that are not followed by the same letter are significantly different ($p <0.05$). Control: 100% sucrose, PG1: 75% sucrose +25%stevioside + pectin + Gelatin, PG2: 50% sucrose + 50%stevioside + pectin + Gelatin, PG3: 25% sucrose + 75%stevioside + pectin + Gelatin, PG4: 100%stevioside + pectin + Gelatin, P1: 75% sucrose + 25%stevioside + pectin, P2: 50% sucrose+50%stevioside + pectin, PG3: 25% sucrose+75%stevioside + pectin, PG4: 100% stevioside + pectin

The results demonstrated that there were significant differences in the chemical composition of sour orange jam as a result of replacing sucrose with stevioside at different ratios among the studied treatments. There was a gradual increase in the content of protein, fat, crude fiber, and ash (on a dry weight basis) in sour orange jam as a result of an increase in sucrose replacement by stevioside from 0-100%. In addition, the crude fiber content of sour orange jam gradually increased from 8.83% in the control sample to 29.99% and 28.57% in PG4 and P4, respectively, as the amount of sucrose decreased, which gives an extra advantage to sour orange jam. The highest moisture content in sour orange jam as a result of an increase in sucrose replacement by stevioside indicates the shortest storage time (Jribi *et al*., 2021). Therefore, preservatives should be used with an increase in sucrose replacement by stevioside to increase storage time. In addition, the data in the same table showed that substitution of sucrose with stevioside gradually reduced the total carbohydrate content of the prepared jam. These data show the same trend as that observed by Sheet (2022); Elsebaie &Mostafa (2018).

3.3. Texture profile

The results presented in Table 4 showed that there were considerable differences in the textural properties of sour orange jam as a result of replacing the sucrose with stevioside at different ratios among the studied treatments. The texture profile of sour orange jam showed a decrease in firmness and gumminess for all types of jams compared to the control. The sour orange jam with the highest sucrose content had the highest firmness value of all types of jams. The cohesiveness of pectin/gelatin (PG) treatments was higher than that of pectin and control treatments. Gelatin gels formed reversibly upon cooling the gelatin solution. It is now well established that protein molecules are cross-linked to form a network of junction zones, where the protein chain is partly refolded in the collagen triple helix structure (Veis, 1964). Therefore, it can be noted that the treatments containing gelatin were the higher in the firmness, cohesiveness, adhesive force and gumminess of than the samples containing only pectin. Fruit peel contains pectin and shows a high water-holding capacity, which aids in gel formation and texture stability of the product by avoiding syneresis and giving it a desired shape and firmness (Younis *et al.*, 2015). Fruit dietary fiber can prevent syneresis by binding to released water (Kuntz, 1994).

Table 4. Effect of replacing sucrose by stevioside at different rates on texture profile of prepared sour orange jam.

Treats	Firmness (N)	Cohesiveness	Adhesive-force (N)	Gumminess (N)
Control	8.43	0.822	1.42	6.93
PG1	4.13	0.852	2.74	3.52
PG2	2.95	0.900	1.23	2.65
PG3	2.36	0.960	3.43	2.26
PG4	1.01	0.950	0.39	0.96
P1	0.83	0.840	0.30	0.70
P2	1.58	0.867	0.43	1.37
P3	1.37	0.830	0.52	1.00
P4	1.82	0.863	1.04	1.57

Control: 100% sucrose, PG1: 75% sucrose +25%stevioside + pectin + gelatin, PG2: 50% sucrose + 50%stevioside + pectin + gelatin, PG3: 25% sucrose + 75%stevioside + pectin + gelatin, PG4: 100%stevioside + pectin + gelatin, P1: 75% sucrose + 25%stevioside + pectin, P2: 50% sucrose+50%stevioside + pectin, PG3: 25% sucrose+75%stevioside + pectin, PG4: 100% stevioside + pectin

3.4. Color properties

Color is one of the most important criteria for quality assessment of jams (Banas *et al.*, 2018). the influence of sucrose substitution with stevioside on the color indices of sour orange jam samples, that is, International Commission on Illumination CIE L* (lightness), a* (redness), and b* (yellowness), are shown in Table 5. The L* parameter determining the color brightness ranged from 26.53 to 41.36 (Table 5). The control had the lowest L*value (26.53), whereas it increased in the rest of the treatments. This can be attributed to two reasons. The first reason is that the gradual decrease in the amount of sucrose causes a decrease in the brown color resulting from the caramel and Millard reactions. Second, with the decrease in sucrose, the light-colored fruit increased, which eventually led to a gradual increase in the L*value. In the jam samples, the value of parameter a * was in the range of 1.54-5.66. Replacing sucrose with stevioside in sour orange increased the value of the a* parameter, compared to the control, which indicates a reduction in the proportion of the red/brown color. The results showed that the values of the b* parameter were within the range of yellow coloration (3.62-18.94). The lowest values were observed for the control group. However, with an increase in the amount of sour orange, the amount of yellow color increased, and thus, the value of b* increased. Similar results have been reported by (Jribi *et al*. (2021) and Vilela *et al*. (2015). Basu *et al*. (2013) reported a close and direct relationship between the soluble solid content and color of jam.

Table 5. Effect of replacing sucrose by stevioside at different ratios on color properties of prepared sour orange jam.

Treatments	*L**(D65)	*a**(D65)	*b**(D65)
Control	26.53 [e]	1.54 [c]	3.62 [h]
PG1	27.77 [e]	1.56 [c]	5.55 [g]
PG2	29.96 [d]	3.43 [b]	9.27 [e]
PG3	31.55 [c]	5.12 [a]	10.84 [d]
PG4	41.1 [a]	5.27 [a]	18.04 [b]
P1	27.42 [e]	2.05 [c]	6.69 [f]
P2	29.54 [d]	3.23 [b]	9.54 [e]
P3	33.92 [b]	4.04 [b]	14.36 [c]
P4	41.36 [a]	5.66 [a]	18.94 [a]
LSD	1.238	0.841	0.843

Means in a column that are not followed by the same letter are significantly different ($p < 0.05$).Control: 100% sucrose, PG1: 75% sucrose +25%stevioside+pectin+Gelatin,PG2:50%sucrose+50%stevioside+pectin+Gelatin,PG3:25%sucrose+75%stevioside+pectin+Gelatin,PG4:100%stevioside +pectin +Gelatin,P1:75%sucrose+25%stevioside+pectin,P2:50% sucrose+50%stevioside + pectin, PG3: 25% sucrose+75%stevioside + pectin, PG4: 100% stevioside + pectin

3.5. Organoleptic proprieties

Sour oranges have a bitter taste, which reduces their use in the preparation of food products. Therefore, the sour orange peel was soaked in water to remove the bitter taste and used with sour orange juice to make jam, and the obtained products were organically evaluated, as shown in Table (6). Statistical analysis of sensory characteristics of studied jams showed significant differences in sensory indices, that is, color, taste, odor, texture, and general acceptability, compared with the control group (100% sucrose). The substitution of sucrose with stevioside had a significant effect on the sensory properties of sour orange jam samples. The lightest-colored jam, which had the lowest value of sucrose, affected the appearance of the jam. However, the sensory evaluation for color remained higher than 7 until reaching 20% sucrose when using (gelatin + pectin) and 30% sucrose when using pectin only. A significant gradual increase in the aromatic odor was observed as the percentage of sour orange used increased, and all treatments outperformed the control. In general, the values of taste and texture were higher than 7, and similarly, the values of general acceptance, except for sample P4. Despite the importance of health information regarding a product, such as its nutrient content or low sucrose content, the organoleptic properties of the product remain a major factor in consumer choice (Markey *et al*., 2015; Grunert, 2003). In this study, the results obtained from the organoleptic properties were within an acceptable range, in addition to the health value of the product.

Table 6. Effect of replacing sucrose by stevioside at different ratios on organoleptic proprieties of prepared sour orange jam

Treats.	Color (10)	Oder (10)	Taste (10)	Texture (10)	General Acceptability (10)
Con.	8.83[a]	7.61[f]	9.00[a]	9.00[a]	9.00[a]
PG1	8.44[b]	8.00[de]	8.83[a]	9.00[a]	8.94[a]
PG2	8.00[c]	8.22[cd]	8.27[b]	9.00[a]	8.77[ab]
PG3	7.55[d]	8.44[bc]	7.88[cd]	8.66[b]	8.55[bc]
PG4	6.83[e]	8.83[a]	7.11[e]	7.88[d]	7.27[e]
P1	8.55[ab]	7.77[ef]	8.66[a]	9.00[a]	8.94[a]
P2	7.61[d]	8.11[d]	8.00[bc]	8.88[ab]	8.38[c]
P3	6.94[e]	8.61[ab]	7.61[d]	8.22[c]	7.66[d]
P4	6.38[f]	8.66[ab]	7.55[d]	7.11[e]	6.94[f]

Means in a column that are not followed by the same letter are significantly different ($p < 0.05$). Control: 100% sucrose, PG1: 75% sucrose +25%stevioside + pectin + gelatin, PG2: 50% sucrose + 50%stevioside + pectin + gelatin, PG3: 25% sucrose + 75%stevioside + pectin + gelatin, PG4: 100%stevioside + pectin + gelatin, P1: 75% sucrose + 25%stevioside + pectin, P2: 50% sucrose+50%stevioside + pectin, PG3: 25% sucrose+75%stevioside + pectin, PG4: 100% stevioside + pectin

3.6. Calorie value

As shown in Table 7, the amount of calories in the control sample was 314.17 Calories, a significant gradual decrease in calories was observed with a decrease in sucrose of samples until it reached 67.04 Calorie and 69.88 Calorie in samples PG4 and P4, respectively. The WHO guidelines recommend maintaining the intake of sucrose to less than 10% of the total energy intake, which can lead to a reduction in the risk of obesity (WHO, 2015).

Table 7. The amount of calories of prepared sour orange jam

Treatments	Calorie/100g	Reduction%	%CDI
Control	314.17[a]	-	15.70[a]
PG1	240.89[b]	23.32[g]	12.04[b]
PG2	198.18[d]	36.91[e]	9.90[d]
PG3	166.36[f]	47.04[c]	8.31[f]
PG4	67.04[h]	78.66[a]	3.35[h]
P1	227.85[c]	27.47[f]	11.39[c]
P2	181.09[e]	42.35[d]	9.05[e]
P3	147.26[g]	53.12[b]	7.36[g]
P4	69.88[h]	77.75[a]	3.49[h]

% CDI Calorie daily intake FDA 2000 calorie (Williams, 2015). Means in a column that are not followed by the same letter are significantly different ($p < 0.05$). Control: 100% sucrose, PG1: 75% sucrose +25%stevioside + pectin + gelatin, PG2: 50% sucrose + 50%stevioside + pectin + gelatin, PG3: 25% sucrose + 75%stevioside + pectin + gelatin, PG4: 100%stevioside + pectin + gelatin, P1: 75% sucrose + 25%stevioside + pectin, P2: 50% sucrose+50%stevioside + pectin, PG3: 25% sucrose+75%stevioside + pectin, PG4: 100% stevioside + pectin.

CONCLUSION

This study focused on the use of stevioside as a substitute for sucrose in the manufacture of sour orange jams. The substitution of sucrose with stevioside gradually reduced the total carbohydrate content of the prepared jams. Fruit dietary fiber can prevent syneresis by binding to released water. An increase in sugar replacement with stevioside in sour orange jams indicated the shortest storage time. Therefore, preservatives should be used to increase storage time. We recommend conducting further studies on the shelf life of low-calorie jams. In addition to completing its standard specifications of low-calorie jams as a result of different TSS% and shelf life compared with traditional jams.

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CONFLICT OF INTEREST:

The authors declare that they have no conflict of interest.

AUTHORS CONTRIBUTION

The authors confirm contribution to the paper as follows: study conception and design: Khaled El-Hefnawy, Ashraf M. Sharaf ; data collection: Khaled El-Hefnawy; analysis and interpretation of results: Khaled El-Hefnawy, Hussain Ferweez M., Eman A. Mahmoud; draft manuscript preparation: Khaled El-Hefnawy, Hussain Ferweez M., Eman A. Mahmoud; Ashraf M. Sharaf. All authors reviewed the results and approved the final version of the manuscript.

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تأثير استبدال السكروز بالاستيفوسيد على خصائص الجودة لمربى النارنج

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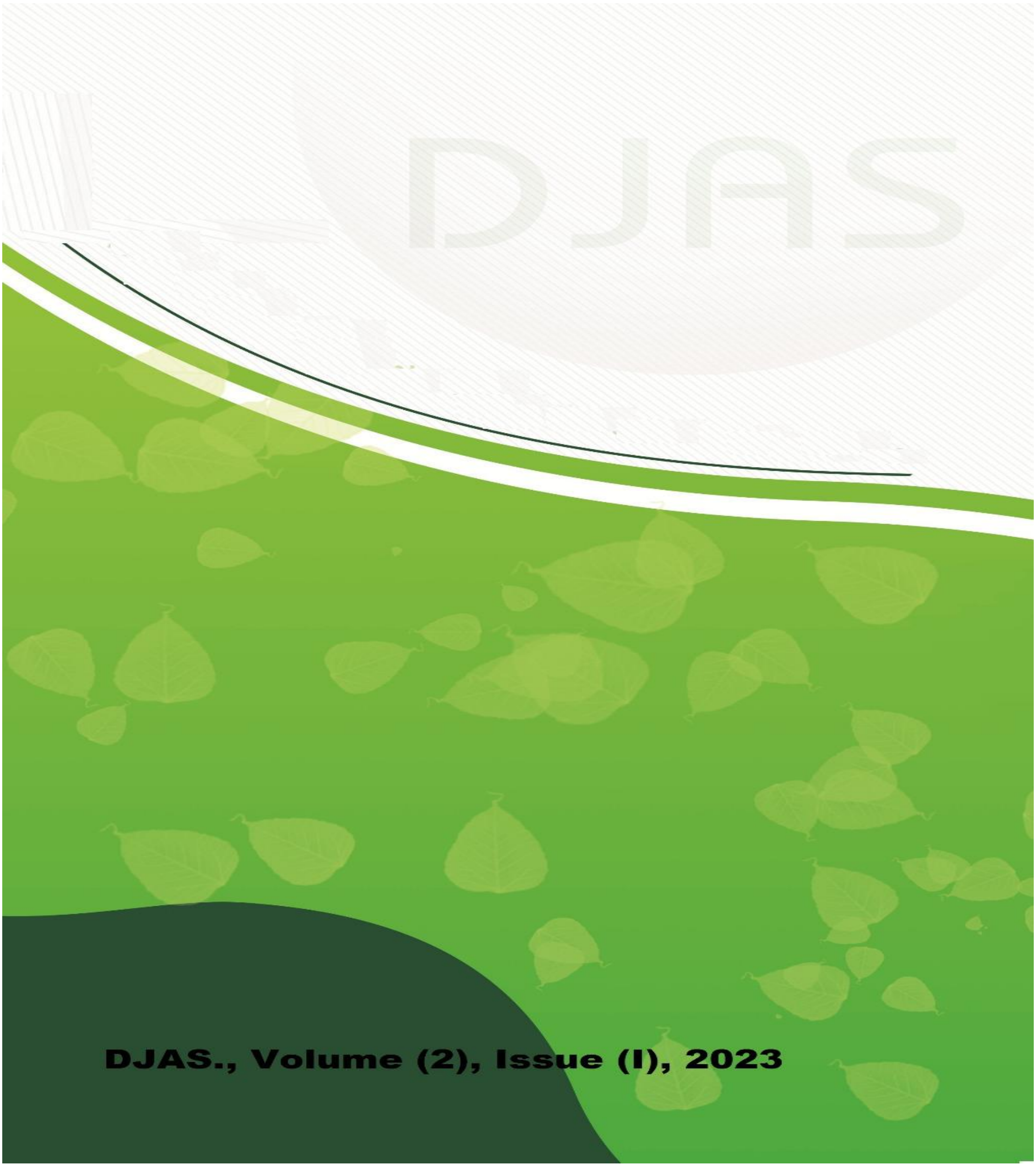
الملخص العربى

يعتبر الهدف الرئيسي في الوقت الحاضرهو تطوير منتجات غذائية عالية القيمة الغذائية ومنخفضة السعرات الحرارية وعالية التقبل لدى المستهلكين. هدفت هذه الدراسة لاستبدال السكروز بالستيفيوسيد (٠ ، ٢٥% ، ٥٠ %، ٧٥ %، ١٠٠%) في تصنيع مربى النارنج. وقد أشارت النتائج إلى أن استبدال الستيفيوسيد بالسكروز بمستويات مختلفة قد أثر معنوياً (P <0.05) على كلا من الخصائص الفيزيائية والكيميائية والحسية للمربى المصنعة. و تناسب طرديا مع زيادة كمية الستيفيوسيد المضافه للمربى مع محتوى البروتين والدهون الخام والرماد والألياف الخام على أساس الوزن الجاف. بينما تناسب عكسيا بشكل معنوى مع محتوى الكربوهيدرات الكلية والسعرات الحرارية. و تعتبر هذه الدراسة بمثابة حجر زاوية لتطوير صناعة مربى النارنج حيث يمكن اعتمادها ضمن النظم الغذائية الصحيه المختلفه.

الكلمات المفتاحية:
مربى – نارنج – الاستيفوسيد – الاستيفيا - السكروز.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