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Chemical, Nutritional and Organoleptical Characteristics of Orange-Based Formulated Low-Calorie Jams

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Abstract

Twelve low-calorie orange-based formulated jams were prepared mainly from orange, pumpkin and papaya, and then sweetened using fructose (F), stevioside (St) and sucralose (Su). The nutritional value of formulated jams was estimated after the approximate chemical composition and total soluble solid have been determined. The effect of storage on total phenolic compounds, antioxidant capacity, carotenoids content and vitamin C was investigated. Organoleptical attributes of prepared low-calorie jams were done as well. Results indicated that the nutritive value [kcal 100 g^{-1} fw] ranged from 88.10 ± 0.60 to 164.34 ± 0.41; total phenol content (TPC, mg GAE 100 g^{-1} fw] ranged from 188.52 ± 2.45 to 411.79 ± 3.3; the antioxidant capacity (µmol TE g^{-1} fw) ranged from 14.57 ± 0.86 to 32.39 ± 1.19; total carotenoids [mg 100 g^{-1} fw] ranged from 115.20 ± 5.66 to 204.33 ± 4.21; vitamin C [mg 100 g fw] ranged from 8.94 ± 1.07 to 28.77 ± 4.46; total soluble solids [Brix] ranged from 22.53 ± 0.05 to 43.37 ± 0.13. Jams storage for a period of 12 months at room temperature led to a decrease in vitamin C content, TPC, antioxidant capacity, while total soluble solids (TSS) and carotenoids increased during storage. The results of organoleptical attributes showed that the formulas O11, O1 had the highest score of color and odor respectively while O7 recorded maximum score for taste, texture and bitterness respectively. Statistical analysis showed that storage intervals and treatments had a significant ($p < 0.05$) effect on sensory quality of diet jam. The organoleptical characteristics were affected with the extension of shelf-life. Addition of stevioside and sucralose to formulate the low-calorie jam increased total phenol and antioxidant capacity, improved color, taste and produced targeted low-calorie jams. The use of sweeteners such as fructose, sucralose and stevioside in the manufacture of orange diet jam was shown to be satisfactory, resulting in low-calorie jams, improved the quality and could be produced commercially.

Keywords

Low-Calorie Jam, Chemical, Nutritional, Organoleptical Characteristics

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1. Introduction

Recently, health concerns associated with high sugar intake include excessive calorie consumption and related diseases are considered as crucial issues for many foods organizations [1]. Several organizations recommend consumption of fruits and vegetables as well as reduce total calories intake [2]-[4]. The growing concern with health and higher incidence of obesity, metabolic syndrome and diabetes has resulted in an increase in interest of low-calorie food consumption [5] [6]. In this context, consumption of low calories and light products which are indicated for peoples with diabetic or other medical restrictions, including obesity was increased [7] as well as for aesthetics and health concerned peoples. With increasing of consumer interest in reducing sugar intake, food products made with sweeteners rather than sugar have become more popular and depleted quickly with high market share [8].

Surely, the production of low-calorie products must comprise low-calorie raw materials and low-calorie sweeteners [9]. To meet the recommended reduction of calories, several foods have been introduced into the market as low-calorie products incorporating natural and/or artificial sweeteners. Low-calorie sweeteners (LCSs) are added to many foods and beverages, for reducing total calories, while maintaining palatability [10]. LCSs have only begun to develop over the past 30 years, concomitant with the increase in obesity and type 2 diabetes, which led to an increased interest in methods of losing weight or maintaining weight loss [11] [12]. The LCSs currently licensed for use in many countries [13]. The varying chemical properties of each LCS mean that they are suited to diverse uses and wide applications could be presented [12]. Typically, the energy difference between regular and LCS-sweetened products is more pronounced in beverages, processed fruits and vegetables more than foods [14] [15].

Interestingly, sucralose is the only commercial sweetener derived from sucrose and is an intense sweetener made by selective substitution of the hydroxyl groups of sucrose with chlorine [16]. It can be used in cooking and baking and in soft drinks, tea, coffee and chilled desserts. Sucralose is non-caloric, noncariogenic and has no effect on blood glucose or insulin levels. It has a taste profile very close to sucrose, presenting very low level of bitterness and sourness. The use of sucralose, one of the newest sweeteners of high sweetening power, has been gradually increasing [17]-[21].

Stevia is a natural sweetener, extracted from leaves of the plant (*Stevia rebaudiana* Bert.), and produces diterpene glycosides that are low-calorie sweeteners. Stevia extracts, besides having therapeutic properties, contain a high level of sweetening compounds, known as steviol glycosides [22] [23]. Stevia contains intensely sweet substances that are 250 to 300 times sweeter than sugar [24]. Steviol glycosides are safe (GRAS) by the FDA. Steviol glycosides can be particularly beneficial to those suffering from obesity, diabetes mellitus, heart disease and dental caries [25]. Production of low-calorie jams could be an important issue for many people groups who suffer from obesity, diabetics, sugar allergic, and dental decay. In addition, it will be a satisfaction to consumers, who maintain their health or for weight management programs.

Nowadays the dietary awareness of consumers has led to the growth of health food industry, and thus alternative jams containing artificial sweeteners should be available. According to the Egyptian specification 2005, there are two kinds of low-calorie jams: 1) contain not less than 200 calorie per 100 gm and 2) should not be less than 100 calorie per 100 gm with shelf-life stability for one year. Recently, Muhammad *et al.* [26], Kopjar *et al.* [27], Tamer *et al.* [28], Basu *et al.* [29], Gao *et al.* [30], Kerdsup *et al.* [31], Youssef *et al.* [32], Teangpook *et al.* [33], Levaj *et al.* [34] investigated many jams formulas sweetened with different LCSs and approved that there are no drastic effects on prepared jam characteristics.

Therefore, the current work is aimed at determining the chemical and nutritional properties of the prepared low-calorie jams incorporated with low-calorie sweeteners compared with the common sweetened jams. The microbiological characteristics of prepared low-calorie jams and sensory attractiveness of prepared low-calorie jams are assessed. Moreover, the study of the effect of storage period on chemical and nutritional properties, microbiological and sensory characteristics of low-calorie jams was investigated.

2. Materials and Methods

2.1. Fresh Fruits

The raw materials used for preparing low calories jams are: orange (*Citrus sinensis*), fully mature Egyptian baladi orange fruits and pumpkin (*Cucurbita maxima*) obtained from local market at Qaliuobia Governorate, Egypt. Papaya fruits (*Carica papaya* L. cv. Sunrise Solo), 750 g to 1750 g/each were obtained from farm of Faculty of

Agriculture, Moshtohor Benha Univ., Egypt. The fruit surface was treated by H_2O_2 5% as disinfectant then ripened at room temperature for 3 - 4 days.

2.2. Fixed Ingredients

Fructose was obtained from the National Company for Maize Products, 10th Ramadan city, A1, Egypt. LM pectin (E 440 (a)—LM 104 AS-FS Pectin, Food grade, Denemark), potassium sorbate (E 202—Food grade, China), citric acid (E 330—Food grade, China), calcium lactate (E 327—Food grade, Belgum), sodium benzoate (E 211—Food grade, China) were obtained from Hero factory for jams and beverages manufacturing, Tersa, Qaluiobia, Egypt. Stevioside and sucralose (Fineprint company) imported by Rebat company for food stuffs trade, Egypt.

2.3. Fruits Preparation

Orange fruits were washed, capsules were removed and external layer had been removed using the carborandum then cut into halves and extracted. Afterword, extracted juice sterilized at 90˚C for 5 min then cooled down to 45˚C. Exactly 1 kg was filled in a polyethylene bag and sealed after removing the air then kept under −20˚C. Peel's halves were cut by sharp knife into small slices then boiled into hot water 100˚C for 1 h, drained, cooled down, filled in a polyethylene bag then kept under −20˚C. Papaya fruit were washed, peeled, cut into small cubic and homogenized by kitchen machine grounder (SIEMENS, type CNCM11ST Germany). Exactly, 1 kg was filled in a polyethylene bag, sealed then kept under −20˚C. Pumpkin fruits were washed, peeled, cut into small cubes, steam blanched for 10 min, cooled down, homogenized by kitchen machine grounder, filled in a polyethylene bag, sealed then kept under −20˚C.

2.3.1. Formulation of Low-Calorie Jams

Many preliminary experiments have been done for selecting the best fruits and sweeteners portions. Twelve jam formulas were prepared according to **Table 1**.

Table 1. Low calories orange-based formulated jams.

Formula No.	Ingredients										
	Fruits puree (%)			Sweeteners (%)				Additives (%)			
	Orange	Pumpkin	Papaya	Fructose	Sucralose	Stevioside	Pectine LM	Citric acid	Ca lactate	Na benzoate	K sorbate
O1	100	-	-	100	-	-	0.75	0.35	0.15	0.01	0.06
O2	100	-	-	75	16.5	8.50	0.9	0.35	0.15	0.01	0.06
O3	100	-	-	50	33.5	16.50	0.9	0.35	0.15	0.01	0.06
O4	100	-	-	25	50	25	1	0.35	0.15	0.01	0.06
O5	75	25	-	100	-	-	0.75	0.35	0.15	0.01	0.06
O6	75	25	-	75	16.5	8.50	0.9	0.35	0.15	0.01	0.06
O7	75	25	-	50	33.5	16.50	0.9	0.35	0.15	0.01	0.06
O8	75	25	-	25	50	25	1	0.35	0.15	0.01	0.06
O9	75	-	25	100	-	-	0.75	0.37	0.15	0.01	0.06
O10	75	-	25	75	16.5	8.50	0.9	0.37	0.15	0.01	0.06
O11	75	-	25	50	33.5	16.50	0.9	0.37	0.15	0.01	0.06
O12	75	-	25	25	50	25	1	0.37	0.15	0.01	0.06

2.3.2. Procedure

Combinations of fruit puree were heated until boiling, LMP (104 AS-FS) food grade Pectin (E 440a), Denmark was added as 0.75% - 1% [35] to fruits mix and allowed to boil for 10 min until all pectin dissolved. Sucralose, fructose, and stevioside were added followed by calcium lactate (0.15%). The mixture was boiled until desired concentration. Finally, citric acid, sodium benzoate and potassium sorbate (0.06%) were added, stirred for 1 min, and hot-filed in sterile jars. After 24 h, formulated jams were subjected to whole analysis.

2.3.3. Analytical Methods

Nutritional value: The nutritional value of different fresh and fried vegetarian diets was calculated basically on the crude protein, lipids and carbohydrates data according to [36].

Ascorbic acid determination: Ascorbic acid determination using the 2,6-dichlorophenol indophenol dye by titration method according to [36].

Determination of carotenoids: Carotenoids were determined in the acetonic extract and expressed as mg 100 g^{-1} fw according to [37]

Determination of total phenolic compounds: After extraction of total phenolic compound, concentration of TPC was determined by Folin-Ciocalteau method. After 1 h at ambient temperature, the absorbance was measured at 765 nm and The TPC was expressed as milligram gallic acid equivalents per gram sample (mg GAE 100 g^{-1} fw) according to [38].

2.3.4. Determination of Radical DPPH-Scavenging Activity

Antioxidant activity was measured spectrophotometrically using the 2,2-diphenylpicrylhy-drazyl (DPPH) radical. According to this method, extracted samples, which were made to react with the radical solution and rest for 30 minutes at room temperature, were measured for absorbance at 517 nm, and the inhibition percentage of DPPH free radical was calculated [39].

2.3.5. Organoleptical Attributes

Organoleptical attributes of the different formulas was carried out. Forty panelists of the staff members and students from the Food Science Department, Faculty of Agriculture, Benha University, in the age range of 20 to 57 years were asked to evaluate the prepared jams towards color, taste, odor, texture, and bitterness. A 7-point hedonic scale (7 being like extremely, 4 like accepted and 1 dislike extremely) was used. Results were subjected to analysis of variance and average of the mean values of the aforementioned attributes and their standard error were calculated according to Wilson *et al.* [40].

2.3.6. Statistical Analysis

The statistical analysis was carried out using SPSS program (ver. 19) with multi-function utility regarding to the experimental design under significance level of 0.05 for the whole results and multiple comparisons were carried out applying LSD with Duncan according to Steel *et al.* [41].

3. Results and Discussion

3.1. Nutritive Value of Prepared Jams

Twelve low calorie orange-based formulated jams were prepared mainly from orange, pumpkin and papaya then sweetened using fructose (F), stevioside (St) and sucralose (Su) as mentioned in **Table 1**. In order to calculate the actual nutritional value of prepared jams, the proximate chemical composition was determined (data not presented). Comparing between mean of storage period for all formulas the nutritive value ranged from 88.10 ± 0.60 in O8 to 164.34 ± 0.41 kcal 100 g^{-1} fw in O9 (**Table 2**). The optimum value observed in O9 formula with (100:0, F:St + Su) while the minimum value observed in O8 formula with (25:75, F:St + Su). Data indicated that the formulas O4, O8 and O12 with (25:75) ratio meet the required specifications of 2005's Egyptian standards for diet jam which instruct that low calorie must be less than 100 kcal 100 g^{-1} jam. Results indicated that there is a significant difference among all formulas regarding the different ratios of fructose replacement by sweeteners. These results are in agreement with Salvador *et al.* [42] who demonstrated that caloric value of the low calorie yacon jams was ranged from 116.4 to 140.0 kcal 100 g^{-1}. The orange and orange mixed jams reduced caloric value and can be considered as light or "low calorie" products. The high sweetening ability of the sugars present

Table 2. Nutritional value (kcal 100 g^{-1} fw) of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	167 ± 0.04	163.95 ± 0.15	165.07 ± 0.24	164.03 ± 0.07	161.21 ± 0.14	164.25 ± 0.20i	131.94 ± 2.34b
	O2	145.82 ± 0.21	152.32 ± 0.13	147.5 ± 0.28	141.63 ± 0.23	143.81 ± 0.21	146.21 ± 0.36g	
	O3	119.72 ± 0.29	130.9 ± 0.54	121.79 ± 0.07	125.61 ± 0.27	118.96 ± 0.15	123.40 ± 0.49e	
	O4	88.18 ± 0	95.59 ± 0.57	96.6 ± 0.1	96.26 ± 0.15	92.94 ± 0.27	93.92 ± 0.42b	
75% orange/ 25% pumpkin	O5	150.88 ± 0.27	156.35 ± 0.39	153.29 ± 0.07	155.69 ± 0.14	153.43 ± 0.05	153.93 ± 0.25h	124.35 ± 2.31a
	O6	139.18 ± 0.3	146.41 ± 0.4	134.93 ± 0.25	133.36 ± 0.2	141.38 ± 0.3	139.05 ± 0.48f	
	O7	102.94 ± 0.23	125.32 ± 0.4	115.38 ± 0.2	118.02 ± 0.2	119.85 ± 0.47	116.30 ± 0.76d	
	O8	81.55 ± 0.29	94.92 ± 0.1	87.44 ± 0.28	93.09 ± 0.25	83.5 ± 0.05	88.10 ± 0.60a	
75% orange/ 25% papaya	O9	166.66 ± 0.14	170.57 ± 0.13	160.73 ± 0.37	157.36 ± 0.02	166.4 ± 0.01	164.34 ± 0.41i	132.6 ± 2.26b
	O10	132.94 ± 0.23	154.08 ± 0.36	146.76 ± 0.06	149.86 ± 0.09	144.67 ± 0.19	145.66 ± 0.64g	
	O11	113 ± 0.3	130.53 ± 0.51	119.29 ± 0.15	126.09 ± 0.16	125.4 ± 0.17	122.86 ± 0.62e	
	O12	92.08 ± 0.09	106.91 ± 0.16	94.99 ± 0.22	94.8 ± 0.09	98.9 ± 0.68	97.54 ± 0.61c	
Mean of total storage period		125.00 ± 2.61A	135.65 ± 2.19C	128.65 ± 2.29B	129.65 ± 2.16B	129.21 ± 2.33B		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		160.84 ± 0.49D	143.64 ± 0.57C	120.85 ± 0.69B	93.18 ± 0.68A			
LSD at 0.05	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	1.34	1.20	1.20	2.33	2.69	2.08	4.65	

a, b & c: There is no significant difference (P > 0.05) between any two means, within the same column have the same superscript letter. *n* = 3. A, B & C: There is no significant difference (P > 0.05) between any two means for the same attribute within the same row have the same superscript letter.

in orange, mainly fructose [43], contributed to the preparation of a jam with low addition of sucrose and therefore low content of calories occurred. Comparing between mean of total storage period, results indicated that increasing in nutritive value during storage period. The cause of increasing nutritive value may be due to increasing the soluble carbohydrates during storage. Mean of sweetener formula indicated that maximum nutritive value was 160.84 ± 0.49 kcal 100 g^{-1} fw obtained by (100:0) while minimum value was 93.18 ± 0.68 kcal 100 g^{-1} fw obtained by (25:75) and there is a significant difference between all ratios. Yuyama *et al.* [44] found reduction in the caloric value ranged from 25.9% to 37.9% in jambolão fruit jams using four types of sweeteners individually or in combination (saccharin, cyclamate, acesulfame and St). Moreover, [45] [46] reported that stevioside give low calories.

3.2. Total Phenolic Compounds and Antioxidant Capacity

Phenolics are naturally occurring compounds widely distributed in the plant kingdom and beneficial components of human daily diet Le *et al.* [47]. Presented data in **Table 3**, indicated that orange jams had the highest score for total phenol compounds (TPC) which was311.24 ± 4.95 mg GAE 100 g^{-1} followed by 284.18 ± 5.82 mg GAE 100 g^{-1} in OY jams while minimum score was 252.19 ± 4.63 mg GAE 100 g^{-1} in OK jams. Tamer *et al.* [28] reported that pumpkin dessert containing 111.64 ± 1.16 to 234.14 ± 7.47 mg GAE 100 g^{-1}. Comparing between mean of storage period after 12 month the results indicated that maximum TPC was 411.79 ± 3.31 mg GAE 100 g^{-1} in O4 while minimum total phenol was 188.52 ± 2.45 mg GAE 100 g^{-1} in O9. The results illustrated that the TPC increased with decreasing the fructose. These results are in agreement with Istratii *et al.* [48] who found TPC in goji fruits jam and jelly was 351 ± 7.25 mg GAE 100 g^{-1}. Comparing between mean of total storage period, results indicated that TPC decreased from 274.4 ± 4.59 mg GAE 100 g^{-1} at zero time to 251.04 ± 4.94 mg GAE 100 g^{-1} after 9 months during storage at room temperature. These results are in agreement with [49]-[52]

Table 3. Total phenol content (mg GAE 100 g^{-1} fw) of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	221.71 ± 1.18	180.8 ± 1.66	306.88 ± 1.53	229.5 ± 1.13	214.41 ± 0.29	230.66 ± 3.03ac	311.24 ± 4.95c
	O2	282.94 ± 0.81	275.27 ± 0.15	297.53 ± 0.99	245.35 ± 3.73	263.3 ± 0.66	272.88 ± 1.82cd	
	O3	303 ± 0.48	407.01 ± 6.61	312.31 ± 0.65	291.16 ± 3.47	334.74 ± 0.85	329.65 ± 3.87e	
	O4	361.04 ± 0.46	400.63 ± 2.43	506.98 ± 1.93	342.76 ± 0.85	447.57 ± 0.86	411.79 ± 3.31f	
75% orange/ 25% pumpkin	O5	167.66 ± 1.13	279.99 ± 1.08	197.36 ± 1.76	164.13 ± 1.18	179.44 ± 0.56	197.72 ± 3.31a	252.19 ± 4.63a
	O6	270.37 ± 3.8	283.68 ± 6.36	292.68 ± 2.86	191.73 ± 5.41	189.83 ± 1.91	245.66 ± 4.79c	
	O7	269.76 ± 3.77	288.35 ± 4.41	284.72 ± 3.4	227.34 ± 6.12	232.78 ± 0.89	260.59 ± 3.81cd	
	O8	290.78 ± 6.61	312.57 ± 2.13	371.9 ± 2.21	261.28 ± 5.35	287.34 ± 1.25	304.78 ± 4.01d	
75% orange/ 25% papaya	O9	170.17 ± 3.04	216.21 ± 1.22	206.8 ± 2.76	178.99 ± 3.05	170.41 ± 0.45	188.52 ± 2.45a	284.18 ± 5.82b
	O10	279.75 ± 4.21	299.91 ± 1.83	256.03 ± 2.87	224.45 ± 2.81	261.89 ± 1.57	264.41 ± 2.87cd	
	O11	291.96 ± 2.54	354.52 ± 4.38	224.66 ± 1.45	276.35 ± 4.18	327.02 ± 2.07	294.9 ± 3.82de	
	O12	383.6 ± 2.46	254.29 ± 2	424.21 ± 1.23	379.44 ± 2.22	502.83 ± 6.5	388.88 ± 5.28f	
Mean of total storage period		274.4 ± 4.59AB	296.1 ± 4.86BC	306.84 ± 5.31C	251.04 ± 4.94A	284.3 ± 6.43BC		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		205.63 ± 3.16A	260.98 ± 3.34B	295.05 ± 4.10C	368.48 ± 4.83D			
LSD at 0.05 for:	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	23.96	21.43	21.43	41.51	47.93	37.12	83.01	

a, b & c: There is no significant difference ($P > 0.05$) between any two means, within the same column have the same superscript letter. $n = 3$. A, B & C: There is no significant difference ($P > 0.05$) between any two means for the same attribute within the same row have the same superscript letter.

whose indicated TPC decreasing during jam storage. Comparing between mean of sweetener formula the results indicated that TPC increased from 205.63 ± 3.16 mg GAE 100 g^{-1} in ratio of (100:0) to 368.48 ± 4.83 mg GAE 100 g^{-1} in ratio of (25:75). These results are in agreement with Shukla *et al*. [53] who remarked increases in TPC due to addition of stevioside in prepared diet jam. Moreover, Tadhani *et al.* [54] indicated that stevia plant containing 25.18 mg gm^{-1} TPC in stevia leaves.

Data in **Table 4**, indicated that mean of antioxidantactivity in jam types was ranged from 20.48 ± 1.62 to 25.47 ± 1.63 µmol TE g^{-1}. These results indicated that there is a significant difference among all jam types. Increasing of antioxidant activity in formulas O4, O8 and O12 may be due to increasing of stevioside content. Shukla *et al.* [53] reported that stevia plant used as a good source of antioxidant. Tadhani *et al.* [54] reported that stevia is containing 9.66 to 38.24 mg antioxidant. Comparing between mean of total storage period the results indicated that the highest antioxidant activity was 27.69 ± 1.11 µmol TE g^{-1} obtained at zero time while low antioxidant activity was 13.67 ± 1.17 µmol TE g^{-1} at the end of storage. This means that antioxidant activity decreased during storage for 12 month. There is a significant difference among all storage periods. These results were consistent with data reported previously [48] [49] [52] [55]-[59]. They demonstrated that the antioxidant activity of different berries significantly decreased after jam processing and storage period. This decrease can be attributed to the destruction of phytochemicals, phenolics compounds as well as L-ascorbic acid as a result of thermal treatment. Comparing between mean of sweetener formula the results indicated that highest antioxidant was 26.98 ± 1.57 µmol TE g^{-1} in ratio of (25:75) while low antioxidant activity was 17.32 ± 1.19 µmol TE g^{-1} in ratio of (100:0). These results may be due to addition of stevioside to diet jam which increasing antioxidant activity in prepared jams (Shukla *et al.* [53]).

The presented data in **Table 5**, illustrated the carotenoids content prepared jams. Carotenoids content was ranged from 141.75 ± 4.51 mg 100 g^{-1} fw in OK to 155.86 ± 4.76 mg 100 g^{-1} fw in OY jams. The results observed

Table 4. Antioxidant activity (μmol TE g^{-1} fw) of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	23.04 ± 0.17	24.29 ± 0.08	16.55 ± 0.57	16.81 ± 0.61	12.7 ± 0.11	18.68 ± 1.09b	25.47 ± 1.63c
	O2	26.21 ± 0.19	26.08 ± 0.17	31.57 ± 0.44	18.22 ± 0.45	14.81 ± 0.09	23.38 ± 1.32cd	
	O3	30.56 ± 0.31	30.54 ± 0.13	38.39 ± 0.52	20.49 ± 0.35	17.16 ± 0.31	27.43 ± 1.54e	
	O4	39.15 ± 0.1	41.01 ± 0.16	28.14 ± 0.51	28.32 ± 0.47	25.34 ± 0.3	32.39 ± 1.19f	
75% orange/ 25% pumpkin	O5	24.59 ± 0.12	24.79 ± 0.1	16.83 ± 0.43	16.69 ± 0.39	10.74 ± 0.19	18.73 ± 1.30b	22.66 ± 1.57b
	O6	26.42 ± 0.22	26.63 ± 0.18	31.75 ± 0.34	18.19 ± 0.51	10.66 ± 0.1	22.73 ± 1.63c	
	O7	32.22 ± 0.58	27.53 ± 0.4	27.07 ± 2	19.13 ± 0.36	11.84 ± 0.16	23.56 ± 1.77cd	
	O8	28.99 ± 1.54	25.48 ± 1.06	29.4 ± 0.58	27.84 ± 0.53	16.39 ± 0.11	25.62 ± 1.27d	
75% orange/ 25% papaya	O9	17.63 ± 0.3	16.65 ± 0.82	14.51 ± 0.29	14.7 ± 0.23	9.35 ± 0.03	14.57 ± 0.86a	20.48 ± 1.62a
	O10	24.28 ± 0.15	22.65 ± 0.5	27.26 ± 0.19	16.13 ± 0.34	11.04 ± 0.09	20.27 ± 1.38b	
	O11	26.64 ± 0.15	28.27 ± 0.1	32.23 ± 0.03	20.07 ± 0.58	13.59 ± 0.16	24.16 ± 1.40cd	
	O12	32.53 ± 0.44	30.28 ± 0.25	20.57 ± 0.69	20.8 ± 0.75	10.41 ± 0.24	22.92 ± 1.77c	
Mean of total storage period		27.69 ± 1.11E	27.02 ± 1.13D	26.19 ± 1.54C	19.78 ± 1.02B	13.67 ± 1.17A		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		17.32 ± 1.19A	22.13 ± 1.45B	25.05 ± 1.58C	26.98 ± 1.57D			
LSD at 0.05 for:	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	1.16	1.04	1.04	2.02	2.33	1.80	4.03	

a, b & c: There is no significant difference (P > 0.05) between any two means, within the same column have the same superscript letter. *n* = 3. A, B & C: There is no significant difference (P > 0.05) between any two means for the same attribute within the same row have the same superscript letter.

Table 5. Carotenoids content (mg 100 g^{-1} fw) of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	127.78 ± 2.9	127.69 ± 2.92	118.23 ± 2.32	177.95 ± 5.85	115.03 ± 0.94	133.34 ± 3.72abc	153.22 ± 5.80a
	O2	110.4 ± 2.62	105.73 ± 2.58	101.36 ± 2.6	130.42 ± 6.52	163.01 ± 3.08	122.19 ± 3.91a	
	O3	153.55 ± 2.25	124.69 ± 1.07	139.62 ± 1.25	263.51 ± 2.48	173.54 ± 2.74	170.98 ± 4.29cde	
	O4	157.52 ± 5.01	130.37 ± 1.65	179.94 ± 7.87	97.43 ± 3.43	366.61 ± 0.78	186.38 ± 8.00de	
75% orange/ 25% pumpkin	O5	135.4 ± 4.97	87.38 ± 3.67	157.57 ± 7.73	76.22 ± 8.19	119.42 ± 0.33	115.20 ± 5.66a	141.75 ± 4.51a
	O6	131.48 ± 1.67	144.86 ± 0.22	161.1 ± 2.3	94.96 ± 6.62	122.96 ± 1.54	131.07 ± 3.20abc	
	O7	127.82 ± 1.44	175.19 ± 2.7	139.67 ± 0.88	176.33 ± 3.44	136.38 ± 3.09	151.08 ± 2.78abcd	
	O8	123.29 ± 1.71	130.87 ± 1.47	149.7 ± 3.19	255.69 ± 5.9	188.7 ± 1.37	169.65 ± 4.95bcde	
75% orange/ 25% papaya	O9	114.16 ± 1.38	112.9 ± 1.35	141.69 ± 1.67	111.52 ± 1.77	157.26 ± 0.81	127.51 ± 2.08ab	155.86 ± 4.76a
	O10	93.61 ± 1.82	136.8 ± 1.41	112.16 ± 0.98	96.48 ± 9.13	237.83 ± 3.09	135.37 ± 5.85abc	
	O11	143.03 ± 3.17	157.69 ± 1.56	104.56 ± 1.01	175.35 ± 5.54	200.56 ± 1.72	156.24 ± 3.79abcd	
	O12	210.06 ± 4.55	208.72 ± 4.62	204.74 ± 2.81	189.32 ± 8.4	208.79 ± 2.34	204.33 ± 4.21e	
Mean of total storage period		135.68 ± 3.65A	136.91 ± 3.39A	142.53 ± 4.14A	153.77 ± 6.87A	182.51 ± 5.29B		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		125.35 ± 3.99A	129.54 ± 4.42A	159.43 ± 3.68B	186.78 ± 5.89C			
LSD at 0.05 for:	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	21.12	18.89	18.89	36.58	42.24	32.72	73.17	

a, b & c: There is no significant difference (P > 0.05) between any two means, within the same column have the same superscript letter. *n* = 3. A, B & C: There is no significant difference (P > 0.05) between any two means for the same attribute within the same row have the same superscript letter.

that there is no significant difference among all of jam types. These results are in agreement with [28] [60]. Comparing between mean of total storage period the results indicated that higher carotenoids content was 182.51 ± 5.29 mg 100 g^{-1} fw at the end of storage period while lower carotenoids content was 135.68 ± 3.65 mg 100 g^{-1} fw at zero time. These results indicated that carotenoids may be released from the matrix during storage. These results are in agreement with Correa *et al.* [49] who observed that carotenoids increased from 36.66 ± 1.17 to 62.18 ± 1.48 mg 100 g^{-1} fw at day-1and day-90 in grape juice, respectively. Comparing between mean of sweetener formula, the results indicated that higher carotenoids content was 186.78 ± 5.89 mg 100 g^{-1} fw in ratio of (25:75) while lower carotenoids content was 125.35 ± 3.99 mg 100 g^{-1} fw in ratio of (100:0). The results indicated that there is no significant difference between the ratios (100:0) and (75:25) while there is a significant difference between (50:50) and (25:75) ratios.

3.3. Vitamin C and Total Soluble Solids Contents

Vitamin C is involved in protein metabolism, collagen synthesis and an important physiological antioxidant [61]. In **Table 6**, results indicated that there is a significant difference between jam types. The results demonstrated that vitamin C content recorded in OY jams was 22.04 ± 3.51 mg 100 g^{-1} followed by orange jams 11.42 ± 1.03 mg 100 g^{-1} fw while OK jams recorded 9.59 ± 1.03 mg 100 g^{-1} fw. The difference of vitamin C content in formulas may be due to the difference of vitamin content initial fruits pulp. Johnson *et al.* [62] reported that vitamine C content in pumpkin pulp 15.25 mg 100 g^{-1} while Nwofia *et al.* [63] reported that vitamin C content in papaya pulp ranged from 36.37 to 43.41 mg 100 g^{-1}. Comparing between mean of total storage period the results indicated that maximum vitamin C content was 21.21 ± 2.96 mg 100 g^{-1} at zero time while deceased to 6.01 ± 0.50 mg 100 g^{-1} at 12 month storage. These results are in agreement with [50] [64] reported that vitamin C decreased in low calorie jam during storage. The loss of vitamin C in the initial stages is because of the presence of

Table 6. Vitamin C (mg 100 g^{-1} fw) content of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	14.91 ± 0.06	14.65 ± 0.17	9.71 ± 0.92	11.27 ± 0.39	6.93 ± 0.3	11.49 ± 0.99bc	11.42 ± 1.03b
	O2	14.35 ± 0.16	14.56 ± 0.14	12.48 ± 0.44	10.75 ± 0.24	4.85 ± 0.36	11.40 ± 1.11bc	
	O3	16.55 ± 0.26	16.12 ± 0.34	11.79 ± 0.32	11.96 ± 0.3	5.2 ± 0.46	12.32 ± 1.23c	
75% orange/ 25% pumpkin	O4	11.37 ± 0.14	11.22 ± 0.26	11.96 ± 0.3	11.27 ± 0.39	6.41 ± 0.12	10.44 ± 0.69b	9.59 ± 1.03a
	O5	11.35 ± 0.06	10.93 ± 0.11	7.63 ± 0.47	7.63 ± 0.47	7.45 ± 0.48	9.00 ± 0.67a	
	O6	13.26 ± 0.36	13.35 ± 0.36	10.4 ± 0.43	9.19 ± 0.6	5.03 ± 0.35	10.24 ± 1.06ab	
	O7	14.04 ± 0.42	14.65 ± 0.49	8.49 ± 0.27	8.84 ± 0.35	4.85 ± 0.36	10.17 ± 1.24ab	
	O8	13.15 ± 0.18	11.61 ± 0.25	7.97 ± 0.46	5.2 ± 0.23	6.76 ± 0.4	8.94 ± 1.07a	
75% orange/ 25% papaya	O9	20.19 ± 0.16	19.87 ± 0.12	17.68 ± 0.33	6.76 ± 0.2	6.59 ± 0.31	14.22 ± 1.72d	22.04 ± 3.51c
	O10	29.21 ± 0.25	28.51 ± 0.37	15.43 ± 0.2	10.4 ± 0.16	5.37 ± 0.34	17.78 ± 2.37e	
	O11	57.37 ± 0.1	56.33 ± 0.28	13.17 ± 0.3	11.79 ± 0.23	5.2 ± 0.23	28.77 ± 4.46f	
	O12	38.75 ± 0.13	36.55 ± 0.25	44.03 ± 1.2	10.05 ± 0.25	7.45 ± 0.29	27.37 ± 3.11g	
Mean of total storage period		21.21 ± 2.96D	20.70 ± 2.91D	14.23 ± 2.60C	9.59 ± 0.73B	6.01 ± 0.50A		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		11.57 ± 1.41A	13.14 ± 1.97B	17.09 ± 3.93D	15.58 ± 3.21C			
LSD at 0.05 for:	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	0.70	0.63	0.63	1.21	1.40	1.09	2.43	

a, b & c: There is no significant difference (P > 0.05) between any two means, within the same column have the same superscript letter. *n* = 3. A, B & C: There is no significant difference (P > 0.05) between any two means for the same attribute within the same row have the same superscript letter.

oxygen in the headspace or this could due to oxidation or degradation of the thermolabile ascorbic acid into dehydrate ascorbic acid upon storage [64]. Comparing between mean of sweetener formula the results indicated that highest vitamin C content was 17.09 ± 3.93 mg 100 g^{-1} in ratio of (50:50) while lowest vitamin C content was 11.57 ± 1.41 mg 100 g^{-1} in ratio of (100:0).

The mean of TSS was ranged from 31.98 ± 1.15 to 34.13 ± 1.19 [Brix] in OK and Orange jams, respectively (**Table 7**). Significant difference between OK and (orange and OY) jams was found. Comparing between mean of storage period the results indicated that TSS ranged from a low of 22.53 ± 0.05 in O8 to a high of 43.37 ± 0.13 in O1. Comparing between mean of total storage period the results indicated that TSS was almost stable and no trend could be observed even a slight increases was recorded at the end of storage period. These results are in agreement with the results of [65]-[67] who observed minor increase in TSS of strawberry and watermelon lemon jams during storage. The increase in TSS contents of the product may be due to acid hydrolysis of polysaccharides especially gums and pectin into simple sugars [68]. Comparing between mean of sweetener formula a logical significant differences was observed with increasing the replacement level of fructose.

3.4. Organoleptical Parameters of Orange-Based Jams

Twelve low calorie orange-based formulated jams were prepared mainly from orange, pumpkin and papaya then sweetened using F, St and Su as mentioned in materials and methods in **Table 1**, data were illustrated in **Tables 8-12**. Color, taste, odor, texture, and bitterness of prepared jams were organoleptically evaluated. The effect of fructose replacement by (St & Su) on sensory attributes was investigated as well.

The obtained data in **Table 8** indicated that no significant difference ($P < 0.05$) was found in color scores between prepared OK and OY or orange jams. These findings are in agreements with [69]. Also Abdullah *et al.*

Table 7. Total soluble solids (Brix) of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	44.27 ± 0.02	44.27 ± 0.02	43.4 ± 0.03	42.37 ± 0.08	42.53 ± 0.06	43.37 ± 0.13k	34.13 ± 1.19b
	O2	37.73 ± 0.03	37.73 ± 0.03	36.2 ± 0.02	36.43 ± 0.07	36.7 ± 0.03	36.96 ± 0.12g	
	O3	31.97 ± 0.05	32.23 ± 0.02	31.27 ± 0.05	31.33 ± 0.05	30.7 ± 0.04	31.50 ± 0.11e	
	O4	24.53 ± 0.01	24.53 ± 0.01	25.03 ± 0.01	25 ± 0.02	24.43 ± 0.04	24.71 ± 0.06b	
75% orange/ 25% pumpkin	O5	39.6 ± 0.03	39.6 ± 0.03	39.2 ± 0.03	39.6 ± 0.02	39.4 ± 0.04	39.48 ± 0.04i	31.98 ± 1.15a
	O6	36.63 ± 0.01	36.63 ± 0.01	35.3 ± 0.05	35.3 ± 0.05	35.6 ± 0.03	35.89 ± 0.11f	
	O7	28.17 ± 0.03	30.63 ± 0.05	30.3 ± 0.02	30.5 ± 0.07	30.5 ± 0.05	30.02 ± 0.18d	
	O8	22.63 ± 0.05	22.63 ± 0.05	22.27 ± 0.05	22.57 ± 0.02	22.53 ± 0.08	22.53 ± 0.05a	
75% orange/ 25% papaya	O9	42.3 ± 0.03	42.3 ± 0.03	41.13 ± 0.02	40.37 ± 0.17	41.47 ± 0.02	41.51 ± 0.14j	34.06 ± 1.07b
	O10	35.87 ± 0.08	38.53 ± 0.04	37.63 ± 0.02	38.6 ± 0.03	37.53 ± 0.05	37.63 ± 0.17h	
	O11	30.2 ± 0.02	32.53 ± 0.02	31.13 ± 0.03	32.5 ± 0.05	32.4 ± 0.05	31.75 ± 0.17e	
	O12	24.27 ± 0.03	25.9 ± 0.04	25.17 ± 0.03	25.57 ± 0.08	25.7 ± 0.02	25.32 ± 0.13c	
Mean of total storage period		33.18 ± 1.23A	33.96 ± 1.18C	33.17 ± 1.14A	33.34 ± 1.1B	33.29 ± 1.13AB		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		41.45 ± 0.27D	36.83 ± 0.18C	31.09 ± 0.21B	24.18 ± 0.26A			
LSD at 0.05 for:	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	0.13	0.11	0.11	0.22	0.25	0.19	0.43	

a, b & c: There is no significant difference ($P > 0.05$) between any two means, within the same column have the same superscript letter. $n = 3$. A, B & C: There is no significant difference ($P > 0.05$) between any two means for the same attribute within the same row have the same superscript letter.

Table 8. Color of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	5.08 ± 0.89	5 ± 1.11	2.3 ± 1.2	2.6 ± 1.22	2.55 ± 1.13	3.51 ± 1.67bO	3.45 ± 1.53a
	O2	5.1 ± 0.63	4.3 ± 1.11	3.1 ± 1.06	2.03 ± 0.64	2.08 ± 0.67	3.35 ± 1.48b	
	O3	4.7 ± 0.72	4.6 ± 1.37	3 ± 1.2	2.1 ± 0.84	2.05 ± 0.75	3.29 ± 1.54b	
	O4	4.85 ± 1.16	4.9 ± 0.96	3 ± 1.2	2.8 ± 0.88	2.75 ± 0.84	3.65 ± 1.42Od	
75% orange/ 25% pumpkin	O5	5.35 ± 1.25	5.2 ± 0.99	2.8 ± 1.09	2.9 ± 1.15	2.9 ± 1.1	3.83 ± 1.62df	3.81 ± 1.57b
	O6	5.41 ± 0.79	4.6 ± 1.3	2.9 ± 1.06	2.6 ± 1.03	2.6 ± 0.98	3.61 ± 1.56O	
	O7	5.58 ± 0.87	5.2 ± 1.09	3.2 ± 0.99	2.8 ± 1.09	2.78 ± 1.05	3.91 ± 1.59f	
	O8	5.28 ± 0.99	5 ± 1.01	3.6 ± 1.3	2.8 ± 1.09	2.8 ± 1.07	3.90 ± 1.52f	
75% orange/ 25% papaya	O9	4.68 ± 1.14	3.7 ± 1.11	2.5 ± 1.22	2.1 ± 1.15	2.13 ± 1.14	3.02 ± 1.53a	3.56 ± 1.53a
	O10	4.98 ± 1.07	4.2 ± 1.09	2.8 ± 0.88	2.4 ± 1.03	2.38 ± 1.03	3.35 ± 1.46b	
	O11	5.18 ± 1.15	5 ± 1.28	3.5 ± 1.3	3 ± 1.28	2.98 ± 1.27	3.93 ± 1.58f	
	O12	4.65 ± 1.21	4.5 ± 1.52	3.9 ± 1.39	3.3 ± 0.91	3.25 ± 0.95	3.92 ± 1.34f	
Mean of total storage period		5.07 ± 1.04D	4.68 ± 1.24O	3.05 ± 1.23B	2.62 ± 1.10A	2.6 ± 1.07A		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		3.45 ± 1.64A	3.44 ± 1.5A	3.71 ± 1.59B	3.82 ± 1.43B			
LSD at 0.05 for:	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	0.14	0.12	0.11	0.24	0.27	0.21	0.47	

a, b & O: There is no significant difference (P > 0.05) between any two means, within the same column have the same superscript letter. *n* = 40. A, B & O: There is no significant difference (P > 0.05) between any two means for the same attribute within the same row have the same superscript letter.

Table 9. Taste of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	4.9 ± 1.03	4.7 ± 1.11	4.1 ± 0.71	2.9 ± 0.96	2.93 ± 0.94	3.91 ± 1.28fgh	3.76 ± 1.29b
	O2	5.4 ± 0.84	4.6 ± 1.58	4.1 ± 0.84	2.89 ± 0.69	2.95 ± 0.66	4.01 ± 1.37h	
	O3	4.9 ± 0.87	4.5 ± 1.13	3.9 ± 0.55	2.6 ± 0.67	2.65 ± 0.7	3.71 ± 1.24Odf	
	O4	4.33 ± 1.03	3.9 ± 1.46	3.6 ± 0.93	2.6 ± 0.67	2.63 ± 0.67	3.41 ± 1.21ab	
75% orange/ 25% pumpkin	O5	4.78 ± 1.07	5.1 ± 1.32	3.4 ± 1.37	3.2 ± 0.76	3.23 ± 0.7	3.94 ± 1.35gh	3.86 ± 1.35c
	O6	5.21 ± 0.57	4.2 ± 1.26	3.8 ± 0.88	2.8 ± 0.99	2.85 ± 0.98	3.76 ± 1.31dfg	
	O7	5.55 ± 1.04	4.6 ± 1.13	3.6 ± 0.81	3.2 ± 0.76	3.15 ± 0.77	4.02 ± 1.30h	
	O8	4.75 ± 1.78	4.6 ± 1.37	3.7 ± 1.11	2.8 ± 0.61	2.8 ± 0.61	3.73 ± 1.44df	
75% orange/ 25% papaya	O9	4.34 ± 1.17	4 ± 1.11	3.2 ± 1.09	2.6 ± 1.03	2.65 ± 1	3.35 ± 1.28a	3.54 ± 1.26a
	O10	4.38 ± 1.29	4.1 ± 1.66	3.9 ± 0.84	2.7 ± 0.79	2.78 ± 0.73	3.57 ± 1.31bOd	
	O11	4.63 ± 1.25	4.2 ± 1.34	3.6 ± 0.81	3.1 ± 1.15	3.1 ± 1.08	3.73 ± 1.28df	
	O12	3.58 ± 1.2	4.4 ± 1.13	3.6 ± 0.67	3 ± 1.01	3 ± 0.96	3.52 ± 1.13abO	
Mean of total storage period		4.73 ± 1.23D	4.41 ± 1.34O	3.71 ± 0.94B	2.87 ± 0.88A	2.89 ± 0.84A		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		3.73 ± 1.33B	3.78 ± 1.34B	3.82 ± 1.28B	3.55 ± 1.27A			
LSD at 0.05 for:	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	0.13	0.12	0.10	0.22	0.26	0.20	0.45	

a, b & O: There is no significant difference (P > 0.05) between any two means, within the same column have the same superscript letter. *n* = 40. A, B & O: There is no significant difference (P > 0.05) between any two means for the same attribute within the same row have the same superscript letter.

Table 10. Odor of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	5.33 ± 0.92	4.70 ± 1.51	4.3 ± 1.02	3.40 ± 0.93	3.43 ± 0.93	4.23 ± 1.31d	3.91 ± 1.26b
	O2	5.00 ± 0.99	4.60 ± 1.37	4.1 ± 1.06	3.00 ± 0.77	3.00 ± 0.77	3.96 ± 1.30O	
	O3	4.78 ± 1.14	4.20 ± 1.18	4.3 ± 1.11	3.10 ± 0.71	3.08 ± 0.73	3.89 ± 1.20O	
	O4	4.44 ± 0.75	3.90 ± 1.46	4 ± 0.64	2.70 ± 0.65	2.70 ± 0.65	3.54 ± 1.14b	
75% orange/ 25% pumpkin	O5	4.70 ± 1.14	4.70 ± 1.36	3.2 ± 1.26	3.40 ± 0.93	3.43 ± 0.93	3.89 ± 1.31O	3.87 ± 1.31b
	O6	4.95 ± 1.02	4.60 ± 1.52	3.7 ± 1.02	3.20 ± 1.09	3.20 ± 1.09	3.92 ± 1.36O	
	O7	5.03 ± 1.07	4.30 ± 1.64	3.8 ± 0.88	3.30 ± 0.46	3.25 ± 0.54	3.94 ± 1.20O	
	O8	4.73 ± 1.45	4.50 ± 1.30	3.8 ± 1.26	2.90 ± 0.71	2.85 ± 0.70	3.76 ± 1.37O	
75% orange/ 25% papaya	O9	3.95 ± 1.14	4.10 ± 1.46	3.1 ± 0.96	3.00 ± 1.01	3.00 ± 0.96	3.42 ± 1.21ab	3.43 ± 1.24a
	O10	3.58 ± 1.28	4.40 ± 1.22	3.6 ± 1.65	2.90 ± 1.15	2.90 ± 1.10	3.48 ± 1.40ab	
	O11	4.03 ± 1.07	4.00 ± 1.43	3.5 ± 1.52	3.00 ± 0.64	3.00 ± 0.64	3.51 ± 1.20ab	
	O12	3.43 ± 1.30	4.40 ± 1.13	3.4 ± 0.67	2.70 ± 0.79	2.65 ± 0.74	3.32 ± 1.14a	
Mean of total storage period		4.49 ± 1.25O	4.37 ± 1.4O	3.73 ± 1.18B	3.05 ± 0.86A	3.04 ± 0.86A		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		3.85 ± 1.32B	3.78 ± 1.37B	3.78 ± 1.22B	3.54 ± 1.23A			
LSD at 0.05 for:	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	0.14	0.12	0.11	0.24	0.27	0.21	0.47	

a, b & O: There is no significant difference (P > 0.05) between any two means, within the same column have the same superscript letter. *n* = 40. A, B & O: There is no significant difference (P > 0.05) between any two means for the same attribute within the same row have the same superscript letter.

Table 11. Texture of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	4.88 ± 1.51	4 ± 1.63	3.9 ± 1.39	4.1 ± 0.96	4.08 ± 0.97	4.19 ± 1.35Ode	4.16 ± 1.33b
	O2	5.28 ± 0.96	4.4 ± 1.93	4 ± 0.78	3.68 ± 1.32	3.74 ± 1.35	4.23 ± 1.44de	
	O3	4.95 ± 1.43	4.3 ± 1.81	4.3 ± 0.79	3.9 ± 0.96	3.9 ± 0.96	4.27 ± 1.29de	
	O4	4.62 ± 1.41	4.7 ± 1.36	4.2 ± 0.61	3.1 ± 0.55	3.1 ± 0.55	3.94 ± 1.20b	
75% orange/ 25% pumpkin	O5	5 ± 1.34	5.1 ± 1.53	3.6 ± 0.67	4 ± 1.28	4 ± 1.24	4.34 ± 1.37de	4.41 ± 1.34c
	O6	5.51 ± 1.21	4.6 ± 1.82	3.8 ± 0.88	3.9 ± 0.96	3.8 ± 1.04	4.32 ± 1.39de	
	O7	5.75 ± 1.01	4.8 ± 1.68	4.2 ± 0.76	4.2 ± 0.88	4.08 ± 1	4.61 ± 1.27f	
	O8	4.93 ± 1.62	4.9 ± 1.84	4.1 ± 0.84	4 ± 0.78	3.95 ± 0.85	4.38 ± 1.33ef	
75% orange/ 25% papaya	O9	5.03 ± 1.28	4.6 ± 1.3	4 ± 0.78	3.5 ± 0.93	3.45 ± 1.01	4.11 ± 1.23bOd	3.98 ± 1.40a
	O10	4.83 ± 0.98	4.4 ± 1.82	4.2 ± 0.76	3.7 ± 1.02	3.65 ± 1.08	4.16 ± 1.26bOde	
	O11	4.95 ± 1.18	4.7 ± 1.76	3.5 ± 1.22	3.4 ± 1.22	3.35 ± 1.23	3.98 ± 1.50bO	
	O12	4.45 ± 1.93	3.7 ± 1.87	3 ± 1.5	3.6 ± 0.93	3.58 ± 0.96	3.67 ± 1.56a	
Mean of total storage period		5.01 ± 1.38D	4.52 ± 1.73O	3.9 ± 1.01B	3.76 ± 1.04AB	3.72 ± 1.07A		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		4.21 ± 1.32B	4.23 ± 1.36B	4.29 ± 1.38B	3.99 ± 1.40A			
LSD at 0.05 for:	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	0.16	0.14	0.12	0.27	0.31	0.24	0.55	

a, b & O: There is no significant difference (P > 0.05) between any two means, within the same column have the same superscript letter. *n* = 40. A, B & O: There is no significant difference (P > 0.05) between any two means for the same attribute within the same row have the same superscript letter.

Table 12. Bitterness of orange-based formulated low calories jams sweetened with fructose, stevioside and sucralose during 12 months of storage (mean ± SD).

Fruit type	Sweetener formula	Storage period (month)					Mean of storage period	Mean of fruit type
		0	3	6	9	12		
Orange	O1	5.23 ± 1.19	5.2 ± 0.88	3.9 ± 1.06	3.1 ± 0.84	3.08 ± 0.83	4.10 ± 1.36bO	4.02 ± 1.34[a]
	O2	5.13 ± 1.3	5 ± 1.2	4.3 ± 0.65	2.76 ± 1.1	2.92 ± 1.24	4.05 ± 1.50bO	
	O3	5.03 ± 1.1	4.9 ± 1.06	4.1 ± 0.71	3.2 ± 0.88	3.2 ± 0.94	4.09 ± 1.23bO	
	O4	4.49 ± 1.32	5.1 ± 1.24	3.2 ± 1.09	3.2 ± 0.41	3.23 ± 0.53	3.84 ± 1.27a	
75% orange/ 25% pumpkin	O5	5.35 ± 1.25	4.7 ± 1.29	3.7 ± 1.2	3.6 ± 1.03	3.6 ± 1.01	4.19 ± 1.35bOd	4.29 ± 1.36c
	O6	5.62 ± 0.91	5.3 ± 0.79	4.5 ± 0.82	3.1 ± 0.84	3.2 ± 0.94	4.34 ± 1.35de	
	O7	5.63 ± 0.87	5 ± 1.11	4.5 ± 0.82	3.6 ± 1.13	3.6 ± 1.15	4.47 ± 1.29e	
	O8	5.58 ± 0.84	5.2 ± 1.49	3.7 ± 0.91	3.2 ± 0.88	3.25 ± 0.93	4.19 ± 1.44bOd	
75% orange/ 25% papaya	O9	5.05 ± 1.21	4.9 ± 1.24	3.9 ± 1.15	3.3 ± 0.91	3.33 ± 0.89	4.09 ± 1.31bO	4.14 ± 1.34b
	O10	5.63 ± 0.63	4.8 ± 0.99	4.7 ± 1.02	3 ± 0.91	3.05 ± 0.9	4.24 ± 1.37Od	
	O11	5.6 ± 0.78	5 ± 1.2	3.9 ± 1.06	3.3 ± 0.91	3.3 ± 0.94	4.22 ± 1.35bOd	
	O12	5.15 ± 1.1	5 ± 1.2	3.7 ± 0.79	3.1 ± 0.96	3.15 ± 0.98	4.02 ± 1.34ab	
Mean of total storage period		5.29 ± 1.10D	5.01 ± 1.15O	4.01 ± 1.03B	3.21 ± 0.93A	3.24 ± 0.96A		
Ratio of (fructose:sweeteners)		O (1,5,9) (100/0)	O (2,6,10) (75/25)	O (3,7,11) (50/50)	O (4,8,12) (25/75)			
Mean of sweetener formula		4.13 ± 1.34AB	4.21 ± 1.41BC	4.26 ± 1.3C	4.02 ± 1.36A			
LSD at 0.05 for:	Storage (S)	Fruit (F)	Sweetener (T)	S*F	S*T	F*T	S*F*T	
	0.13	0.11	0.10	0.22	0.26	0.20	0.44	

a, b & O: There is no significant difference (P > 0.05) between any two means, within the same column have the same superscript letter. *n* = 40. A, B & O: There is no significant difference (P > 0.05) between any two means for the same attribute within the same row have the same superscript letter.

[35] showed that formulations containing 3.7% to 37.7% papaya in mixed fruit jam produced optimum acceptance for color. A decremental rate in color was monitored during 12 months. This result was in accordance with Ehsan *et al.* [70] who reported decrease in color during storage of grape fruit apple marmalade. Replacing fructose by St & Su improved the color significantly. This result was in agreement with Youssef *et al.* [32]. Also, Carvalho *et al.* [71] showed that used of Reb-A as a sweetener in strawberry diet jam was given a bitter sensory performance.

The obtained data in **Table 9** indicated that the highest score was recorded for OK jams (3.86 ± 1.35) followed by orange jams (3.76 ± 1.29) while OY jams recorded the lowest score (3.54 ± 1.26), significantly. During the storage, the jams taste was deteriorated significantly. This result was in agreement with Bajwa *et al.* [72]. Concerning the mean of sweetener formulas, results indicated that maximum mean score was 3.82 ± 1.28 obtained by ratio of (50:50). These results were in agreement with Kerdsup *et al.* [73] and Gajar *et al.* [74].

Oder of formulated low caloric jams was tabulated in **Table 10**. The obtained data indicated that no significant (P < 0.05) difference was found between OK and orange jam while a significant differences between them and OY and both OK and orange jams was recorded. Replacing the fructose with St & Su did not affect the odor even at 50%. As shown in other sensory attributes the odor also deteriorated with prolong of storage period. The replacing of 75% of fructose affect the odor may be due to the effect of cooking temperature on flavor substances which affecting the odor. These results are in harmony with Gajar *et al.* [74] and Carvalho *et al.* [71].

In **Table 11**, there is a significant difference (P < 0.05) was found among all formulated orange jams. After one year storage, results concluded that OK jam formulas was the better than orange or OY jams. These results are in accordance with confirmed results by [52]. A decremental rate in jam texture was correlated to increasing of storage period. This result is agreement with Ehsan *et al.* [70] whom recorded a decrease in texture from 8.80 to 7.96 in grape fruit apple marmalade during storage. Also, Muhammad *et al.* [75] reported that the mean score for texture significantly decreased from 9.00 to 6.7 during storage in apple diet jam. Regarding the general mean

of sweetener formulas the results indicated no significant differences between the ratios (100:0), (75:25), and (50:50) while there is a significant difference between ratio (25:75) and all replacing ratios confirming the texture degradation in low fructose jams [52] [75].

The Bitterness characteristic of sweetened jam with fructose, St and Su was illustrated in **Table 12**. Comparing the fruits used in jam making a significant difference ($P < 0.05$) was observed among the group formulas recorded the lowest bitterness as high scored for OY jams while the lowest score was given to orange as highest bitterness was recorded. During the storage period, an incremental rate in bitterness was observed when monitoring the mean of total storage period. Comparing between mean of sweetener formulas the results indicated that maximum mean score for bitterness was 4.26 ± 1.3 obtained by ratio (50:50). A non-significant difference was observed between different sweetened jams; means that addition of different Su and St for producing diet jams don not affect the taste. These results are in agreement with Khouryieh *et al.* [76] and Prakash *et al.* [77].

4. Conclusion

The use of sweeteners such as fructose, sucralose and stevioside in the manufacture of orange diet jam was shown to be satisfactory, resulting in a product with jam characteristics and with flavor, taste and texture similar to conventional jam, with low caloric value, allowing its indication as much for diabetics as to the individuals that are on a diet with caloric restriction. This type of product can be recommended as an antioxidant booster for the consumers in health point of view. The product can be safely consumed up to a period of 12 months without any deterioration in its quality at room temperature condition.

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