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PHYSICOCHEMICAL, SENSORIAL, ANTIOXIDANT AND VOLATILE OF JUICE FROM PRICKLY PEAR WITH GUAVA OR MANDARIN

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ABSTRACT

Prickly pear juice has received renewed attention with regard to the effects of processing and preservation on its qualities. Therefore, the present study carried out on different fruit juice blends were prepared as prickly pear with guava or mandarin juice in 25: 75; 50:50 and 75:25 ratios to improve its quality and flavor. These blends were packaged in 200 ml. colorless glass bottles and tested for physico-chemical, sensory evaluation and flavor compounds. Chemical composition and minerals content were carried out unblended juices. The total solids, total solids (TS) pH, total soluble solids (TSS) content, titratable acidity, color analysis, ascorbic acid and viscosity were determined. The blend of prickly pear and mandarin juices at ratio (1:3) received the highest scores in overall acceptability. Therefore, it was subjected to evaluate polyphenol content which determined using Folin–Ciocalteu, antioxidant activity was measured using two in vitro assays 2,2'-diphenyl-1-picrylhydrazyl (DPPH) and metal chelating assays and volatile evaluation. 27 volatile compounds were identified by gas chromatography/mass spectrometry; including 7 alcohols, 5 aldehydes, 5 esters, 2 hydrocarbons, 8 terpenes-hydrocarbon and two ketons.

Key words: Prickly pear, juice blends, physico-chemical, total phenol compound, antioxidant activity, volatile.

INTRODUCTION

Consumption of fruit juices has become a dietary concern worldwide, it retains the physicochemical and organoleptical characteristics of fruits from which they are produced; therefore, their intake also should contribute to maintain health (Takebayashi *et al*., 2013). Health benefits of fruit juices are attributed to a large number of compounds with biological activity include radical scavenging activity, protecting proteins, lipids, and DNA from oxidative damage Liu (2003). The major bioactive antioxidant compounds of fruit and fruit juices are vitamin C and phenolic compounds Perales *et al*. (2008), as well as carotenoids. The intake of vitamin C reduces the risk of several cardiovascular, neurodegenerative diseases…..*etc* Harrison and May (2009). The main biological functions of phenolic compounds are preventing some cancer types and cardiovascular and inflammatory diseases, and carotenoids avoid age-related macular degeneration (Scalbert and Williamson, 2000; Daly *et al*., 2010). For these reasons, the potential market of fruit juices is currently growing, and new fruit-derived products have been designed. Among the new products, blended fruit juices (BFJs) stand out to enhance the sensorial and nutritional characteristics of these products. Mixing fruit juices provides increased concentrations of selected bioactive compounds, adds new nutrients, or improves flavor and appearance. Besides, it has been reported that absorption of bioactive compounds in fruit juices exceeds that after consumption of intact fruits. Therefore, the bioavailability of these substances could be also enhanced through BFJs.

Prickly pear cultivars produce green, yellow, purple and red fruits (Barbera *et al*., 1995; Mizrahi *et al*., 1997). Unprocessed prickly pear fruit has little pulp juice and many hard seeds that are thought to be the cause of constipation in consumers. Prickly pear varieties such as *Skinner Court*, *Morado*, and *Gymno Carpo* are generally sweet, but *Algeria*, which is smaller with a red-pink colour, has a bitter taste. However, *Algeria* has higher vitamin C content than the other varieties. This attribute of *Algeria*, notwithstanding the fact that people dislike its bitter taste, has prompted the need for processing technologies to increase the utilization of its fruit.

Tropical fruits are widely accepted by consumers and are important sources of antioxidant compounds. Guava is a cultivated species of the family Myrtaceae; the fruit is a very rich source of vitamin C, phenolic compounds, carotenoids and dietary fibres (Jawaheer *et al*., 2003; Vasco *et al*., 2008). By incorporating tropical fruits into fruit-juice blends, food technologists have been able to exploit their exotic flavours without adding artificial flavors (Porat *et al*., 2011). This is especially true with highly aromatic fruit such as guava, that may be able to compete in this market, either as guava juice or as mixtures with other juices (Floribeth and Lastreto, 1981). The guava is one the

easiest fruits to process, showing good characteristics for the industry, mainly due to high contents of vitamins A and C. According to Wilson *et al.* (1982), the guava does not show problems of a physical or biochemical nature in relation to texture, shape or pulp browning during the processing.

During the last decade there has been a continuous rise in consumption of fresh easy-to-peel mandarins. However, mandarins are much more perishable than other citrus fruit, mainly due to rapid deterioration in sensory acceptability after harvest (Cohen, 1999). Egypt has lately been producing almost 2 million tons of citrus per year and the production is continuously increasing. Processing of mandarin juice is low compared to orange juice but a huge increase is anticipated due to the saturation of the fresh market (FAO, 2013).

All these fruits are valued very much for their refreshing juice with nutritional, sensory properties and are also famous for excellent quality with pleasant flavor, rich in sugar, vitamins 'C' and minerals. Therefore blending of fruit juices for the preparation of Ready-To-Serve (RTS) juices is thought to be a convenient and economic alternative for utilization of these fruits. So far, no more work has been carried out on mixed prickly pear fruit juice either with mandarin or guava. Keeping these in view, the present study was conducted to note the changes in physio-chemical properties, colour, viscosity and volatile compounds of these fruits juice blends.

MATERIALS AND METHODS

PLANT MATERIALS

Algeria prickly pear (*Opuntia spp*) fruits were obtained from private farm at El-Sharkia Governorate, Egypt during 2012-2013 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 center. The fruit was carefully selected and sorted using criteria of homogeneity in terms of red-purple colour, maturity and ripeness. Fruits that were low in quality (defective, damaged and darkest purple color which was indication of overripeness) were removed. Cleaning of prickly 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 fruit was stored in a cold room (4 ^{o}C) for up to 48 hrs before juice extraction.

All the selected fruits were gently washed with water, manually peeled, and blended for 10 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.

Mandarin (*Citrus reticulate*) and guava (*Psidium guajava*) at the commercial maturity stage were obtained from private farm at El-Kalubia government, Egypt. The fruits were sorted to eliminate damaged fruits, selected for uniform size and colour, then washed and dried at room temperature. The juice was extracted using a household extractor (Citromatic Deluxe MPZ-22 Braun, Spain) and filtered through cheese cloth to remove coarse particles.

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 by straining cooling till used. The juice blends were divided into 6 lots as shown in (Table 1).

Table 1- Prepare blends as per flowing blending ratio

S/No.	Type of juice	Blending ratio	Treatment symbol
1	Prickly pear : Guava (P:G)	75:25	K_1
2		50:50	K_2
3		25:75	K_3
4	Prickly pear : Mandarin (P:M)	75:25	K_4
5		50:50	K_5
6		25:75	K_6

CHEMICALS

For the determination of kovat indices, a hydrocarbon mixture (Supelco, Bellefonte, PA, USA) ranging from C_6-C_{22} was used. All other chemicals of analytical grade.

ANALYSES OF JUICE QUALITY PARAMETERS

The moisture, protein, fat, fiber, ash, total sugars, reducing sugars and total solids contents of the samples were determined according to the methods of AOAC (1998). Potassium, magnesium, sodium, calcium, iron and phosphor were determined using perkin Elmer 2380, atomic absorption spectrophotometer according to the method of AOAC (1998).

pH, TOTAL SOLIDS, TOTAL SOLUBLE SOLIDS (TSS) AND TITRATABLE ACIDITY (TA)

The pH was measured using Hanna pH-meter HI 9021 m Germany. TSS expressed as (^{0}Brix) value was determined using a Hand refractometer (ATAGO, Japan). The total solidsd, total sugars and reducing sugars were determined with phenol–sulphuric acid method according to Masuko *et al*. (2005). Non reducing sugars were determined by difference between total sugar and reducing sugar. ^{0}Brix / acid ratio was calculated by dividing the value of total soluble solids on the total acidity value for each sample.

Titratable acidity (TA) was determined according to the official method (AOAC, 1998). Diluted juice (5 mL) was titrated with 0.1 N NaOH to pH 8.2. The results were calculated as percentage of anhydrous citric acid.

VISCOSITY MEASUREMENTS

The viscosity measurements were carried out using HAAKE viscometers (Haake, M ess-Technik Gmbhu. Co., Germany) with thermostatic bath to control the working temperature within the temperature of 25°C

results of viscosity were expressed in centipoise (cP) according to the method of Ibarz *et al*. (1994).

COLOUR ANALYSIS

Objective evaluation colour of juice samples were measured by Hunter L*, a*, and b* parameters were measured with a colour difference meter using a spectro-colorimeter (Tristimulus Colour Machine) with the CIE lab colour scale (Hunter, Lab Scan XE - Reston VA, USA) in the reflection mode. The instrument was standardized with white tile of Hunter Lab Colour Standard (LX No.16379): X= 72.26, Y= 81.94 and Z= 88.14 (L*= 92.46; a*= -0.86; b*= -0.16) (Sapers and Douglas, 1987). The Hue (H)* and Chroma (C)* were calculated according to the method of (Palou *et al*., 199) as follows:

$H^* = \tan^{-1}[b^*/a^*]$ ..... (1)

$C^* = [a^{2*}+b^{2*}]^{1/2}$ ..... (2)

$\Delta E = (\Delta L^2 + \Delta a^2 + \Delta b^2)^{½}$ ..... (3)

SENSORY EVALUATION

Sensory evaluation was carried out by hedonic scale consisting of 10 points (1–10), where 9–10 = excellent, 7–8 = very good, 5– 6 = good, 3–4=fair, 1–2= poor (**Sidel and Stone, 1993**). An internal panel of ten expert members at food technology and flavor chemistry labs at national research center evaluated the products for color, appearance, taste/flavor, mouth feel and overall acceptability.

TOTAL PHENOLIC CONTENT (TPC)

The amount of total phenolic compounds in studied samples was determined according to the Folin-Ciocalteu procedure Singleton *et al*.(1999). A sample of 50 mL juice was centrifuged for 15 min, 5000 rpm at 4 ^{0}C (HERMLEZ 323 K German) and then filtered through a Whatman No. 1 filter. An aliquot of 0.5mL of the supernatant was added to 0.5 ml of Folin-Ciocalteu solution. After 3 min, 10mL of saturated sodium carbonate solution were added and brought up to 25mL with distilled water. Absorbance was determined using UV-Vis Shimadzu Spectrophotometer (UV-1601 PC) at 765 nm. Total phenolic content data were obtained from the calibration curve prepared with gallic acid at concentrations of 8-80 mg/L and are expressed as gallic acid equivalents (mg GAE/L).Two trays were taken at each sampling time to perform replicate analyses throughout 14 d of storage.

ANTIOXIDANT ACTIVITY MEASUREMENTS

DPPH RADICAL SCAVENGING ACTIVITY

Free radical scavenging activity of methanolic extract for treatment under investigation was determined using the 2,2'-diphenyl-1-picrylhydrazyl (DPPH^0) method (Lim *et al*., 2007)**.** A methanol solutions (150, 300 and 450 uL) containing crude extracts was added to 3.9 ml of freshly prepared DPPH methanol solution (0.1 mM). An equal amount of methanol was used as a control. After incubation for 30 min at room temperature in the dark, the optical density (OD) was measured at 517 nm using a UV-Vis Shimadzu (UV-1601 PC) Spectrophotometer. Scavenging activity (%) was calculated using the following formula:

$$\%\ DPPH^0\ Inhibition = \frac{(OD_{control} - OD_{sample})}{OD_{control}} \times 100$$

BHA and TBHQ were used as a positive control.

METAL CHELATING ASSAY

The metal chelating ability of the blended juice was estimated by method of Dinis *et al*. (1994)**.** Briefly, 50 µl of 2mM $FeCl_2$ was added to 1ml of different concentrations of the juice samples. The reaction was initiated by the addition of 0.2 ml of 5mM ferrozine solution. The mixture was vigorously shaken and left to stand at room temperature for 10 min. The absorbance of the solution was thereafter measured at 562 nm. The ability of the extract to chelate ferrous ion was calculated using the following equation:

$$\%\ chelating\ effect = [1 - Abs_{sample}/Abs_{control}] \times 100$$

EXTRACTION OF VOLATILE AROMA COMPOUNDS

The aroma volatiles in headspace from the selected juice blend under investigation was isolated using a dynamic headspace system. The sample was purged for ~ 3 h. with nitrogen gas (grade of N_2 > 99.99 %) at a flow rate 100 ml/min. The headspace volatiles were swept into cold traps containing diethyl ether and pentane (1:1, v/v) and hold at –10ºC. The solvents containing the volatiles were dried over sodium sulfate anhydrous for 1h. The volatiles were obtained by evaporation of the solvents under reduced pressure.

ANALYSIS OF VOLATILE AROMA COMPONENTS BY GAS CHROMATOGRAPHY (GC) AND GAS CHROMATOGRAPHY-MASS SPECTROMETERY (GC-MS)

GC analysis was carried out using a Perkin-Elmer Autosystem apparatus equipped with FID and fused silica capillary columns (60 m X 0.22 mm i.d., film thickness 0.25 µm), DB-5. Oven temperature was programmed from 50°C to 220°C at 5 °C/min and then held isothermal at 220 °C for 3 min; injector and detector temperature was 250 °C; carrier gas, helium (0.8 ml/min); automatic sample injection, 0.5µl of a diluted solution; split: 1/60. The relative proportions of the volatile constituents were expressed as percentages obtained by peak area normalization without using correcting factors. Retention indices (RIs) were determined relative to the retention times of a series of *n*-alkanes with linear interpolation.

GC–MS analysis was performed on a Perkin-Elmer quadrupole MS system (Model 910) coupled with the above gas chromatograph, equipped with a DB-5

capillary column and operating under the same conditions described above. The MS operating parameters were: ionization 70 eV; ion source temperature, 230 °C; scan mass range, 40–400 Da.

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 (Adams, 2007).

STATISTICAL ANALYSIS

For each of the above-mentioned analyses, three replications were carried out. All data were subjected to analysis of variance (ANOVA) and least significant difference (LSD) test to determine significant differences ($P \leq 0.05$) among samples. Statistical analyses were done using SPSS 16.0 (SPSS Science, Chicago, IL, USA).

RESULTS AND DISCUSSION

CHEMICAL COMPOSITION AND MINERAL CONTENTS OF FRESH FRUIT JUICES

Chemical characteristics of the fresh fruits juices are presented in Table 2, it shows the percentage of general composition of prickly pear, guava and mandarin fruits. Protein (2.50%) and fat (0.92%) highly significant ($P \leq$ 0.05) differences were recorded for guava while, fiber (5.65%), ash (1.52%) and total sugars (12.65%) were significantly higher in mandarin than that found in of prickly pear. The obtained values in this study within the range reported by Aberoumand (2011). In the same table the proximate chemical composition of the raw prickly pear pulp for moisture, total sugar, reducing sugar (%), and non reducing sugar (%) were 84.55, 10.75, 8.24 and 2.72%, respectively. The obtained results are in agreement with (Mo-ßhammer *et al*., 2006).

The mineral content of prickly pear, guava and mandarin fruits were determined and the obtained datas are given in Table (2). It showed that Ca, k, p, Fe, Mg, and Na were 48, 208, 26, 1.6, 75, and 0.90 mg /100 gm in prickly pear; 29.7, 688, 66, 0.43, 39 and 3.6 mg /100 gm in guava, and 0.46, 7.83, 3.2, 0.51, 123, and 1.62 in mandarin**,** respectively. These results also in agreement with the results recorded by Stintzing *et al*. (2001).

PHYSICOCHEMICAL PROPERTIES OF BLENDED FRUIT JUICES

The juices from prickly pear and its blends with guava or mandarin fruits were determined for pH, total solids (TS), total soluble solids (TSS), acidity, TSS /acidity ratio, viscosity and vitamin C (mg/100g) contents and the results are shown in (Table 3). The results of fresh prickly pear were 14.22, 12.00, 0.22, 54.54, 6.02, 300 and 17.5 for the aforementioned measurements, respectively. The mixed of prickly pear with guava or mandarin at different levels (Table 1) led to decrease of TS, TSS, acidity, TSS /acidity ratio, and pH while, increase of vitamin C and viscosity in mixture of prickly pear with guava or mandarin had occured. These results agreement with, El-Samahy *et al*. (2006) and Cassano *et al*.(2010).

pH of the juices was in the range of 3.8 to 5.8, in K_6 and K_1, respectively, this low pH in K_6 indicates that microbiological shelf life would be high for this treatment. The total acidity in our prickly pear juice is of the order of 0.22%, which is similar with the acidity of other fruit juices such as pear (0.3%), and very low in comparison with the acidity of fruit juice from orange (0.8%), apple (0.9%), peach (0.9%), strawberry (0.9%), pineapple (1.1%), raspberry (1.8%), plum (2.2%), and apricot (2.4%) (Belitz and Grosch, 1999).

Table (2): Gross chemical composition and mineral contents of investigated fruit juices

Components (%)	Juice			LSD at 5%
	Prickly pear	Guava	Mandarin	
Moisture	84.55 ±0.81 * a	83.35 ±0.65 b	79.13 ±0.59 c	0.101
Protein	0.72 ±0.02 c	2.50 ±0.06 a	1. 82 ±0.07 b	0.719
Fat	0.45 ±0.002 b	0.92 ±0.001 a	0.48 ±0.003 b	0.054
Fiber	0.54 ±0.001 c	5.4 ±0.002 b	5.65 ±0.009 a	0.276
Ash	0.42 ±0.001 c	0.78 ±0.006 b	1.52 ±0.02 a	0.055
Total Sugars	10.75 ±0.02 b	9.50 ±0.11 c	12.65 ±0.15 a	0.142
Reducing Sugars	8.24 ±0.13 a	4.28 ±0.05 c	5.52 ±0.09 b	0.077
None Reducing Sugars	2.51 ±0.01 c	5.22 ±0.03 b	7.13 ±0.02 a	0.064
Minerals (mg/100gm)				
Ca	48 ±0.22 a	29.7 ±0.17 b	0.46 ±0.00 c	1.16
K	208 ±0.68 a	688 ±1.62 b	7.83 ±0.07 c	1.631
P	26 ±0.11 b	66.0 ±0.42 a	3.2 ±0.003 c	1.636
Fe	1.6 ±0.007 a	0.43 ±0.001 b	0.51 ±0.002 b	0.117
Mg	75 ±0.32 b	39 ±0.09 c	123 ±0.29 a	1.997
Na	0.90 ±0.002 c	3.6 ±0.22 a	1.62 ±0.002 b	0.117

*: Values are expressed as mean ± SD; the same letter within the same row are not significant ($P \leq 0.05$)

Table (3): Physicochemical properties of juice from prickly pear and its blends with guava or mandarin

Component	Prickly pear	Blends						LSD at 5%
		K_1	K_2	K_3	K_4	K_5	K_6	
TS	14.22 ± 0.11 [*b]	16 ±0.03 [a]	13.6 ±0.07 [bc]	13.0 ±0.11 [c]	13.6 ±0.15 [bc]	13.1 ±0.19 [c]	11.4 ±0.15 [d]	0.688
TSS (^{0}Brix)	12.00 ±0.09 [a]	11.0 ±0.09 [abc]	10.0 ±0.02 [c]	8.5 ±0.17 [d]	10.5 ±0.21 [bc]	11.0 ±0.05 [abc]	11.50 ±0.11 [ab]	1.44
Acidity	0.22 ±0.001 [f]	0.31 ±0.001 [e]	0.38 ±0.002 [d]	0.42 ±0.00 [b]	0.32 ±0.003 [e]	0.40 ±0.001 [c]	0.50 ±0.002 [a]	0.018
(^{0}Brix)/ acidity	54.54 ±0.29 [a]	35.48 ±0.62 [b]	26.32 ±0.55 [d]	20.24 ±0.19 [f]	32.81 ±0.66 [c]	27.50 ±0.20 [d]	23.00 ±0.26 [e]	2.387
pH	6.02 ±0.07 [a]	5.8 ±0.07 [b]	5.2 ±0.05 [c]	4.8 ±0.06 [d]	5.2 ±0.08 [c]	4.5 ±0.13 [e]	3.8 ±0.05 [f]	0.153
Viscosity (cp)	300 ±0.09 [e]	324 ±1.02 [b]	328 ±1.32 [a]	330 ±2.12 [a]	310 ±1.62 [d]	317 ±1.39 [c]	325 ±2.17 [ab]	3.648
Vitamin C (mg/100gm)	17.50 ±0.16 [g]	30.20 ±0.75 [a]	42.0 ±0.48 [b]	55.0 ±1.13 [a]	25.0 ±0.36 [f]	32.0 ±0.22 [d]	38.0 ±0.25 [c]	1.481

*: Values are expressed as mean ± SD; the same letters within the same row are not significant ($P \leq 0.05$)

COLOUR ANALYSIS

Colour characteristic is one of the major parameters that affect on the quality of the final product. The juice prepared from prickly pear with guava or mandarin showed a difference in colour values. Table 4 shows Hunter values of whiteness (L*), redness (a*) and yellowness (b*) measured for product colors. All samples had slightly lower L* values for juice produced from prickly pear with guava or mandarin. The results showed that the* values are getting higher in the juice produced from blends of prickly pear and mandarin. The b* was higher in juice prickly pear compared with juice produced mixture of prickly pear with guava or mandarin.

Table (4): Hunter colour values of juice from prickly pear and its blends with guava or mandarin

Samples	L	a	b	a/b	Δ E	H*	C*
Prickly pear	44.71 ±0.32 [*a]	5.06 ±0.06 [e]	26.09 ±0.14 [a]	0.19 ±0.001 [f]	52.01±0.16 [a]	78.82 ±0.32 [b]	26.58 ±0.11 [a]
K_1	34.46 ±0.25 [b]	2.40 ±0.03 [g]	25.88 ±0.11 [b]	0.09 ±0.0 [g]	43.16±0.13 [b]	67.38 ±0.65 [d]	25.99 ±0.21 [b]
K_2	27.90 ±0.21 [c]	4.94 ±0.01 [f]	20.93 ±0.15 [c]	0.24 ±0.003 [e]	35.23 ±0.11 [c]	78.56 ±0.41 [c]	21.51 ±0.25 [c]
K_3	24.81 ±0.17 [d]	5.36 ±0.06 [d]	19.33 ±0.17 [d]	0.28 ±0.001 [d]	31.90 ±0.21 [d]	79.43 ±0.52 [a]	20.06 ±0.17 [d]
K_4	26.88 ±0.13 [e]	13.44 ±0.13 [a]	9.42 ±0.09 [g]	1.43 ±0.006 [a]	31.49 ±0.17 [d]	35.03 ±0.31 [g]	16.41 ±0.11 [g]
K_5	25.46 ±0.11 [f]	12.38 ±0.19 [b]	13.56 ±0.07 [f]	0.91 ±0.002 [b]	31.39±0.13 [d]	47.60 ±0.28 [f]	18.36 ±0.09 [f]
K_6	24.50 ±0.18 [g]	11.42 ±0.05 [c]	17.32 ±0.12 [e]	0.66 ±0.003 [c]	32.10 ±0.15 [d]	56.60 ±0.24 [e]	20.75 ±0.12 [e]
LSD at 5%	0.121	0.0172	0.021	0.019	1.146	0.058	0.246

*: Values are expressed as mean ± SD; the same letters within the same column are not significant ($P \leq 0.05$)

SENSORY EVALUATION

Organoleptic evaluation is generally the final guide of the quality from the consumer's point of view. Thus the evaluation was applied on the products from prickly pear, guava or mandarin. Taste, odour, colour, mouth feel, appearance and overall acceptability were evaluated. Data presented in Table (5) show those significant differences ($P \leq 0.05$) between samples. Juice was the best in color values, odor, taste, mouth feel, appearance and overall acceptability of prickly pear and mandarin (K_6) followed by K_5.

Table (5): Sensory evaluation of juice from prickly pear and its blends with guava or mandarin

Characteristic Samples	Taste (20)	Odour (20)	Colour (20)	Mouth feel (20)	Appearance (20)	OAA (100)
Prickly pear	17.0±0.23* [d]	17.5 ±0.90 [b]	17.2±0.50 [d]	17.8 ±0.77 [e]	18.5 ±0.63 [e]	88.00 ±0. 56 [d]
K_1	15.5±0.66 [e]	18.5 ±0.80 [a]	16.2±0.60 [f]	18.3 ±1.03 [c]	19.0 ±0.88 [c]	87.50 ±0.28 [d]
K_2	15.3±0.83 [f]	17.5 ±0.60 [b]	16.7±0.16 [e]	17.9 ±0.62 [de]	18.7 ±0.25 [de]	86.10 ±0.72 [e]
K_3	17.2±0.60 [c]	18.5 ±0.45 [a]	16.5±0.20 [e]	18.0 ±0.81 [d]	18.9 d±0.77[a]	89.10 ±0.55 [c]
K_4	17.1±0.43 [d]	17.5 ±0.42 [b]	17.5±0.61 [c]	18.2 ±0.79 [c]	19.0 ±0.72 [bc]	89.30 ±0.69 [c]
K_5	17.5±0.28 [b]	17.5 ±0.30 [b]	18.1±0.16 [b]	18.5 ±0.92 [b]	19.2 ±0.35 [b]	90.80 ±0.81 [b]
K_6	17.8±0.72 [a]	18.5 ±0.65 [a]	18.3±0.15 [a]	19.0 ±0.30 [a]	19.5 ±0.56 [a]	93.10 ±0.65 [a]
LSD at 5%	0.191	0.184	0.176	0.170	0.176	0.679

*: Values are expressed as mean ± SD; the same letters within the same row are not significant ($P \leq 0.05$), OAA: Overall acceptability

PHENOLIC CONTENT

Phenolic compounds provide antioxidant potential and health-promoting properties and contribute to the flavour and colour attributes of fruits and vegetables (Kaur and Kapoor, 2001). The levels of phenolic compounds also used to gauge the physical stages and potential loss in the quality of fruit products due to browning, formation of hazes and sediments (Savikin *et al.*, 2009). As it was shown in Fig. 1, time of storage significantly affected the total polyphenol content as determined by Folin–Ciocalteu assay during 14 days under the experimental conditions applied.

At the end of storage, blends of juice showed a stable or slight significant increase in total phenolic content (Fig. 1). It is possible that during blend storage, some compounds are formed and react with Folin–Ciocalteu reagent and significantly enhance total phenolic content. This observation is supported by the findings of Klimczak et al. (2007), who reported that the total phenols of orange juice decreased after 4 months of storage and increased significantly at the end of 6 months' storage time. Another similar finding was reported by Tavarini et al. (2008**)**, who found that the phenols in kiwi fruits remained stable during the initial 2 months of storage at 0 ^{0}C and increased significantly after 6 months of storage.

It has been reported that there is a direct relationship between the phenolic content and antioxidant capacity of plants**.** They are known to constitute one of the most important groups of natural antioxidants due to their diversity and extensive distribution. They possess biological and chemical properties which include; reducing character, capacity of sequestering reactive oxygen species and several electrophiles, chelating metallic ions and capacity for modulating the activity of some cell enzymes (Al-Mamary *et al.*, 2002).

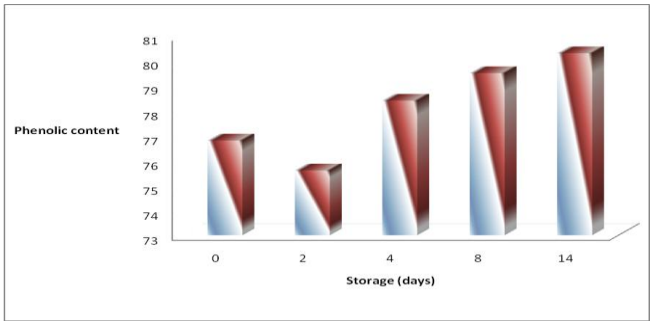

Fig (1) Effect of storage on phenolic content of prickly pear/mandarin juice blend "K_6" during storage for two weeks at 4 ^{0}C

ANTIOXIDANT ACTIVITY

The evaluation of antioxidant activity in food sample is becoming increasingly important in the field of nutritional research as it provides useful information with regard to health promoting functional quality of food material without the analysis of each antioxidant compound (Scalfi *et al.*, 2000). In this experiment antioxidant activities of selected blend, measured by DPPH and metal chelating assays (Fig. 2). Various natural antioxidants in the complex food matrix work synergistically and/or antagonistically through multiple reaction mechanism under different phase locations. Therefore a simple universal method by which total antioxidant activity can be measured accurately and quantitatively does not exist. At least two different antioxidant methods allows to compare samples identify variations in response under various reaction mechanisms (Sun *et al.*, 2009).

In the test blend, there was a slight stability in antioxidant capacity during storage. The results presented are in line with the data obtained by Arena et al. (2001) Dharmalingam and Nazni, (2013) and Piga et al. (2002). They showed the increase in the antioxidant activity after 2 months of storage in orange juices reconstituted from concentrate. According to Piga et al. (2002)**,** storage of mandarin juices during 15 days at 4 ^{0}C also resulted in the increase in the DPPH^0 antioxidant activity. In contrast to Piga et al. (2002), Del-Caro et al. (2004) described a slight decrease in the TEAC (trolox equivalent antioxidant capacity) value obtained by DPPH^0 method for orange juice stored in the same conditions. If the decrease in the antioxidant activity may be linked to a lower content of phenolic compounds and vitamin C in stored juice as compared to fresh, the increase in the antioxidant activity is usually ascribed to Maillard's reaction products (Anese *et al*., 1999)**.**

The previous studies have shown that the antioxidant efficiency of orange juice may be attributed, in a significant part, to their total phenolic content (Rapisarda *et al*., 1999). However, according to Kahkonen et al. (2001), ascorbic acid could exert a synergistic effect with phenolic components. In work of (Gonzalez-Molina *et al.*, 2008), the addition of 5% black chokeberry concentrate to lemon juice did not increase the antioxidant activity with respect to the control. According to data showed in the Fig. 2 could be observed that stable or slight increase in antioxidant activity with increasing mandarin juice ratio or prolonging the storage time.

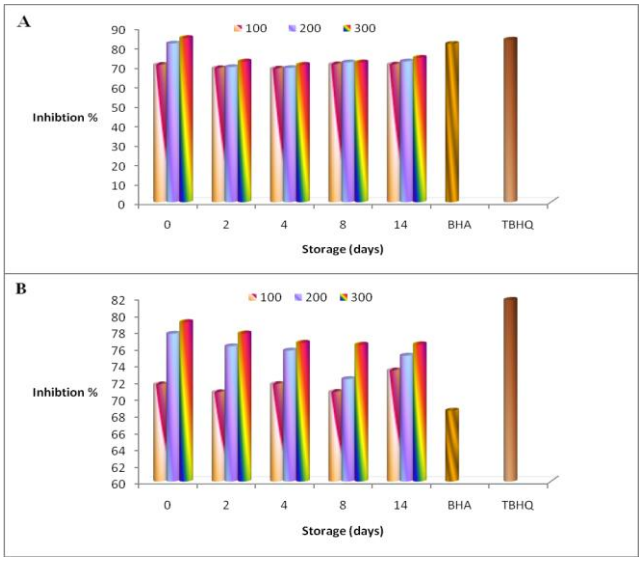

Fig. (2) Antioxidant activity of prickly pear/mandarin juice blend "K_6" during storage for two weeks at 4 ^{0}C as determined by DPPH^0 (A) and metal chelating (B) assays.

VOLATILE COMPOUNDS

Since the observed changes in TSS and acidity levels likely could not, in themselves, account for the described overall changes in blend juice flavour, we further evaluated possible changes in the composition of aroma volatiles that followed application of blend fruit juice. Overall, we detected in selected sample (K_6) a total of 27 volatile compounds were identified by gas chromatography/mass spectrometry in this blend; including 7 alcohols, 5 aldehydes, 5 esters, 8 terpenes-hydrocarbon, and two lactones (Table 6). The identification of these volatiles was verified according to their mass spectra and by comparing their calculated RIs with those of published databases (Table 6).

A complete understanding of flavour requires an investigation of the reactants and dynamics of the flavour reaction (Acree, 1993). For example, D-limonene contributes very little to the aroma of mandarin juice even though it is the organic volatile compound in highest concentration. However, the oxygenated terpenes, present in low concentrations, are the main compounds responsible for the juice aroma Attaway and Oberbacher (1968). The contribution of chemical compounds to food odour and flavour is best understood when their perception thresholds are known. The major limitation in this approach is that it requires the use of published threshold values, mostly established in water or air. In the present study, only 12 compounds were identified with their odour threshold (Table 6). In study of Plotto *et al.* (2004), for instance, the odour threshold of D-limonene (13 700 μgL^{-1}) was much higher than that of other compounds such as linalool (113 μgL^{-1}), myrcene (773 μgL^{-1}), α-pinene (1650 μgL^{-1}) and γ -terpinene (3260 μgL^{-1}). The high odour threshold of D-limonene is the main reason for its low contribution to the final aroma of mandarin juice. The mandarin group contains a number of species and is a more diverse citrus group than orange or grapefruit.

Table (6) Volatile compounds identified in prickly pear/ mandarine juice blend "K_6 "

Compound	RI[a]	Area %	OT[b]	Odour description [c]	Juice [e]
Esters					
Ethyl acetate	645	5.24		Pineapple, fruity	P-M
Methyl butanoate	751	4.19		Fruity, sweet	P-M
Ethyl 2-methylbutanoate	875	2.59			P
Hexyl acetate	1015	1.68		Sweet, fruity	P
Ethyl hexanoate	1019	0.28			P-M
Alcohols					
Ethanol	612	11.3	53		M
1-Penten-3-ol	679	0.31			P-M
1-Butanol	692	0.14			P-M
1,8-Cineol	1036	2.47			P
1-Nonanol	1098	8.49			P-M
Linalool	1162	17.19	6	Floral, green, citrus	P-M
Terpinen-4-ol	1215	0.27	130		P-M
Aldehydes					
E-2-Hexenal	669	5.84	17		P-M
Hexanal	768	1.42	4.5	green, grassy	P
Octanal	1028	1.18	0.0005		P-M
Nonanal	1157	0.17	0.043	Piney, floral, citrusy	P-M
Decanal	1217	0.34	0.032		P-M
Terpenes-Hydrocarbon					
α-Pinene	931	0.76	1650	Pine-like, resinous	P-M
Sabinene	951	0.58			P-M
β−Pinene	978	0.37	37 200	Resinous, dry, woody	M
β-Myrcene	992	0.25	42		P-M
Limonen	1034	28.45	13 700	Citrus	M
β-Ocimene		1.67		Floral, herbs	P-M
p-Cymene	1022	2.11			M
γ-Terpinene	1075	1.46		Lemony, lime-like	M
Lactones					
γ-Nonalactone	2097	1.12			P
γ-Decalactone	2142	0.86			P

[a:] Calculated retention indices using a series of *n*-alkanes. [b:] OT: Odour threshold (ppb in water) [c]: Plotto *et al*., 2004; Porat *et al*., 2011.
[e]: P: Prickly pear; M: mandarin

Yajima *et al*. (1979) identified 68 volatile components in satsuma mandarin juice using fruit peeled prior to extraction to minimise peel oil in the juice. The main juice volatiles were 3-methylbutan-1-ol, trans- hex-2-enal and hexanal. Also among the identified components were thymol, α-pinene and γ -terpinene. In the present study, only α-pinene and γ -terpinene were identified (Table 6). Linalool is likewise often identified in fruit volatiles. This terpene derivative, mainly from D-limonene, is responsible for "citrus" and "floral" notes in the mixtures, due to their low odour threshold (6 µg/L), and is usually found in citrus fruits (Nguyen *et al*., 2009) coriander flower (Dharmalingam and Nazni, 2014) and mango (Pino and Mesa, 2006). However**, (**Flath and Juan 1978) found traces from this alcohol in prickly pear, this compound is predominant in mandarin juices and could be used as quality control parameters in mandarin juices, since contents of α-terpineol and terpinen-4-ol increased in processed juices and their accumulation was negatively correlated with juice acceptability**.**

CONCLUSION

On the basis of the results of this study it may be concluded that formulation of mixed (blend) fruit juice from prickly pear with guava or mandarin is possible to satisfy consumer taste and preferences. Blending of prickly pear with mandarin at ratio (1:3) gave better sensory score quality. To the best of our knowledge the present work is the first trial to perform these blends, so the study will be extended to clarify the effect of different storage temperature and times on the volatile components by GC-MS and ascorbic acid degradation by HPLC of selected blended juice. So blending of prickly pear juice with mandarin juice can prove a boon to the growers in getting a good remunerative for their produce and to consumers in getting acceptable and antioxidant rich beverage at reasonable price.

REFERENCES

- Aberoumand A. Preliminary Evaluation of Some Phytochemical and Nutrients Constituents of Iranian Cordia myxa Fruits. Intern. J. Agric. Food Sci., 2011, 1, 30-33.
- Al-Mamary M., Al-Meeri A., Al-Habori M. (2002). Antioxidant activities and total phenolics of different types of honey. Nutr. Research, 22, 1041–1047.
- Acree T.E. Bioassays for flavor, in Flavor Science. Sensible Principles and Techniques, ed. by Acree TE and Teranishi R. American Chemical Society, Washington, DC: 1993, 1–20.
- Adams R. Identification of essential oils components by gas chromatography/quadrupole mass spectroscopy. Allured Publishing Corporation, Illinois, USA, 2007.
- Anese M. Manzocco L. Nicoli M.C. and Lerici C.R. Antioxidant properties of tomato juice as affected by heating. J. Sci. Food Agric. 1999, 79: 750–754.
- AOAC 1998. Official methods of Analysis of the Association of Official Analytical Chemists, 20th ed.
- Arena E. Fallico B. and Maccarone E. Evaluation of antioxidant capacity of blood orange juices as influenced by constituents, concentration process and storage. Food Chem. 2001, 74, 423–427.
- Attaway J.A. and Oberbacher, M.F. Studies on the aroma of intact Hamlin oranges. J. Food Sci., 1968, 33, 287–289.
- Barbera G. Inglese P. and Pimienta-Barrios E. Agro Ecology Cultivation and Uses of Cactus Pear, FAO Plant Production and Protection Paper no 132, Rome: Food and Agriculture Organization of the United Nations. 1995.
- Belitz H. D. and Grosch W. Food Chemistry; Springer-Verlag: Berlin, Germany. 1999.
- Cassano A. Conidi, C. and Drioli E. Physico-chemical parameters of cactus pear (*Opuntia ficus-indica*) juice clarified by microfiltration and ultrafiltration processes. Desalination, 250, 2010.
- Cohen E. Problems unique in postharvest handling of mandarin varieties. Inter. J. Tropical Plant Disease, 1999, 17, 143–163.
- Daly T. Jiwan, M., O'brien N. and Aherne, S. Carotenoid content of commonly consumed herbs and assessment of their bioaccessibility using an in vitro digestion model. Plant Foods Human. Nutr., 2010, 65, 164−169.
- Del-Caro A. Piga A. Vacca V. and Agabbio, M. Changes of flavonoids, vitamin C and antioxidant capacity in minimally processed citrus segments and juices during storage. Food Chem. 2004, 84, 99–105.
- Dharmalingam,R and Nazni.P**,** Phytochemical Evaluation Of *Coriandrum* L Flowers, International Journal of Food And Nutritional Sciences, 2013, Vol.2, Iss.4,(Oct-Dec) pp.35-39, e-ISSN 2320 –7876.
- Dinis, T.C. Madeira, V.M. and Almeida M.L. Action of phenolic derivates (acetoaminophen, salycilate and 5-aminosalycilate) as inhibitors of membrane lipid peroxidation and as peroxyl radical scavengers. Arch. Biochem. Biophys. 1994, 315: 161-169.

  El-Samahy S Abd-Elhady E. Habiba R. and Moussa, T. Effect of ripening stage on rheological properties of cactus pear pulp. 4th International Symposium on Food Rheology and Structure, Switzerland: 2006, 581-582.
- FAO (Food and Agriculture Organization of The United Nations). Trade in agriculture, fisheries and forestry. http:// www.fao.org (accessed April 29, 2013). 2013.
- Flath R. and Juan M. Volatile Constituents of Prickly Pear (*Opuntia ficus indica Mill., de Castilla* Variety). J. Agric Food Chem., 1978, 4, 835-837.

- Floribeth V. and Lastreto C. A study of the production of clarified banana juice using pectinolytic enzymes. J. Food Techn., 1981, 16, 115-125.
- González-Molina E. Moreno D. A. and García-Viguera, C. Aronia-enriched lemon juice. A new highly antioxidant beverage. J. Agric Food Chem., 2008, 56 (23), 11327–11333.
- Harrison F. E. and May J. M. Vitamin C function in the brain: vital role of the ascorbate transporter SVCT2. Free Radical Biolology Medicine. 2009, 46, 719−730.
- Ibarz A. Gonzalez, C. and Esplugs S. "Rheology of clarified fruit juice 111: Orange juice", J. Food Eng. 1994, 21, 485-494.
- Jawaheer B. Goburdhun D. and Ruggoo A. Effect of processing and storage of guava into jam and juice on the ascorbic acid content. Plant Food for Human Nutri., 2003, 58, 1–12.
- Kahkonen M.P. Hopia, A.I. and Heinonen M. Berry phenolics and their antioxidant activity. J. Agric. Food Chem. 2001, 49, 4076–4082.
- Kaur C. and Kapoor H.C. Antioxidants in fruits and vegetables-the millennium's health. Inter. J. Food Serv. Techn. 2001, 36: 703-725.
- Klimczak I. Malecka M. Szlachta M. and Gliszcynska, A. Effect of storage on the content of polyphenols, vitamin c and the antioxidant activity of orange juices. J. Food Composition and Analysis 2007, 20: 313-322.
- Lim Y.Y. Lim T.T. and Tee J.J. Antioxidant properties of several tropical fruits: a comparative study. Food Chem. 2007, 103:1003–1008.
- Liu R. Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. Amer. J. Clinical Nutr., 2003, 78, 517S−520S.
- Masuko T. Minami A. Iwasaki N. Majima T. Nishimaru S. and Lee Y. Carbohydrate analysis by a phenol–sulfuric acid method in microplate format. Analytical Biochem., 2005, 339, 69–72.
- Mizrahi Y. Nerd A. and Nobel P. Cacti as Crops, Horticultural Review. 1997, 18, 291-320.
- Mo-ßhammer M.R. Stintzing F.C. and Carle R. Cactus Pear Fruits (Opuntia spp.): A Review of Processing Technologies and Current Uses. Journal of the Professional. Association for Cactus Development, 2006, 8, 1-25.
- Nazni, P and Dharmaligam.R Isolation and Separation of Phenolic Compound from Coriander Flowers, International Journal of Agricultural and Food Science, 2013, Vol.4, Iss.1, pp. 13-21, ISSN 2249-8516.
- Nguyen H. Campi E.M. Jackson W.R. and Patty A.F. Effect of oxidative deterioration on flavor and aroma components of lemon oil. Food Chem., 2009, 112,388–93.
- Palou E. Lopez-Malo A. Barbosa-Canovas G. Chanes-Welti J. and Swanson W. Polyphenoloxidase and colour of blanched and high hydrostatic pressure treated banana puree. J. Food Sci., 1999, 64, 42–45.
- Perales S. Barbera R. Lagarda M. J. and Farre R. Antioxidant capacity of infant fruit beverages; influence of storage and in vitro gastrointestinal digestion. Nutrition Hospital, 2008, 23, 547−553.
- Piga A. Agabbio M. Gambella F. and Nicoli, M.C. Retention of antioxidant activity in minimally processed mandarin and Satsuma fruits. Lebensmit-Wiss Techn. 2002, 35, 344–347.
- Pino J.A. and Mesa J. Contribution of volatile compounds to mango (*Magnifera indica* L.) aroma. Flav. Frag. J., 2006, 21, 207–13.
- Plotto A. Margaria C. Goodner K. Goodrich R. and Bald-Win E. Odour and flavour thresholds for key aroma components in an orange juice matrix: terpenes and aldehydes. Flav. Frag. J., 2004, 19, 491–498.
- Porat R. Zipora T. Isaac Z. and Arnon D. Aroma volatile compositions of high-and low-aromatic guava varieties. J. Sci. Food Agric., 2011, 91, 2794–2798.
- Rapisarda P. Tomaino A. Lo-Cascio R. Bonina F. De-Pasquale A. Saija A. Antioxidant effectiveness as influenced by phenolic content of fresh orange juices. J. Agric. Food Chem. 1999, 47, 4718–4723.
- Sapers G. and Douglas F. Measurement of enzymatic browning at cut surfaces and in juice of raw apple and pear fruits. J. Food Sci., 1987, 52, 1258–1262, 1285.
- Savikin K. Zdunic G. Jankovic T. Tasic S. Menkovic N. Stevic T. et al. Phenolic content and radical scavenging capacity of berries and related jams from certificated area in Serbia. Plant Foods for Human Nutrition, 2009, 64(3), 212–217.
- Scalbert A. and Williamson G. Dietary intake and bioavailability of polyphenols. J. Nutri. 2000, 130, 2073S−2085S.
- Scalfi L. Fogliano V. Pentagelo A. Graziani G. Giordano I. and Ritieni A. Antioxidant activity and general fruit characteristics in different ecotypes of Corbarini small tomatoes. J. Agric. Food Chem., 2000, 48, 1363–1366.
- Sidel J. L. and Stone H. The role of sensory evaluation in the food industry. Food Quality and Preference 1993, 4, 65–73.
- Singleton V. Orthofer R. and Lamuela-Raventos R. Analysis of total phenols and other oxidation substrates and antioxidant by means of Folin-

Ciocalteu reagent. Methods Enzymol. 1999,299, 152–178.

- Stintzing F. Schieber A. and Carle R. Phytochemical and nutritional significance of cactus pear. Euro. Food Res. Techn., 2001, 212, 396-407.
- Sun T. Simon P. W. and Tanumihardjo S. A. Antioxidant phytochemicals and antioxidant capacity of biofortified carrots (*Daucus carota* L.) of various colors. J. Agric Food Chem., 2009, 57, 4142–4147.
- Takebayashi J. Tomoyuki O. Jun W., Koji Y. Jianbin C. Maki S. Megumi T. Kyoko T. Kazuhisa G. Teruki M. and Yoshiko I. Hydrophilic antioxidant capacities of vegetables and fruits commonly consumed in Japan and estimated average daily intake of hydrophilic antioxidants from these foods. J. Food Composition and Analysis, 2013, 29, 25–31.
- Tavarini S. Innocenti E.D. Remorini D. Massai R. and Guidi, L. Antioxidant capacity, ascorbic acid, total phenols and carotenoids changes during harvest and after storage of Hayward kiwi fruit. Food Chem. 2008,107, 282-288.
- Vasco C. Ruales J. and Kamal-Eldin A. Total phenolic compounds and antioxidant capacities of major fruits from Ecuador. Food Chem., 2008, 111, 816–823.
- Wilson C. Shaw P. and Campbell C. Determination of organic acids and sugars in guava (*Psidium guajava* L.) Cultivars by high-performance liquid chromatography. J. Sci. Food Agric., 1982, 33, 777-780.
- Yajima I. Yanai T. Nakamura M. Sakakibara H. and Hayashi K. Compositions of the volatiles of peel oil and juice from Citrus unshiu. Agric. Biolo. Chem., 1979, 43, 259–264.