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Evaluation of quality attributes, antioxidant activity and volatile compounds of two cactus pear juices blended with guava juice

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Abstract

The current investigation carried out on blends of two species from cactus pear (CP) juices with guava juice to evaluate the changes in physicochemical properties, ascorbic acid, phytochemicals, antiradical activity as well as volatile compounds. The blends of purple CP showed a significant increase in pH, TSS and ratio of TSS/TA values compared to blends of green CP with guava juice. An opposite trend had occurred in determination of titratable acidity. Ascorbic acid concentration in blends ranged from 42.45 to 59.43 mg/100 mL in T1 and T3 respectively. The blends showed a remarkable increase in total phenolic content with the increase of cactus pear in blends in formula to reach the maximum level at T1 and T3. Against reducing power, the antiradical activity was generally higher than that of DPPH by factor about 1.3 at T1 and 1.4 at T6. The radical scavenging activities of studied blends were in the range of 8.37 – 13.46 µmol TE/100 mL in T6 and T1 respectively when the determination carried out using DPPH assay. The highest score of panellists recorded for the T3 [(3) purple pear: (1) guava juice). Therefore, this blending ratio subjected to GC-MS analysis. Thirty volatile compounds were identified; the major alcohols in T3 were 1-hexanol and linalool which represent 12.35% and 7.23% respectively.

Keywords: cactus pear, guava, physicochemical, antioxidant, volatile

Introduction

The family cataceae contain several species like cactus pear-future plant- with different colours ranged from green, yellow and purple due to pigments like carotenoids and betalains [1-2]. The fruits are native in Mediterranean area of Africa, and America. Recent biological studies showed that there are several positive effects of cactus pear consumption such as hepatoprotective effects; anticancer and antioxidant properties [3-4]. The sweet taste, delicate flavor and attractive colours of the fruits encourage the consumers for selling and consumption the fresh fruits. However, the rapid sensitivity of fresh fruits to chilling and dark colour formation is a major problem for long time availability of these fruits [5].

A little industrial application of opuntia genus comes from susceptibility of pulp to microbial attack, pH is neutral, high water content which makes the handling of fruits after harvest is difficult [6-7]**.** Also, the fruits are valuable as functional food and had important nutraceutical properties correlated with bioactive components especially amino acids like taurine, biothiols, carotenoids and vitamins [8-9]**.**

The fruits of guava (*Psidium guajava*) are climacteric type native in Egypt. The widespread of guava consumption because of characteristic taste, aroma and flavour. In addition, the guava fruits are important source of nutritional components like vitamins especially ascorbic acid- about 6-folds of orange- and riboflavin, niacin as well as pro-vitamin A [10]. However, guava are limited shelf-life fruits due rapid ripening rate and high susceptibility for diseases and microbial fermentation.

Flavour is the most important sensory quality which contributes the juice acceptance and attract the consumer [11]. The volatile composition of different colour cactus pear studied by Agozzino et al. [12] and they mentioned that the main volatile compounds in white and yellow cultivars are 2-2'-hexen-1-ol and 2-nonen-1-ol while the red cultivars characterized by 1-hexanol. On the other hand, Karadag et al. [13] found that the main volatile compounds in n-hexan extract of cactus pear were hexadecanoic acid and heptacosane

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with concentrations of 39.4% and 12.3% respectively. The early study by Mac-Leod and Troconis [14] on guava fruit volatile referred to that hexyl acetate, 2-methy-lpropyl acetate and benzaldehyde were the most predominant volatiles among about 40 identified compounds using GC-MS. However, Pino et al. [15] mentioned that α-pinene, hexadecanoic acid, (E)-β-caryophyllene and ethanol were the major volatile compounds in guava.

Nowadays, non-thermal technologies had increased with the increase demand of consumers to take the ready-to-use, fresh-like or minimally processed food products [16-17]. These types of food products contain the bioactive ingredients, healthy components that destroyed during thermal treatments and minimal loss of sensory attributes and nutritional quality [18-19].

The improvement of nutritional quality in beverages like drinks and juices can be performed using blending methodology. Blending juice enhance the utilization of minerals and vitamins depending on the quality and kind of used fruits and vegetables [20]. The improved juice blend in nutritional and quality take in account the variables of blending such as ratio, packaging, storage conditions……*etc.* Therefore, a novel product development by blending of healthy and natural juice characterized with high sensory evaluation may be served [21-22]**.** The objective of the present work to study the changes when blending two species of cactus pear juice with guava juice on quality attributes, antioxidant and volatile compounds.

Materials and Methods

Fruit samples and juice processing

Cactus pears fruits O. ficus-indica (green) and O. lindheimeri (purple) were obtained from private farm at Alexandria Governorate, Egypt during 2019-2020 seasons. The fruits were dethorned by removing the glochids, sweeping them on grass and rinsing them with tap water. The fruits were stored in plastic bags and transported to the Food Science and flavour chemistry laboratories in National Research Centre. The fruit was carefully selected and sorted using criteria of homogeneity in terms of green and red-purple colour, maturity and ripeness. Fruits that were low in quality (defective, damaged and darkest purple color which was indication of over ripeness) were removed. Cleaning of cactus pear fruit involved dethorning for the second time under running tap water followed by a cold water rinse, and rubbing the fruit surface with a cheese cloth to remove the hair thorns. The fruits were stored in a cold room (4 ^{0}C) for up to 48 hrs before juice extraction. All the selected fruits were gently washed with water, manually peeled, and blended for 30 S in a Moulinex blender (type LM2421 41, France). The pulp is then sieved to separate the seeds and stored in the dark at -20^{0}C until use.

Guava fruits were clean, washed with water and cut into small pieces with a clean knife, and the pulp was mixed for a few minutes in a mixer. The seeds were recovered from the resulting pulp juice and washed using distilled water for several times. The pulp juice kept in polyethylene bags under straining cooling till used. The juice blends were divided into 6 lots as shown in (Table 1).

Table (1) Blending ratio of juices and symbol

S/No.	Juice type	Ratio	Symbol
1	Purple PP: Guava	1:3	T_1
2		1:1	T_2
3		3:1	T_3
4	Green PP: Guava	1:3	T_4
5		1:1	T_5
6		3:1	T_6

Chemicals and reagents

DPPH (2,2$^{'}$-diphenyl-1-picrylhydrazyl), quercetin, ethanol, Foline-Ciocalteu's reagent and hexane was obtained from Sigm-Aldrich (Germany). All other reagents and chemicals were of analytical grade.

Physicohemical Analyses

Physicochemical characterization of each juice as well as blends were done with measurements of pH, titratable acidity (TA) and total soluble solids (TSS) [23]**.** pH values were measured using a pH meter (Hanna pH-meter HI 9021 m Germany). Titratable acidity was determined by titration with 0.1 N NaOH in 10 g of sample and pH meter up to pH = 8.2, the results were expressed as citric acid. TSS was determined by measurement of the refractive index with a digital refractometer (JEN way) at 25 ± 1 ^{0}C.

Determination of ascorbic acid and browning index analysis

Ascorbic acid content was measured with a 2,6- dichlorophenol- indophenol dye solution and expressed as mg per 100 mL juice [23]**.** Samples of 10 ml each were diluted to 100 ml with 3% metaphospho-ric acid and then filtered through Whatman (No. 4) filter paper. An aliquot of 5 ml filtrate was titrated with 2,6-dichlorophenol iodophenol indicator to the end point. Ascorbic acid content was calculated as milligrammes ascorbic acid per 100 ml sample juice.

The browning index analysis (BI) was measured using the method of Cruz-Cansino et al. [17]**.** Briefly, 10 mL of each juice sample was centrifuged (10 min, 1850 xg) (6500, Hamilton Bell, New Jersey, USA) to remove coarse particles and then 5 mL of ethyl alcohol (95%, Sigma–Aldrich, Dublin, Ireland) were added to 5 mL of supernatant before centrifugation was repeated. The absorbance of the obtained supernatant was measured at 420 nm using spectrophotometer.

Phytochemical and antiradical analysis

Preparation of the extracts.

The ethanol 50 ml/100 ml was used in order to extract the phenolic compounds. Each juice sample (10 ml) was mixed with 20 ml of solvent, after stirring for 40 min, the mixture was centrifuged at 1800 xg during 30 min and it was filtered with filter paper No. 1

Total phenolic measurement

The total phenolic (TP) concentration of the samples was measured according to the method of Nencini et al. [24]**.** Extract from juice samples (10 ml) was mixed with 1 ml of Foline-Ciocalteu's reagent. After 3 min, the mixture was neutralized with 800 ul of aqueous sodium carbonate (2 g/100 ml). The colour absorbance was read at 720 nm. The concentration of total phenolics was expressed as mg of gallic acid equivalent (GAE)/100 mL.

Total flavonoid (TF) determination

The method of Djeridane et al. [25] was used to determine the concentration of total flavonoids. One milliliter of the extract was mixed with 1 ml of aqueous aluminum chloride (2 g/100 ml). After incubation at room temperature for 10 min, the absorbance of the mixture was read at 410 nm. Total flavonoids concentration was expressed as ug of quercetin equivalent (QE)/100 mL juice.

DPPH assay

The extracts ability to scavenge DPPH radical was determined according to the method Al et al. [26]**.** Methanolic DPPH solution (100 ul, $6*10^{-5}$mol/l) was added to 1000 ul of extract. After 20 min of incubation at room temperature, the absorbance was read at 517 nm. The percentage of reduction of radical DPPH was calculated as follows:

Radical-scavenging activity % = [(Abs $_{control}$ –Abs $_{sample}$)/(Abs $_{control}$)]*100,

where Abs $_{control}$ is the absorbance of DPPH radical + methanol and Abs $_{sample}$ is the absorbance of DPPH radical +sample extract. Trolox calibration solutions of 10-50 μM concentration were used to generate the standard curve. The results were expressed as μmol TE/100 mL.

Reducing power

The reducing power of the tested juice samples was estimated according to the method described by Yildrimet al. [27]**.** One milliliter of the extract was added to 2.5 ml of phosphate buffer (0.2 mol/l, pH 6.6) and 2.5 ml of aqueous potassium ferricyanide solution (1 g/100 ml). After stirring, the mixture was incubated at 50 ^{0}C for 20 min. Then, 2.5 ml of aqueous trichloroacetic acid solution (10 g/100 ml) were added.1.25 ml of distilled water and 0.25 ml of aqueous ferric chloride solution (0.1 g/100 ml) were added to 1.25 ml of the mixture. After10 min, the absorbance was determined at 700 nm. The standard curve was linear between 100 and 1000 μM Trolox. The results were expressed in μmol TE/100 mL.

Determination of sensory attributes

Sensory quality attributes viz. colour, appearance; consistency, flavour, taste and overall acceptability of the samples were evaluated using a 9-point hedonic rating test (9 = like extremely and 0 = dislike extremely) by a panel of ten judges by the method recommended by Yadav et al. [28]**.**

Volatile compounds analysis

Volatile extraction

Sampling was carried out by using a SPME (Supelco, Bellafonte, PA) fiber coated with a 100 μm film of polydimethylsiloxane (PDMS) in the headspace for 15 min. Desorption time in the chromatograph injector at 250°C was fixed at 5 min in the splitless mode.

Gas-chromatography/Mas spectrometry (GC-MS)

The analysis was run on a GC/MS Varian Saturn 3-Ion Trap System, equipped with a 60 m x 0.25 mm i.d. fused-silica capillary column DB-5 with a film thickness of 0.25 μm. The carrier gas (helium) pressure was fixed at 12 psi at the head of the column. The transfer line and ion trap temperature was 180°C. The GC temperature program started at 40°C (5 min hold), first step 5°C/min to 130°C (10 min hold), second step 10°C/min to 220°C (5 min hold). The ion trap mass spectrometer parameters were: electron ionization mode (EI) 70 eV, mass range 40-400 Da and the scan frequency was 3 scans-second.

Compounds identification

The identification of the volatile constituents was based on the comparison of their retention indices relative to (C_6-C_{22}) n-alkanes either with those of published data or with authentic compounds. Compounds were also identified using their MS data compared to those from the NIST mass spectral library and published mass spectra [29]**.**

Statistical Analysis

The averages and the standard deviations are calculated with Microsoft Office Excel 2010**.** The parameter results of the various indicators obtained in the experiment were analyzed by using SPSS 20.0 software (SPSS Inc., Chicago, Illinois, USA). Correlation coefficients at $P \leq 0.05$ level between antioxidant activity using DPPH and flavonoid as well as phenolic contents were performed using Microsoft Excel Data Analysis. Analysis of variance (ANOVA) was used to determine significant differences between the results, and Duncan's test was used to compare the means with a significance level of 0.05.

Results and discussion

The assayed physical and chemical properties of two cactus pear either green or purple with guava juice as well as their blends with various ratios are summarized in Table 2**.** The purple species of cactus pear juice showed higher pH value (5.37) compared to

green one and guava juice which represent 4.53 and 4.26 respectively. The blends of purple CP showed a significant increase in pH, TSS and ratio of TSS/TA values compared to blends of green CP with guava juice. An opposite trend had occurred in determination of titratable acidity. These results in good agreement with Hashem et al. [30].

Table (2) Blending effect of guava with two species of cactus pear juices on physicochemical properties

	Guava	Purple CP	Green CP	T1	T2	T3	T4	T5	T6
pH	4.26±0.25	5.37±0.61	4.53±0.72^{a}	4.63±0.14^{a}	4.77±0.15^{b}	4.79±0.12^{b}	4.39±0.07	4.45±0.03^{c}	4.49±0.02^{c}
TA	0.61±0.16^{a}	0.48±0.08	0.59±0.13	0.52±0.02^{b}	0.53±0.08	0.53±0.09^{b}	0.60±0.06^{a}	0.61±0.11^{a}	0.61±0.08^{a}
TSS	12.40±0.19^{a}	12.68±0.28^{a}	11.75±0.07^{b}	12.79±0.16^{c}	12.98±0.13^{c}	13.04±0.11	11.95±0.05^{b}	12.16±0.09^{d}	12.19±0.05^{d}
TSS/TA	20.34±0.18	26.42±0.75	19.94±0.26^{a}	24.53±0.12^{b}	24.47±0.15^{b}	24.67±0.14	19.93±0.28^{a}	19.96±0.32	19.98±0.24^{a}
Ascorbic acid	35.8±0.42	42.45±0.12	39.7±0.19	42.45±0.24	54.82±0.16^{a}	59.43±0.42	42.06±0.18	53.89±0.31	54.43±0.15^{a}
BI	0.29±0.31	0.37±0.51	0.31±0.62	0.45±0.07	0.46±0.03	0.48±0.02	0.39±0.02	0.40±0.01	0.42±0.05
L	2.95±0.05	14.25±0.08	18.59±0.13	26.85±0.05	19.76±0.21	15.48±0.14	30.19±0.07	25.47±0.13	21.62±0.15
a	4.39±0.12	17.64±0.12	8.46±0.27	2.76±0.08	0.45±0.11	-1.75±0.19	19.58±0.11	17.43±0.03	13.45±0.10
b	0.08±0.01	3.27±0.18	5.47±0.19	4.53±0.09	2.49±0.06	1.37±0.19	14.62±0.05	11.76±0.16	9.58±0.12

Values are expressed as mean ± SD; the same letters in the same raw are not significant (P < 0.05); BI: browning index

The determination of ascorbic acid was significantly higher in purple cactus juice compared to green specie and guava juice. These results are in agreement with previous studies [31-32]. The data for ascorbic acid in blends ranged from 42.45 to 59.43 mg/100 mL. T3 showed the highest content of ascorbic acid, while T4 was the lowest one. The high content of ascorbic acid in the studied blends of current study may be due to rich content of ascorbic acid in cactus pear and guava juice compared to other fruits such as plums, nectarines or peaches [33].

The browning index (BI) of each juice for guava, purple and green CP were evaluated using spectrophotometer and the obtained data are given in Table 2. The purple CP had BI higher than green CP and guava juices. Also, the blends prepared from purple CP with guava juice were higher than those of green CP and guava. The browning occurred in cactus pear juices due to ascorbic acid degradation [34] in non-enzymatic browning reactions and breakdown of carotenoids [35]. On the other hand, cactus pear are rich in sugars especially fructose and had a significant content of proline, so the browning was expected [36].

The acceptability of juice by consumers can be condition by colour which consider as one the most important quality attribute. Colour parameter L, a, and b-values were evaluated in blends of guava and two pears juices and the data are given in Table 2. The blends of green CP pear juice with guava juice exhibited a higher L-value in cpmarison with purple CP with guava. On the other hand, the blends of purple CP with guava juice showed lower values of a-values compared to blends of green CP with guava juice at all ratios of blend. A similar trend was observed for b-values; this trend may be becomes from the fact that purple cactus pear contain a significant amounts of betacyanin and indicaxanthin which leads to the variation in colour values from red to yellow which determine the colour level in fruits [37].

Phytochemical and antiradical activities

The total phenolic content (TPC) was determined using Folin-Ciocalteu method which depends on the ability of phenolic compounds to reduce the Folin-Ciocalteu reagent in the alkaline media. There is a proportional relation between the concentration of phenolic concentration and absorbance which indicate by the colour intensity of each solution [38]. The TPC in the blends of guava with green and purple cactus pear juice ranged from 62.43 mg GAE/100 mL in T4 to 82.45 mg GAE/100 mL in T3 (Table 3).

Table (3) Antiradical activities, phytochemical contents of guava juice blended with two species of cactus pear juice at different ratios

Sample	TP	TF	DPPH	Reducing power	Correlation coefficient (r)	
	mg/100 mL	ug/100 mL	µmol TE/100 mL	µmol TE/100 mL	TP	TF
Guava	31.26±0.14	26.48±0.45	7.56±0.14	10.29±0.24	0.93	0.91
Purple CP	58.49±0.28	40.89±0.39	9.62±0.15	11.56±0.13	0.78	0.85
Green CP	47.32±0.08	38.76±0.27	8.47±0.34^{a}	10.78±0.14	0.82	0.88
T1	76.42±0.19	62.76±0.38	13.46±0.06^{c}	17.43±0.19^{a}	086	0.96
T2	79.53±0.25	65.82±0.46	12.59±0.14^{c}	16.92±0.52^{a}	0.89	0.96
T3	82.45±0.16	69.34±0.25	11.62±0.13	13.46±0.49	0.92	0.94
T4	62.43±0.45	45.23±0.17	10.34±0.08^{b}	13.54±0.16^{b}	0.75	0.85
T5	65.72±0.37	49.54±0.19	10.25±0.12^{b}	12.86±0.43^{b}	0.78	0.87
T6	72.59±0.42	51.28±0.12	8.37±0.17^{a}	10.76±0.17	0.82	0.91

Values are (n=3); the same letters in the same column are not significant.

The obtained values for blends indicate that juices is a rich source for polyphenols in comparison with the previous studies which mentioned that Opuntia spp juices contain polyphenols in range of 2.2-66 mg GAE/100 mL [39-40]. The blends showed a remarkable increase in total phenolic content with the increase of cactus pear in blends in formula to reach the maximum level at T3 and T6 (Table 3). The total phenolic content in the present study are confirmed by Chávez-Santoscoy et al. [41] who mentioned that phenolic content in purple and red cactus pear are higher than that of yellow and green fruit juices when they evaluate the phenolic content of nine prickly pear juices.

Regarding to the determination of flavonoids content; the blends of purple cactus pear with guava showed a remarkable increase compared to green CP blends with guava juice. This higher value in blends may be due to the high concentration of total flavonoids in purple CP (40.89 ug QE/100 mL) compared to green CP and guava juice which had 38.76 and 26.48 ug QE/100 mL juice respectively (Table 3). Fernández-López et al. [42] reported that the main flavonoid in Spanish cactus pear were quercetin and isorhamnetin with a significant concentrations followed by kaempferol and luteolin. The present study showed a higher concentrations of total flavonoids when compared with Tesoriere [43] due to prepared blends of cactus pear with guava and they performed the assays only on pulp of cactus pear or blend peel with pulp.

The assessment of antioxidant activity *in vitro* for cactus pear fruits and their juices, DPPH and reducing power method recommended by several studies [44-45]**.** So, these methods had been used in the present investigation for antioxidant analysis. Against reducing power, the antiradical activity was generally higher than that of DPPH (Table 3) by factor about 1.3 at T1 and 1.4 at T6. The radical scavenging activities of studied blends were in the range of 8.37 – 13.46 µmol TE/100 mL in T6 and T1 respectively when the determination carried out using DPPH assay (Table 3). There is a report by Wang et al. [46] who mentioned that a poor correlation between ascorbic acid and antiradical activity in cactus pear. Therefore, we made the correlation between the antioxidant activity by DPPH method with both total phenolic and flavonoids content in studied blends. The results in (Table 3) revealed that the correlation coefficient between total flavonoids and radical scavenging activity higher than total phenolic content at all blending ratios. Also, the purple CP with guava juice exhibited stronger correlation coefficient compared to green CP with guava juice. The obtained results confirmed by Velliogluo et al. [47] regarding the correlation between antioxidant activity and some phytochemicals such as phenolics and flavonoids in grain products, fruits and vegetables. Some natural flavonoids can be considered as a potential antioxidant higher than nutrient antioxidants like vitamin E and ascorbic acid [31].

Sensory evaluation

The data of sensory evaluation properties for the blends of two cactus pear green and purple with guava juice at various ratios are given in Table 4. The studied attributes showed a significant difference in colour when blending ratio of purple cactus increase to guava juice at (3:1) compared to the less or equal of green cactus to guava juice. However, there is no significant difference in colour between all ratio of blending when the purple cactus pear juice blend with guava juice. The obtained results showed a gradual increase in the scores of appearance, flavour, taste, consistency and overall acceptability when the blending ratio of both pears increase with the decrease of guava juice.

Table (4) Effect of blending guava juice with two species of cactus pear juices at various ratios on sensory attributes

Sample	Colour	Appearance	Flavour	Taste	Consistency	OAA
T1	8.5±0.14^{a}	8.1±0.15^{a}	8.4±0.12^{a}	8.5±0.23^{a}	7.7±0.25^{a}	8.3±0.19^{a}
T2	8.7±0.25^{a}	8.6±0.11^{a}	8.5±0.19^{a}	8.6±0.17^{a}	7.9±0.39^{a}	8.5±0.42^{b}
T3	8.8±0.45^{a}	8.8±0.18^{b}	8.7±0.12	8.7±0.52^{a}	8.5±0.14^{b}	8.7±0.26^{b}
T4	7.5±0.31^{b}	7.4±0.17^{c}	7.7±0.45^{b}	7.5±0.16^{b}	7.2±0.63^{c}	7.5±0.46^{c}
T5	7.6±0.15^{b}	7.5±0.19^{c}	7.9±0.38^{b}	7.7±0.14^{b}	7.4±0.19^{c}	7.6±0.52^{c}
T6	7.9±0.12^{c}	7.9±0.34^{a}	8.2±0.27	7.9±0.18^{b}	7.6±0.14^{a}	8.1±0.34^{a}

OAA: Overall acceptability' Values with the same letter in the same column are not significant ($P \leq 0.05$)

The highest score of panelists recorded for the T3 (purple pear: guava juice). Therefore, this blending ratio subjected to GC-MS analysis. The data of taste evaluation revealed that there is no significant difference between all blending ratios for both cactus pear and guava juice with higher scores for purple type compared to green species (Table 4).

Volatile compounds profile for blends of two cactus pear juices with guava

Data in Table 5 the summarized isolated and identified volatile compounds in T3. The analysis of volatile compounds was dominated with various chemical classes such as alcohols, aldehydes and terpenoids. Thirty volatile compounds were identified with available from literature their odor note and odour

threshold values are tabulated in (Table 5). The identified volatile compounds can be grouped to alcohols (10), esters (5), aldehydes (9), mnoterpenes (4) and lactones (2). Similar classes had reported in previous studies [48-50].

Table (5) Volatile composition of guava juice blended with purple cactus pear at ratio of T3

Volatile compounds	RI[a]	T_3	Odor Note [c]	OT (ug/L)[d]
Alcohols				
Ethanol	613	2.17[b]		
1-butanol	692	0.95		
1-Pentanol	736	2.48		
3-Hexen-1-ol	786	1.34	Woody, green, leafy	
2-Hexen-1-ol	842	4.52	Green, fruity, leafy	
1-Hexanol	859	12.35	Green, fruity	500-2500
3,5-Hexadien-1-ol	867	0.54		
1-heptanol	975	1.23		
Octanol	1026	0.56		
Linalool	1165	7.23	Floral, green, citrus	
Subtotal		**33.37**		
Esters				
Ethyl acetate	648	5.29	Fruity, sour	
Methyl-2- methyl propanaotae	682	1.37		
Methyl butanoate	723	0.92	Fruity, sweet	
Butyl acetate	825	0.32		
Ethyl butanoate	843	4.26		
Subtotal		**12.16**		
Aldehydes				
Pentanal	623	1.46	Bready, fruity, berry-like	
Hexanal	772	3.27	Green, grassy, floral	9.18-10.50
(E)-2-hexenal	775	4.58		
2-Hexenal	833	11.29	Soapy, fatty, green	24.2
2,4-Hexadienal	854	3.27	Green, fruity, waxy	
Heptanal	879	1.45	Fruity, oily-greasy	
2-Heptenal	931	3.26	Green, fatty, oily, fruity	
2-Octenal	1028	0.28	Sweet, green, fatty	
Nonanal	1062	0.45	Piny, floral, citrusy	2.53-5.00
Subtotal		**29.31**		
Monoterpenes				
α–Pinene	942	1.28	Pine-like, resinous	
β–Pinene	975	2.76	Resinous, dry, woody	
β-Myrcene	993	3.48		
D-limonene	1031	9.57	Fruity, lemon, herbal	
Subtotal		**17.09**		
Lactones				
γ-Nonalactone	2095	1.25		
γ-Decalactone	2146	1.49		
Subtotal		**2.74**		

[a]: RI: retention index; [b]: values are relative area percentage; [c] Berger [62] ; [d]: AIHA [63].

Alcohols; the major alcohols in T3 were 1-hexanol (Green, fruity) and linalool (floral, green, citrus) which represent 12.35% and 7.23% respectively. Our data in accordance with Oumato et al. [51] who mentioned that volatile compounds different cultivars of prickly pear in Morocco analysis; 1-hexanol was the most dominant alcohol. In addition, Andreu-Coll et al. [52] found a significant amount of linalool in different cultivars of prickly pear.

Aldehydes; in the current study we could identify nine aldehydes which represent about 29.31% of the total volatile in T3. The main aldehydes were 2-hexanal and (E)-2-hexenal with concentrations of 11.29% and 4.58% respectively. These results confirmed by Farag et al., and Yi et al. [53-54] who reported that aldehydes were the most common volatile in pulp and peel of some Opuntia ficus-indica varieties. The alcohol (1-hexanol) and aldehyde (2-octenal) contribute to the flavour of peas [55]. Nonanal

(piny, floral, citrusy) and hexanal are known as aldehydes which to provide herbaceous aroma [56]. Moreover, a strong aroma of orange peel and rose-like aroma can be formed by nonanal [53]**.** The obtained results are in agreement with Weckerl et al. [57] who found that 1-hexanol, E-2-hexanal, and other alcohols are the major volatile compounds in cactus pear and the aforementioned compounds originate from lipid degradation.

Generally, the flavour formation in fruits and vegetables due to several mechanisms of autoxidation reactions and various enzymes like lipoxygenase [58,27]. Also, a great numbers of volatile compounds can be formed during maturation processing steps such as cutting, thermal treatments especially in fruits like apple, plums and pears [59-60]**.** In previous study Sulieman et al. [61] who found that octanal, nonanal, hexnal and (E)-2-hexenal were belong to characteristic volatile compounds in prickly pear juice or its blend.

Esters; play a domestic role in flavour of juice by minimize acidity [64]. The identified five esters in T3 including; ethyl acetate and ethyl butanoate as the main esters with concentrations of 5.29% and 4.26% respectively (Table 5). Ethyl acetate (fruity, sour) was identified by Oliveira et al. [48] in different varieties of fig with concentration higher than reported in the current study.

Another characteristic volatile class, monoterpens which include β-myrcene and D-limonene with a valuable concentration of (3.48% and 9.57% respectively). Limonene had a characteristic flavour of citrus and formed by cyclization of a neryl carbocation from geranyl pyrophosphate [65]**.** In the literature limonene was reported as a strong microbial and anticancer [66-67] together that of menthol. The low odour threshold values of aldehydes compared to alcohols explain the important role of these compounds in characteristic flavor of cactus pear even in low concentrations.

Lactones; we abled to identify only two lactones namely γ-nonalactone (1.25%) and γ-decalactone (1.49%) which found in a few studies and with small concentration compared to other identified volatile compounds; this may be due to difference in method of extraction, ripening and maturity stage of fruits as well as agriculture treatments [57,12]

Conclusions

The data of this investigation concluded that blend T3 from purple cactus pear and guava juice able to satisfy the consumer demand from colour, taste and flavour. The obtained values for blends indicates that they are a rich source for polyphenols. The blends showed a remarkable increase in total phenolic content with the increase of cactus pear in blends in formula to reach the maximum level at T3 and T6. The results revealed that the correlation coefficient between total flavonoids and radical scavenging activity higher than total phenolic content at all blending ratios. Also, the purple CP with guava juice exhibited stronger correlation coefficient compared to green CP with guava juice. Therefore, further studies of storage for this blend are in need with analysis of non-volatile as well as volatile compounds during storage.

Several studies carried out on the isolation and identification of volatile compounds in cactus pear or guava. To the best knowledge of authors, no studies performed on the volatile compounds of blend guava with different species of cactus pear juice.

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تقييم خصائص الجودة والنشاط المضاد للأكسدة والمركبات المتطايرة لمخلوط عصير نوعين من ثمار التين الشوكى مع عصير الجوافه

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أجريت الدراسة الحالية لتقييم التغير فى الخواص الفيزيائية والكيميائية ، حمض الأسكوربيك، المواد الفينولية الفلافونويدات، النشاط المضاد للأكسدة وكذلك مركبات النكهة الطيارة فى مخلوط عصير لنوعين من ثمار التين الشوكى مع عصير الجوافه بنسب خلط مختلفة. أظهرت خلطات عصير التين الشوكى البنفسجى مع الجوافة زيادة معنوية فى رقم الحموضة، الجوامد الصلبة الكلية ، ونسبة الحموضة المعاير/ الجوامد الصلبة الكلية مقارنة بمخلوط عصير التين الشوكى الأخضر مع عصير الجوافه. ولكن كانت هناك علاقة عكسية بالنسبة للحموضة المعايرة. تراوح تركيز حمض الأسكوربيك فى الخلطات بين 52.46 إلى 59.43 مجم لكل 100 مل عصير فى الخلطات الأولى والثالثة على التوالى. أظهرت النتائج زيادة فى محتوى الفينولات الكلية مع زيادة نسبة عصير التين فى الخلطات وكانت أعلى القيم فى الخلطات الثالثة والسادسه. عند تقييم النشاط المضاد للأكسده بطريقة الشقوق الحرة DPPH بالنسبة بطريقة الإختزال كان هناك معامل بنسبة 1.3 ، 1.4 فى الخلطات الاولى والسادسة . تراوحت قيم نشاط الأكسده بين 8.37 -13.46 ميكرومولتر/100 مل عصير كمكافىء Trolox في الخلطات السادسة والأولى على التوالي. كانت أفضل نتائج التقييم الحسى في المعاملة الثالثة وهى خلط عصير التين الشوكى البنفسجى مع عصير الجوافه بنسبة 1:3 ولذا تم تحليل مركبات النكهة الطيارة في هذه الخلطة بجهاز التحليل الغازى الكروماتوجرافى – طيف الكتلة. تم التعرف على ثلاثين مركب نكهة طيار وكانت الكحولات هي المركبات السائدة وكانت كحولات 1-هكسانول واللينالول هي الأعلى تركيزا بنسب 12.35% ، 7.23% على التوالي.

الكلمات الدالة: التين الشوكى – الجوافه –مضادات الأكسدة- مركبات النكهة