J. Food and Dairy Sci., Mansoura Univ., Vol. 8 (6): 243- 252, 2017

Improving Bioactive Compounds and Antioxidant Activity of Fruit Nectar Blends Using Some Medicinal Extracts

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ABSTRACT

A great global interest in developing processing and consuming functional foods has emerged because of the increasing clinical evidence on the health promoting impacts of those foods. So, some fruit juices are mixed to obtain functional and nutraceuticals fruit nectar blends. Different ratios (10, 15 and 20%) of aromatic plant extracts namely, ginger, rosella, peppermint and aloe vera, which are rich sources of phytochemicals, were mixed with best selected nectar blends to enhance the bioactive compounds of nectar blends and improve flavors, antioxidant activity and functional properties. The main physico-chemical properties, bioactive compounds and the antioxidant activity of selected fruit nectar blends were determined. The obtained results revealed that, fruit nectar blends had antioxidant activity higher than sole fruit nectars. Antioxidant activity of all medicinal extracts ranged from 30.450 to 94.698%. Roselle and peppermint extracts had the highest antioxidant activity (94.698 and 84.273%, respectively). Twelve flavonoid and twenty-six phenolic compounds were separated from medicinal extracts and identified by HPLC. Hesperidin was the predominant flavonoid compound in all extracts which recorded 5119.542, 2729.49, 2399.185 and 815.593 mg/100gm for roselle, peppermint, aloe vera and ginger extracts, respectively. While, chlorogenic and catechin (1659.769 and 1008.031 mg/100gm, respectively) were the major phenolic compounds. Roselle and peppermint extracts were more effective than aloe vera and ginger extracts. All medicinal extracts led to increase flavonoid and phenolic compounds contents of fruit nectar blends and improved the bioactive compounds content which had healthy benefits of these blends. Generally, mixing of fruit juices resulted in the greatest antioxidant activity which was accumulative and synergistic. As well as, addition of medicinal extracts to fruit nectar blends increased the bioactive compounds contents and improved the antioxidant activities of these blends.

Keywords: Fruit blends, medicinal extracts, antioxidant activity, bioactive compounds.

INTRODUCTION

Consumer demands for huge nectar blends especially functionalized fruit blends, due to their nutritional or nutraceutical properties. Juice blending is one of the best methods to improve the nutritional quality of the juice or beverages. It can improve flavors, functional properties, vitamins and minerals contents, which depending on the variety and quality of fruits used (De Carvalho *et al*., 2007).

Juices are a good source of sugars, vitamins, minerals, phytochemicals and all valuable components to human health. Fruits contain various natural antioxidants and secondary metabolites which play an important role in human health. Fruit juices have been proposed as a convenient substitute for fresh fruit (Beh *et al.,* 2012).

Fruit antioxidant metabolites are a group of vitamins, carotenoids, phenolic compounds and flavonoids and with health-enhancing effects on our bodies. Those compounds exert antioxidative, anti carcinogenic and immune enhancer effects (Neyestani, 2008). All fruits antioxidants play an important role in maintaining human health. They have long been known to protect biological systems via inhibition or prevention of oxidation stress induced by reactive oxygen substances generated from normal metabolic activity or environmental factors (Hwang *et al.,* 2010). Thus, insufficient level of antioxidants in human may lead to the damage of DNA, lipids and proteins which may induce various diseases such as cancer and heart disease (Profir and Vizireanu, 2013).

Production of Ready-To-Serve (RTS) beverages has been increasingly gaining popularity throughout the country due to their health and nutritional benefits, apart from pleasant flavor and taste. Fruit based RTS beverages are not only rich in essential minerals, vitamins and other nutritive factors but are also delicious and having good appeal. Herbal beverages in the form of RTS, squashes, appetizers, health drinks are important from the nutritional point of view (Thamilselvi *et al*., 2015). Medicinal plants belong to a big plant group with a great interest due to its pharmaceutical, cosmetic and nutritional application. They are considered a big repository of many types of bioactive compounds in all plants any or all parts of which are used for varied therapeutic properties. These plants can be used as medicinal herbs in preserving food or treating gastric disorders and became spices because of their beneficial effects, pleasant taste and smell (Németh, 2012).

Accordingly, the objective of current study was a trial to develop and assess functional and nutraceutical nectar blends, formulated by complete integration of multiple classes of antioxidant compounds from the best selected fruit juices and some medicinal plant extracts.

MATERIALS AND METHODS

Materials

Four ripe fruits namely, apple (Malus domestica) variety Anna, red grape (Vitis vinifera) variety red Roomy, pomegranate (Punica grantum L.) and strawberry (Fragaria x ananassa) were obtained from a local market at Giza city, Egypt.

Fresh rhizomes of ginger (Zingiber officinale) and fresh leaves of peppermint (Mentha x piperita) were purchased from a supermarket at Giza city, Egypt. Roselle (Hibiscus sabdariffa) was purchased from a local retail spice market at Giza city, Egypt. Aloe vera (Aloe vera L. Burm.f.) living plants were obtained from a private plant nursery at Mansoura city, Egypt

Commercial cocktail nectar fruits with trade name Best nectar (product of Egyptian Canning Company, Best), as a control, was purchased from local market at Giza city, Egypt.

All chemicals (analytical grade) were purchased from Elgomhouria Pharmaceuticals Co., Cairo, Egypt. 2.2 diphenyl-1-1picryl-hydrazyl (DPPH), Folin-Ciocalteu reagent, gallic acid and quercitin were obtained from Sigma-Aldrich Chime, Steinheim, Germany.

Methods

Preparation of fruit juices

All fruits were sorted, washed and left in refrigerator for 6 hrs. then cut into small pieces (pomegranate arils were manually separated), then were blended in a blender (Moulinex, France) and the juices were strained through four folded organza cloth.

Preparation of medicinal plant extracts

Aloe vera leaves were washed with distilled water and dissected longitudinally. The colorless parenchyma's tissue was scrapped out and blended three times (10 seconds each) in a blender (Moulinex, France) at maximum speed to obtain gel. The gel was diluted with distilled water (1:10) prior to use. Boiled distilled water was added to chopped fresh ginger rhizomes, fresh leaves of filfily peppermint and roselle dried calyces in ratio of 1:10 (W/V), then kept overnight in the refrigerator at 5˚C ±1 for extraction. The extracts were filtered through filter paper (Whattman, No.1) according to Youssef *et al.* (2015).

Preparation of medicinal blends

The medicinal plant extracts were added to the selected fruit blends with different ratios (10, 15 and 20% V/V). The blends were subjected to organoleptic evaluation to select the most favorite and palatable ones.

Preparation of fruit nectar blends

Fruit juices were mixed with different ratios as shown in Table (1) to make thirteen different blends. The total soluble solids were adjusted to (14%).

The obtained blends were filled into sterilized glass bottles, pasteurized at 90°C for 10 minutes, cooled at room temperature using running tab water and sorted in refrigerator at 5±1°C to analysis according to El-Bastawesy *et al.* (2008). The obtained blends were subjected to organoleptic evaluation to select the most favorite and palatable ones.

Table 1. Formulation of selected fruit juice blends

Blends	Apple	Red grape	Pomegranate	Strawberry
1	40	20	20	20
2	20	40	20	20
3	20	20	40	20
4	20	20	20	40
5	--	40	30	30
6	40	--	30	30
7	30	30	--	40
8	30	30	40	--
9	20	40	40	--
10	40	40	20	--
11	--	40	40	20
12	40	40	--	20
13	30	--	40	30

Organoleptic evaluation

Sensory attributes (color, taste, odor, texture and palatability and overall palatability) of blends were evaluated directly after preparation by more than ten panelists (chosen by random) in the Food Tech. Res. Inst. according to the method of Lindley *et al.* (1993).

Analytical methods

Chemical composition

Moisture content, ash, total solids, total soluble solids (TSS), total acidity and ascorbic acid were determined according to the A.O.A.C (2007). The pH values were measured at 25°C using a pH meter (Jenway, 3510, UK).

Minerals (Na , K , Ca , Mg , Fe and Zn) were determined after dry ashing according to the methods described by the A.O.A.C (2007), using Atomic absorption (Perkin – Elmer , Model 3300, USA) .

Total, reducing and non-reducing sugars were determined according to the methods described by the A.O.A.C (2007). Non-enzymatic browning and total anthocyanins of samples were determined colorimetrically according to the methods described by Ranganna (1979).

Total phenolic compounds content was determined using the Folin-Ciocalteau reagent and gallic acid was used as a standard according to the method described by Kaur and Kapoor (2002). Phenolic compounds were fractionated and identified by HPLC (Hewllet Packared, series 1050) in FTRI , according to the method of Goupy *et al.* (1999).

Total flavonoids content was determined by Jenway UV-visible Spectrophotometer and Quercetine was used as a standard according to the method described by Zhuang *et al.* (1992). Flavonoids compounds were fractionated and identified by HPLC (Hewllet Packared, series 1050) in FTRI , according to the method of Loon *et al.* (2005).

Antioxidant activities of the tested samples were analyzed by investigating their ability to scavenge the 2, 2-diphenyl-1-picrylhydrazyl (DPPH) free radicals using the method of Baraca *et al.* (2001).

Total β-carotene content was determined spectrophotometrically according to the method described by Knockaert *et al.* (2011).

Statistical analysis

The statistical analysis was carried out using one way analysis of variance (ANOVA) under significant level of 0.05 for the whole results using the statistical program CoStat (Ver. 6.400) and data were treated as complete randomization design according to Steel *et al.* (1997).

RESULTS AND DISCUSSION

Physico-chemical properties and bioactive compounds of fresh fruit juices

The main physico-chemical properties of four fruit juices namely, apple, red grape, pomegranate and strawberry were studied and the results are illustrated in Table (2). Moisture content ranged from 83.857% in apple juice to 90.418% in strawberry juice and TSS% of all fruit juices ranged from 9.10% in strawberry to 15.8% in apple. These results are in agreement with those reported by (Wani *et al.* (2012).

Strawberry juice had the highest content of total acidity (0.750%), but apple juice recorded the lowest one (0.264%). These results are in agreement with those of Hassan *et al.* (2012), Schonenberger *et al.* (2012) and Bindon *et al.* (2013).

Grape juice had the highest content of ash content (0.38%), but the lowest value recorded in apple juice (0.252%). The obtained results are in agreement with those reported by Hassan *et al.* (2012), Schonenberger *et al.* (2012), Segovia-Bravo *et al.* (2012) and Bindon *et al.* (2013). Apple juice was the highest total sugars (14.834%) and reducing sugars contents (12.37%), whereas strawberry juice recorded the lowest levels being 8.04 and 7.412% for total and reducing sugars, respectively (Table, 2). Those results are in accordance with those reported by Wani *et al.* (2012) and higher than those of Hossain *et al.* (2016).

From the same data presented in Table (2), it could be clearly observed that, pomegranate juice had the highest amounts of total flavonoids (77.716 mg/100g) and phenols (124.556 mg/100g), followed by apple, grape and strawberry juices that having 43.166 & 108.384, 48.299 & 91.414 and 59.206 &81.081 mg/100g, respectively. These results are in agreement with those reported by O'Grady *et al*. (2014), Karacam *et al*., (2015) and Xu *et al*. (2017). Fresh grape and strawberry juices contained approximately the same amounts of ascorbic acid that found in a relatively high content (48.814 and 48.606 mg/100gm, respectively). These results are in accordance with those reported by Boas *et al.* (2014) and Sapeia and Hwaa (2014). Meanwhile, pomegranate (27.056 mg/100gm) and apple (32.266 mg/100gm) juices had moderate amounts. These results are in agreement with those reported by Imtiyaz *et al*. (2012). Anthocyanins are the predominant bioactive compounds in strawberry which have been attributed many beneficial effects as antioxidants (Basu *et al*., 2014). Strawberry and pomegranate juices had the highest contents (32.627 and 25.702 mg/100gm, respectively), whereas, noticeable amounts of total anthocyanins were found in grape and apple juices (Table, 2). These results are in agreement with those reported by Buendia *et al*. (2010).

Table 2. Physico-chemical properties and bioactive compounds of fresh fruit juices

Samples / *Constituents %	Apple	Grape	Pomegranate	Strawberry	LSD
Moisture content	83.857 c	87.974b	87.321 b	90.418 a	1.208
Total solids	16.143 a	12.026b	12.679 b	9.582 c	1.208
Ash	0.252 b	0.380 a	0.253 b	0.276 b	0.042
TSS	15.800 a	11.600c	11.900 b	9.100 d	0.188
Total acidity	0.264 d	0.585 b	0.400 c	0.750 a	0.006
Total sugars	14.834 a	10.296c	11.229 b	8.040 d	0.100
Reducing sugars	12.370 a	10.243c	10.805 b	7.412 d	0.106
Non reducing sugars	2.464 a	0.053d	0.423 c	0.628 b	0.032
**Total flavonoids	43.166 f	48.299e	77.716 c	59.206 d	0.313
**Total phenols	108.384c	91.414e	124.556 b	81.081 g	0.628
**Ascorbic acid	27.056 f	48.814d	32.266 e	48.606 d	0.377
**Total anthocyanins	2.688e	5.621d	25.702c	32.627 b	0.219
**Total carotenoids	0.111 i	0.794 g	0.011 i	0.493 h	0.134
pH Value	4.193 a	3.724 c	3.953 b	3.373 d	0.003
Specific gravity	1.056 a	1.041 c	1.046 b	1.029 d	0.006

***On wet weight basis. ** (mg/100gm) Values are the mean of three independent determinations.**
Different small letters in the same row indicate significant differences (P<0.05).

Also, from the same data, it's obviously clear that all selected fruit juices had negligible amounts of total carotenoids. These results are in agreement with those reported by Buendia *et al*.(2010) and Lima *et al*. (2014).

Strawberry juice had the lowest pH value (3.373), whereas, apple juice was having the highest value (4.193%). These results are in accordance with those reported by Segovia-Bravo *et al*. (2012), Schonenberger *et al.* (2012), Bindon *et al*. (2013), Chandra *et al.* (2015). The specific gravity of juices is related to the concentration of sugar and other soluble solids (Askar and Treptow, 1993). Data in Table (2) reveal also that the specific gravity of all fruits were significantly highly correlated with TSS values.

Organoleptic evaluation of some fruit nectar blends

Thirteen, different pasteurized fruit nectar blends were prepared with different ratios of selected fruit juices as previously mentioned in materials and methods before. Those blends were sensory evaluated for, color, taste, odor, texture, general palatability and overall. The data were statistically analyzed and the results are shown in Table (3).

Table 3. Organoleptic evaluation of some fruit nectar blends

Properties *Blends	Color 10	Taste 10	Odor 10	Texture 10	Palatability 10	Overall Σ 50
Control	8.46a	8.12ab	8.00a	7.79ab	8.37a	40.74a
1	7.13cd	7.71abc	7.67ab	7.42ab	7.81abc	37.74abcd
2	7.50bc	7.87abc	7.67ab	7.54ab	7.58abc	38.16abc
3	6.92cde	6.83cde	7.54abc	7.54ab	7.21bc	36.04bcd
4	7.75abc	7.96ab	7.71ab	7.58ab	8.12ab	39.12ab
5	8.33ab	8.46a	7.83a	7.67ab	8.42a	40.71a
6	8.04ab	8.42a	7.75ab	7.71ab	8.35a	40.27a
7	8.25ab	8.58a	8.08a	8.29a	8.58a	41.78a
8	6.29def	7.17bcd	6.67cde	6.75bc	6.75cd	33.63de
9	5.83f	5.54f	5.87e	6.21c	5.96d	29.41f
10	6.08ef	5.87ef	5.87bcde	6.79bc	5.79d	30.4ef
11	7.04cd	6.54def	6.37de	6.75bc	6.92c	33.62de
12	7.17c	7.33bcd	7.17abcd	7.25abc	7.21d	36.13bcd
13	7.17c	6.46def	6.79e	7.12bc	7.17bc	34.71cd

***see Table (1)**

Insignificant differences between the general palatability and overall of fruit nectars for blends 4, 5, 6 and 7 and control sample were observed. These blends were more palatable and recorded the highest scores (39.12, 40.71, 40.27 and 41.78, respectively) comparing with the control sample (Best) and other fruit nectar blends. Increasing the ratios of strawberry and/or apple juices improved the general palatability of the formulated blends.

Generally, blends 4, 5, 6 and 7 had the highest scores and were preferred by the consumer. Therefore, these blends were selected being the most favorite ones with the control sample to continue the investigation.

Physico-chemical properties and bioactive compounds of selected fruit nectar blends

The data illustrated in Table (4) reveal that moisture content of fruit nectar blends ranged from 85.146% to 85.644% comparing with control sample (84.161%) which was slightly low. The TSS values of all fruit nectars were fine adjusted to 14% meanwhile; TSS% of control sample was 15.5%.

Concerning total acidity, F4 had the highest value (0.50%) comparing with other fruit blends which ranged from 0.395 to 0.143. These due to F4 contained more than 70% strawberry and grape juices which had highly acidity values than other fruits. Non significant differences of ash contents between F1, F2, F3 and F4 nectar blends. But, all fruit blends had higher amounts than control sample (0.122%).These results are in agreement with those of Hassan *et al.* (2012), Schonenberger *et al.* (2012) and Bindon *et al*. (2013).

Total sugar contents of all fruit nectar blends ranged from 13.049 to 13.353% and were lower than the control sample which recorded the highest value (14.741%) (Table, 4). Reducing sugars ranged from 5.459 to 6.640%. Meanwhile, non-reducing sugars more increased after processing. The elevation of non-reducing sugars due to the addition of sucrose during the processing of fruit nectar blends. These results are in accordance with the data reported by Vijayanand *et al.* (2015).

Data in Table (4) also show that, total anthocyanins content in F1 nectar blend was the highest level (29.776 mg/100gm) followed by F3 (27.251 mg/100gm) and F2 (25.113 mg/100gm). The main ingredients of these blends are strawberry and pomegranate juices adhering in higher ratios. Increasing the strawberry and pomegranate juices levels improved the anthocyanins content. These results are in agreement with those of Basu *et al.* (2014). F4 nectar blend had the lowest value of anthocyanin (24.135 mg/100gm), these due to the presence of apple and red grape in this blend by a ratio of 60 %, which had noticeable amounts of total anthocyanins (Table, 2).

Ascorbic acid content of all selected fruit nectar blends ranged from 25.789 to 32.98 mg/100gm, comparing with commercial control sample (56.167 mg/100gm). It worth mentioning that, commercial fruit nectar labeled as external ascorbic acid added as preservative material. Increasing the red grape and strawberry juices ratios improved the ascorbic acid contents. These results are in accordance with those reported by Boas *et al*. (2014) and Sapeia and Hwaa (2014).

Table 4. Physico-chemical properties, bioactive compounds and antioxidant activity of selected fruit nectar blends

Samples / *Constituents %	Control	F1	F2	F3	F4	LSD
Moisture content	84.161 b	85.446 ab	85.222 ab	85.146 ab	85.644 a	1.297
Total solids	15.839 a	14.554 ab	14.778 ab	14.854 ab	14.356 b	1.296
Ash	0.122 b	0.195 a	0.206 a	0.233 a	0.206 a	0.038
Total acidity	0.550 a	0.410 c	0.413 c	0.395 d	0.500 b	0.008
TSS	15.50	14.00	14.00	14.00	14.00	--
Total sugars	14.741 a	13.246 b	13.255 b	13.353 b	13.149 c	0.132
Reducing sugars	1.967 d	6.217 b	5.459 c	6.640 a	6.658 a	0.121
Non-reducing sugars	12.774 a	7.029 c	7.796 b	6.713 d	6.491 e	0.077
Non-enzymatic browning	0.074 e	0.237 c	0.365 a	0.260 b	0.216 d	0.009
**Total flavonoids	9.951 e	27.059b	28.354 a	26.320 c	22.948 d	0.548
**Total phenols	36.619 e	37.030 d	41.091 c	47.140 b	54.338 a	0.832
**Total anthocyanins	1.120 e	29.776 a	25.113 c	27.251 b	24.135 d	0.593
**Ascorbic acid	56.167 a	30.940 c	28.187d	25.789 e	32.980 b	0.414
**Total carotenoids	0.903 a	0.163 e	0.278 d	0.769 b	0.593 c	0.016
Antioxidant activity	85.372 a	56.605 e	60.372d	62.855 c	71.365 b	1.219
pH value	3.856 e	3.934 b	3.925 c	3.985 a	3.864 d	0.004
Specific gravity	1.055 a	1.054 a	1.051 a	1.053 a	1.053 a	0.003

*** On wet weight basis ** (mg/100gm) Values are the mean of three independent determinations.**
Different small letters in the same row indicate significant differences (*P*<0.05).
F1"Blend 4" (Apple20% + red grape 20% + pomegranate 20% + Strawberry 40%)
F2"Blend 5" (Red grape 40% + pomegranate 30% + Strawberry 30%)
F3"Blend 6" (Apple40% + pomegranate 30% + Strawberry 30%)
F1"Blend 7" (Apple30% + red grape 30% + Strawberry 40%)

F4 and F3 nectar blends recorded the highest content of total phenols and flavonoids (54.338 & 22.948 and 47.14 &26.32 mg/100gm, respectively) (Table, 4). These could be attributed to pomegranate, apple and grape juices which are the main sources of phenol and flavonoid compounds. These results are in agreement with those reported by O'Grady *et al*. (2014), Karacam *et al*. (2015) and Xu *et al*. (2017). All the best selected fruit nectar blends (F2, F3 and F4) had more amounts of total phenols and total flavonoids comparing with commercial control sample.

Data in Table (4) show also that, all the best selected fruit blends had negligible amounts of total carotenoids that ranged from 0.163 to 0.769 mg/100gm. Concerning the antioxidant activity, F4 recorded the highest value (71.365%) followed by F3 (62.855%). The antioxidant activity was highly correlated with the contents of total phenols, flavonoids and ascorbic acid of the fruit nectar blends. On the other hand, commercial control sample recorded the highest value of antioxidant activity (85.372%), due to the adding of external ascorbic acid (56.167 mg/100gm) (Table, 2).

Generally, it is worth to mention that fruit nectar blends had antioxidant activity higher than sole fruit nectars. This could be due to synergism between different antioxidants from different fruit juices which support each other to achieve a higher value of antioxidant activity more than its sole components. In addition, nutrient antioxidants may act together to reduce reactive oxygen species (ROS) level more effectively than single dietary antioxidants, because they can function as synergists (Trombino *et al*., 2004).

The pH values of fruit blends ranged from 3.864 to 3.985 and slight differences between fruit blends and control sample (3.856) (Table, 4). Concerning specific gravity, non significant differences between all fruit nectars due to it similar TSS values. Data in the same table reveal also that significant difference between non-enzymatic browning of fruit nectar blends and control sample. These results are in agreement with those of Rizk (2011).

Fractionation of flavonoids compounds of selected fruit nectar blends

Flavonoid compounds of selected fruit nectar blends were separated and identified by HPLC and the results are presented in Table (5).

Hisperidin was the major flavonoid compound detected in all selected fruit blends that represented about 150.422, 73.783, 15.487 and 23.083 mg/100gm for F1,F2,F3 and F4, respectively comparing with control sample which had a trace amount of hisperidin (1.004 mg/100gm). These data are confirmed with those represented before in Table (4) which shown that F1 and F2 had the highest total flavonoids content.

Fractionation of phenolic compounds of selected fruit nectar blends

Fourteen phenolic compounds were identified from selected fruit blends by HPLC and the results are presented in Table (6). Pyrogallol was the predominant phenolic compounds detected in all selected fruit nectar blends which recorded 213.290, 121.424, 66.719 and 56.332 mg/100gm, followed by catechine being 67.928, 39.657, 15.28 and 10.061 mg/100gm for F4, F3, F1and F2, respectively. F4 nectar blend had the highest fractions concentrate, followed by F3 then F1 and F2 which recorded the lowest ones. These data are verified with the data of total phenolic compounds shown in table (3) before.

Table 5. Fractionation of flavonoid compounds of selected fruit nectar blends

**Samples / *Compounds (mg/100gm)	Fruit nectar blends				
	Control	F1	F2	F3	F4
Narengin	0.000	0.161	0.238	0.546	0.219
Hesperetin	0.000	0.255	0.000	0.209	0.288
Quercitrin	0.141	3.352	2.047	1.388	2.298
Kampferol	0.000	0.283	0.000	0.033	0.008
Quercetin	0.000	2.068	2.156	6.063	0.053
Hisperidin	1.004	150.422	73.783	15.487	23.083
Rutin	0.000	2.656	1.582	1.022	3.116
Rosmarinic	0.887	5.279	3.262	2.474	5.684

*** On dry weight basis** **** See Table (3)**

Finally, the observed quantitative and qualitative differences for the phenolic compounds generated by the blend process may be attributed, at least in part, to the variation in phenolic compounds content for each other. It worth mentioning that, most of thermal processes lead to a degradation of phenolic compounds (Gerard and Roberts, 2004).

Table 6. Fractionation of phenolic compounds of selected fruit nectar blends

**Samples / *Compounds (mg/100gm)	Fruit nectar blends				
	Control	F1	F2	F3	F4
P-coumaric acid	0.000	3.107	3.687	3.892	9.010
Salycillic acid	15.660	0.000	0.000	0.000	0.000
Ferulic acid	0.000	0.000	1.380	0.710	0.000
Caffeine	0.000	2.052	1.323	1.201	0.000
Vanillic acid	0.000	2.600	1.643	2.156	3.463
Caffeic acid	5.397	0.000	2.645	6.673	6.509
Catechol	0.000	7.868	6.536	11.699	25.715
Chlorogenic acid	6.077	18.987	13.679	0.000	0.000
Catechine	59.079	15.280	10.061	39.657	67.928
Protocatechoic	21.594	7.161	4.057	5.582	15.399
Gallic acid	33.641	7.130	2.506	6.188	9.433
Pyrogallol	27.728	66.719	56.332	121.424	213.290
Ellagic acid	5.402	0.000	0.086	0.000	0.000
Cinnamic acid	0.410	0.400	0.285	0.598	0.947

*** On dry weight basis** **** See Table (3)**

Physico-chemical properties of selected medicinal extracts

Four medicinal plants namely, fresh ginger rhizomes, fresh peppermint leaves, roselle calyxes and aloe vera gel were extracted and the main physico-chemical characteristics of these extracts were illustrated in Table (7).

The moisture content of ginger, aloe vera and peppermint extracts were 99.693, 99.368 and 99.981%, respectively. Meanwhile, roselle extract was slightly decreased (96.475%). Roselle extract had the highest contents of ash (0.076 %), total acidity (3.298 %), total soluble solids (2.500 %), total sugars (1.286 %) and reducing sugars (1.036%), followed by aloe vera extract which had 0.032 %, 0.479 %, 1.00%, 0.359 % and 0.323 % for ash, total acidity, total soluble solids, total sugars and reducing sugars, respectively. On the other hand, the peppermint extract represented the lowest values (Table, 7).

Table 7. Physico-chemical properties, bioactive compounds and antioxidant activity of selected medicinal plant extracts

*Constituents% / Samples	Ginger	Roselle	Aloe vera	Peppermint	LSD
Moisture content	99.693b	96.475d	99.368c	99.981a	0.101
Total solids	0.307c	3.525a	0.632b	0.019d	0.101
Ash	0.051 b	0.076 a	0.032 c	0.006 d	0.003
Total acidity	0.009 c	3.298 a	0.479 b	0.009 c	0.002
TSS	0.100	2.500	1.000	ND	--
Total sugars	0.021 c	1.286 a	0.359 b	ND c	0.029
Reducing sugars	0.020 c	1.036 a	0.323 b	ND d	0.015
Non-reducing sugars	0.001 c	0.250 a	0.036 b	ND c	0.026
Minerals(mg/100gm)					
Mg	0.0011	7.6958	0.0750	0.0001	-
Na	0.0941	0.7095	0.1038	0.0031	-
K	0.0368	0.4879	0.0334	0.0004	-
Mn	0.0015	0.0020	ND	0.0002	-
Fe	0.0016	0.5827	0.0016	0.0001	-
Ca	0.0630	11.2800	0.0868	0.0051	-
Zn	0.0036	0.0221	ND	ND	-
**Total flavonoids	4.644 c	202.605 a	30.337 b	0.639 d	1.985
**Total phenols	7.637 c	225.003 a	102.749 b	0.875 d	2.993
**Ascorbic acid	1.020 c	4.420 a	2.040 b	ND d	0.744
**Total anthocyanins	ND b	37.411 a	ND b	ND b	0.087
**Total carotenoids	ND c	ND c	0.465 a	0.278 b	0.001
**Antioxidant activity	30.450d	94.698a	39.485c	84.273b	0.233
pH value	7.100a	2.951d	4.771c	6.743b	0.003
Specific gravity	1.002b	1.012a	1.004b	1.000b	0.006

On wet weight basis** * (mg/100gm)** **Values are the mean of three independent determinations.**
Different small letters in the same column indicate significant differences (*P*<0.05).

Also, roselle extract had the lowest pH value (2.951%) and the highest specific gravity (1.012). Also, slight differences between specific gravity values of all extracts. These results are in agreement with those reported by Wong *et al.* (2002).

Concerning data of minerals content, roselle extract had the highest contents of Ca (11.28 mg/100gm) and Mg (7.6958 mg/100gm) followed by Na (0.7095 mg/100gm), Fe (0.5827mg/100gm) and K (0.4879 mg/100gm) compared to those of the other medicinal extracts, which had negligible minerals content(Table, 7).

Also, roselle extract had the highest contents of total flavonoids (202.605 mg/100gm) and total phenols (225.003 mg/100gm), followed by aloe vera and ginger extracts (30.337, 4.644 and 102.749, 7.637 mg/100gm for total flavonoids and total phenols, respectively). Peppermint extract had the lowest values (Table, 7). The total anthocyanins content of roselle extract was 37.411 mg/100gm, meanwhile, no anthocyanins content found in the other extracts. Furthermore, roselle extract had the highest ascorbic acid content (4.420 mg/100gm) followed by aloe vera (2.040 mg/100gm) and ginger (1.020 mg/100gm), while peppermint extract had not any ascorbic acid (Table, 7).

Antioxidant activity of all extracts ranged from 30.450 to 94.698%. Roselle and peppermint extracts, had the highest antioxidant activity (94.698 and 84.273%, respectively) followed by, aloe vera and ginger extracts, which was having 39.485 and 30.450 % antioxidant activity, respectively.

Fractionation of flavonoid compounds of selected medicinal extracts

Twelve flavonoid compounds were separated from medicinal extracts and identified by the HPLC and the results are presented in Table (8). Hisperidin was the predominant flavonoid compound in all extracts that were 5119.542, 2729.49, 2399.185 and 815.593 mg/100gm for roselle, peppermint, aloe vera and ginger extracts, respectively followed by narengin (1384.841 mg/100gm) which was the major flavonoid compound in aloe vera extract. These results are in accordance with those reported by ELbandy *et al.* (2014).

Table 8. Fractionation of flavonoid compounds of selected medicinal extracts

Samples *Compounds (mg/100gm)	Roselle	Aloe vera	Peppermint	Ginger
Narengin	35.359	1384.841	51.872	91.091
Rutin	210.014	47.212	352.437	234.118
Hisperidin	5119.542	2399.185	2729.490	815.593
Rosmarinic	5.936	17.545	88.631	21.600
Quercitrin	2.438	124.165	33.010	50.100
Quercetin	0.331	10.443	3.875	16.661
Narenginin	0.313	11.477	4.331	12.772
Kampferol	1.812	93.699	4.222	35.584
Luteolin	6.493	39.503	61.242	0.000
Hesperetin	0.493	16.407	9.435	52.602
Apignen	0.198	8.730	2.053	17.693
7-Hydroxy flavone	0.031	6.360	0.368	8.120

*** On dry weight basis**

Rutin was the second predominant compound in peppermint, ginger and roselle extracts (352.437, 234.118 and 210.014 mg/100gm, respectively) (Table, 8). Meanwhile, nine flavonoid compounds of roselle extract were detected in trace amounts. As well as, some components namely, rosmarinic, quercitrin, kampferol, luteolin and hesperetin represented in moderate amounts comparing with others flavonoids in aloe vera ,peppermint and ginger extracts. These results are in agreement with those reported by Dormana *et al.* (2009).

Fractionation of phenolic compounds of selected medicinal extracts

Twenty six phenolic compounds were separated from medicinal extracts and identified by the HPLC and the results are presented in Table (9). Chlorogenic and catechin (1659.769 and 1008.031 mg/100gm, respectively) were the major phenolic compounds that existed in roselle extract, whereas, pyrogallol (268.318 mg/100gm), protocatechuic (200.951 mg/100gm), e-vanillic (144.554 mg/100gm) and amino benzoic acid (132.245 mg/100gm) represented in moderate amounts.

Table 9. Fractionation of phenolic compounds of selected medicinal extracts

Samples *Compounds (mg/100gm)	Roselle	Aloe vera	Peppermint	Ginger
Syringic acid	3.521	3.365	1.940	26.882
Gallic acid	36.635	10.608	6.365	1.658
Pyrogallol	268.318	245.980	100.470	21.438
Amino benzoic acid	132.245	19.622	8.740	1.287
3Hydroxy tyrosol	0.000	71.955	50.452	1.870
Protocatechuic acid	200.951	29.117	25.590	2.707
Catechin	1008.031	22.821	169.690	76.212
Chlorogenic acid	1659.769	170.545	292.437	17.981
Catechol	76.581	6.931	2.308	0.203
Epicatechin	14.918	5.697	0.586	0.095
Caffeine	25.549	131.405	12.700	1.538
P-OH benzoic acid	33.810	22.641	38.590	7.249
Caffeic acid	14.527	10.697	24.125	1.434
Vanillic acid	54.416	69.718	41.262	1.320
P-coumaric acid	4.935	107.912	23.937	1.609
Ferulic acid	11.601	17.787	31.207	0.000
Iso ferulic acid	6.219	21.761	22.590	2.685
E-vanillic acid	144.554	271.068	357.702	27.850
Ellagic acid	17.593	49.938	38.965	22.018
Oleoropein	43.033	1240.050	150.817	27.302
Alpha-coumaric acid	10.392	30.789	26.700	0.730
Benzoic acid	78.993	117.210	145.435	21.770
Salicylic acid	10.562	145.254	57.300	4.874
3,4,5 methoxy cinnamic	8.656	0.000	22.337	2.010
Coumarin	1.476	2.356	8.160	1.636
Cinnamic acid	1.422	5.935	1.320	0.300

*** On dry weight basis**

Concerning data of aloe vera extract, oleoropein (1240.050 mg/100gm) was the major phenolic compound, more than six phenolic compounds namely, e-vanillic, pyrogallol, chlorogenic, salicylic, caffeine and benzoic acid found in reasonable amounts. Whereas in peppermint extract, e-vanillic acid, chlorogenic acid and catechin were the major phenolic compounds (357.702, 292.437 and 169.690 mg/100gm, respectively) (Table, 9). These results are in accordance with those reported by Dormana *et al.* (2009) and Mahdavikia and Saharkhiz (2015). Also, catechin (76.212 mg/100gm) was the predominant phenolic compound found in ginger extract followed by e-vanillic acid and oleoropein (27.850 and 27.302 mg/100gm, respectively). Selection of medicinal fruit nectar blends

Forty eight different pasteurized fruit nectar blends were prepared with different ratios (10, 15 and 20%) of four medicinal extracts (roselle, aloe vera, ginger and peppermint). These blends were sensory evaluated and sex blends were selected namely, F1G, F2R, F2G, F3R, F4R and F4A, which recorded the highest scores of organoleptic parameters and were more preferred by the panelists, as described in previous study to continue the investigation.

Physico-chemical properties bioactive compounds and antioxidant activity of selected medicinal fruit nectar blends

The main physico-chemical properties of selected medicinal fruit nectar blends which had the highest organoleptic scores were illustrated in Table (10). Moisture content was the same in all medicinal fruit nectar blends that ranged from 85.548% to 85.827% and the TSS values were fine adjusted to 14%. Whereas, ash contents ranged from 0.110 to 0.174 %, that had slightly decreased after fortification by medicinal extracts. F3R nectar blend had the highest ash content (0.174%). Meanwhile, there were no significant differences between F4R and F2R

Concerning total titratable acidity, F2R had the highest value (1.313%) comparing with other medicinal fruit blends which ranged from 0.572 to 1.313%. Increasing titratable acidity in medicinal fruit blends could be due to add of roselle extract which recorded before the highest titratable acidity content (3.298%) (Table, 4). Total sugar contents of all medicinal fruit nectar blends were relatively reduced after adding medicinal extracts being 12.462 for F2R to 13.254 for F4A %. Reducing sugars also decreased and ranged from 4.614 to 5.946%. Meanwhile, non-reducing sugars more increased after processing. These results are in accordance with those reported by Hussain *et al.* (2011).

Non-enzymatic browning of medicinal fruit blends also ranged from 0.546% for F4R to 0.913% for F3R nectar blend. It could be clearly seen that there were increase in the values of non-enzymatic browning, as indicator of nectars color, of fruit nectar blends after adding medicinal extracts. Increasing browning due to addition of medicinal extracts especially roselle extract which had a dark red color.

Concerning the data of minerals content, magnesium, potassium and sodium were the major minerals detected in all medicinal fruit nectar blends, whereas, calcium found in high amounts compared to iron and zinc which detected in small amounts. Ginger extract increased the levels of Mg, K and Zn of F2 blend (102.654, 41.939 and 0.495mg/100g, respectively) than rosella extract which were 87.91, 35.703 and 0.456 mg/100g, respectively (Table, 10). Increasing the ratios of medicinal extracts leads to reduce the minerals content of fruit nectar blends.

From the data in Table (10), it was clearly notices that, ascorbic acid of medicinal fruit nectar blends were decreased after addition of roselle, ginger and aloe vera extracts which had low ascorbic acid contents. Addition of roselle extract with ratios 15 or 20 % to fruit nectar blends (F4R, F2R and F3R) increased anthocyanins content, total flavonoids and total phenols of those blends, as well as improved the antioxidant activities being 82.291, 80.162 and 74.854%, respectively. Moreover, total phenol and flavonoids contents of all medicinal fruit nectar blends highly improved as results of addition all selected medicinal extracts which considered a big repository of many types of bioactive compounds and phytochemicals. Furthermore, antioxidants activity of all selected medicinal nectar blends increased and highly enhancement occurred by adding ginger, roselle and aloe vera extracts. F4R had the highest antioxidant activity (82.591%) followed by F2R, F4A, F3R, F2G and F1G nectar blends, which having 80.162, 77.688, 74.854, 64.327 and 63.383, respectively (Table, 10).

Table 10. Physico-chemical properties, bioactive compounds and antioxidant activity of selected medicinal fruit nectar blends

*Constituents / Samples %	F1G	F2R	F2G	F3R	F4R	F4A	LSD
Moisture content	85.682bc	85.739abc	85.827a	85.625cd	85.548d	85.761ab	0.132
Total solids	14.255bc	14.2bcd	14.138d	14.362ab	14.433a	14.253cd	0.132
Ash	0.110 d	0.155 b	0.131 c	0.174 a	0.153 b	0.129 c	0.014
Total acidity	0.732 e	1.313 a	1.001 b	0.802 c	0.783 d	0.572 f	0.058
TSS	14.000	14.000	14.000	14.000	14.000	14.000	-
Total sugars	13.101 ab	12.462 d	12.825 c	13.089 b	13.204 a	13.254 a	0.108
Reducing sugars	5.586 b	4.614 c	5.630 b	5.783 ab	5.933 a	5.946 a	0.256
Non-reducing sugars	7.515 b	7.848 a	7.195 c	7.306 c	7.271 c	7.308 c	0.212
Non-enzymatic browning	0.568	0.800	0.557	0.913	0.546	0.626	0.004
Minerals(mg/100gm)							
Mg	84.411	87.910	102.654	136.719	201.761	116.154	-
Na	24.078	23.258	21.334	52.888	41.846	52.366	-
K	20.371	35.703	41.939	63.647	49.975	62.538	-
Mn	0.047	0.272	0.209	0.120	0.137	0.115	-
Fe	0.800	1.007	0.872	2.239	2.485	2.234	-
Ca	13.708	22.776	22.677	14.682	33.929	36.815	-
Zn	0.298	0.458	0.495	1.205	1.036	1.000	-
**Total flavonoids	28.873 e	60.894 a	29.850 d	59.667 b	48.064 c	22.276 f	0.572
**Total phenols	38.751 e	75.187 b	45.966 d	79.147 a	75.940 b	56.740 c	2.028
**Total anthocyanins	23.716 d	34.666 b	20.040 e	36.491 a	31.517 c	20.534 e	0.535
**Ascorbic acid	20.649 b	18.620 c	18.654 c	17.324 d	23.430 a	23.483 a	0.740
**Total carotenoids	0.130 f	0.188 e	0.222 d	0.522 a	0.428 c	0.505 b	0.013
**Antioxidant activity	63.383 e	80.162 b	64.327 e	74.854 d	82.591 a	77.688 c	1.185
pH value	4.022c	3.690e	4.081a	3.732d	3.681f	4.060b	0.003
Specific gravity	1.053ab	1.054ab	1.046c	1.056a	1.056a	1.051b	0.004

*** On wet weight basis ** (mg/100gm) Values are the mean of three independent determinations.**
Different small letters in the same row indicate significant differences (*P*<0.05).
F1G (Apple20% + red grape 20% + pomegranate 20% + Strawberry 40%)+ 20% ginger extract
F2R (Red grape 40% + pomegranate 30% + Strawberry 30%) + 20% roselle extract
F2G (Red grape 40% + pomegranate 30% + Strawberry 30%) + 20% ginger extract
F3R(Apple40% + pomegranate 30% + Strawberry 30%) + 20% roselle extract
F4R(Apple30% + red grape 30% + Strawberry 40%) + 15% roselle extract
F4A(Apple30% + red grape 30% + Strawberry 40%) + 15% aloe extract

Accordingly, it could be clearly concluded that the antioxidant activity was highly correlated with the contents of total anthocyanins, total phenols and total flavonoids. Combinations of fruits resulted in the greatest antioxidant activity that was additive and synergistic. As well as, addition of medicinal extracts to fruit nectar blends increased the bioactive compounds content and improved the antioxidant activities of these blends. These results are in agreement with those reported by Trombino *et al.* (2004).

The pH values of medicinal fruit blends ranged from 3.681 to 4.081 and slight differences occurred after adding medicinal extracts. Furthermore, specific gravity ranged from 1.046 to 1.056 and slight differences between all medicinal fruit nectar blends due to their similar TSS values.

Fractionation of flavonoid compounds of selected medicinal fruit nectar blends

Twelve flavonoid compounds of selected medicinal fruit nectar blends were separated and identified by HPLC and the results are presented in Table (11). Four new flavonoid compounds namely, luteolin, hesperetin, apignen and 7-Hydroxy flavones not detected in all fruit nectar blends before, and then they recorded after adding medicinal extracts.

Hisperidin was the major free flavonoid compound detected in all selected nectar blends. Addition of 15 or 20 % roselle extract to blends F3R, F2R and F4R highly increased the hesperidin contents (370.058, 282.310, and 187.651 mg/100g, respectively) which was the predominant flavonoid compound of roselle ,ginger and aloe vera extracts. Hesperidin content increased more than four folds (282.310mg/100gm) by adding 20 % roselle extract to F2R nectar blend than 20% ginger extract which recorded 62.108 mg/100g. These mean that roselle extract more effective than ginger extract. Furthermore, highly improvement occurred of the contents of narengin, rutin, rosmarinic and quercitrin of all fruit nectar blends after adding medicinal extracts. These data are confirmed with the results reported in Table (10) before and the results of Dormana *et al.*(2009); Elbandy *et al.* (2014) and Mahdavikia and Saharkhiz (2015).

Table 11. Fractionation of flavonoids compounds of selected medicinal fruit nectar blends

**Samples *Compounds (mg/100gm)	F1G	F2G	F2R	F3R	F4R	F4A
Narengin	5.660	0.162	5.879	6.875	4.298	4.219
Rutin	2.453	2.503	9.504	10.955	7.623	2.859
Hisperidin	112.755	62.108	282.310	370.058	187.651	72.955
Rosmarinic	4.215	1.216	2.869	2.178	5.087	5.154
Quercitrin	2.320	0.387	1.647	1.420	2.135	3.027
Quercetin	1.400	1.418	1.441	0.459	0.036	0.075
Narenginin	0.087	0.215	0.182	0.079	0.187	0.066
Kampferol	3.725	0.069	0.108	0.141	0.085	0.099
Luteolin	0.000	0.247	2.205	0.604	0.170	20.960
Hesperetin	0.109	0.220	0.218	0.154	0.165	0.224
Apignen	0.028	0.010	0.016	0.041	0.006	0.011
7-Hydroxy flavone	0.000	0.000	0.016	0.028	0.000	0.282

*** On dry weight basis** **** See Table (10)**

Accordingly, all medicinal extracts increased flavonoids and the bioactive compounds contents of fruit nectar blends which improved healthy benefits of these blends.

Fractionation of phenolic compounds of selected medicinal fruit nectar blends

Twenty six phenolic compounds were identified from selected medicinal fruit nectar blends. Pyrogallol was the major phenolic compound detected in all selected fruit nectar blends which recorded 169.98, 161.39, 110.99, 60.32, 51.20 and 51.13 mg/100gm, for F4R, F4A, F3R, F2R F1G and F2G, respectively. Substitution of 15% roselle extract to F4R nectar blend more effective than 15 % aloe vera extract. Roselle extract highly increased the levels of pyrogallol, protocatechuic acid, catechine, chlorogenic acid and catechol being 169.98, 16.75, 87.85, 13.69 and 28.81 mg/100gm, respectively than aloe vera extract.

Table 12. Fractionation of phenolic compounds of selected medicinal fruit nectar blends

**Samples *Compounds (mg/100gm)	F1G	F2G	F2R	F3R	F4R	F4A
Syringic acid	3.15	2.71	1.85	3.20	3.12	2.32
Gallic acid	4.75	1.54	2.71	6.58	9.25	2.71
Pyrogallol	51.20	51.13	60.32	110.99	169.98	161.39
Amino benzoic acid	0.34	0.06	5.24	5.95	4.20	1.01
3Hydroxy tyrosol	1.79	1.19	4.24	3.87	2.60	3.98
Protocatechuic acid	3.25	0.86	6.80	9.25	16.75	10.70
Catechine	9.61	7.86	15.41	61.55	87.85	48.88
Chlorogenic acid	20.57	13.52	17.25	106.83	13.69	0.68
Catechol	3.91	2.69	19.71	17.92	28.81	2.04
Epicatechin	1.16	2.45	5.69	2.94	4.65	5.91
Caffeine	0.78	0.42	0.73	1.53	1.43	0.78
P-OH benzoic acid	1.94	2.71	0.89	0.46	4.37	2.82
Caffeic acid	0.43	1.66	2.51	4.97	5.13	3.22
Vanillic acid	2.38	1.56	1.10	5.64	5.35	2.89
P-coumaric acid	1.75	0.31	0.46	3.52	4.85	6.06
Ferulic acid	1.28	1.17	1.98	1.93	0.19	0.17
Iso ferulic acid	0.71	0.31	0.81	0.31	0.45	0.73
E-vanillic acid	34.55	21.06	7.29	5.08	10.56	28.79
Ellagic acid	2.92	0.33	0.51	0.82	0.62	1.18
Oleoropein	20.86	0.80	2.78	3.79	2.68	16.04
α-coumaric acid	0.13	0.16	0.53	0.57	0.17	0.16
Benzoic acid	0.92	0.50	4.24	4.29	2.74	1.53
Salycillic acid	1.07	0.20	1.00	1.13	0.87	1.00
3,4,5 methoxy cinnamic acid	0.10	0.37	0.39	0.76	0.57	0.35
Coumarin acid	0.25	0.14	0.16	0.05	0.05	0.03
Cinnamic acid	0.06	0.04	0.41	0.39	0.41	0.41

*** On dry weight basis** **** see Table (10)**

Meanwhile, adding of 15% ginger extract to F1 or F2 nectar blends added new ten phenolic compounds namely, 3 Hydroxy tyrosol, epicatechin, P-oH benzoic acid, iso ferulic acid, E-vanillic, oleoropein, alpha-coumaric acid, salycillic acid, 3,4,5 methoxy cinnamic acid and coumaric acid, some of them recorded in relatively high levels as E-vanillic (34.55 and 21.06 mg/100gm for F1G and F2G, respectively) and oleoropein (20.86 and 0.80 mg/100gm for F1G and F2G, respectively) (Table, 12).

From the aforementioned data it could be clearly concluded that roselle extract more effective than aloe vera and ginger extracts. Furthermore, highly improvement occurred of the contents of all fruit nectar blends phenolic compounds after adding medicinal extracts. These data are confirmed with the results reported before in Table (10).

Finally, combination of fruit juices resulted in the greatest antioxidant activity which was accumulative and synergistic. As well as, substitution of medicinal extracts to fruit nectar blends increased the bioactive compounds content and improved the antioxidant activities of these blends.

REFERENCES

A.O.A.C. (2007). Official Methods of Analysis of the Association of Official Analytical Chemists. 18th Ed. Gaithersburg, Maryland, U.S.A.

Askar, A. and Treptow, H. (1993). Quality Assurance in Tropical Fruit Processing. Springer-Verlag, Berlin. Pp 9.

Baraca, A.; Tommasi, N.; De, B.; Lorenzo, D.; Pizza, C.; Politi, M. and Morelli, I. (2001). Antioxidant principles from Bauhinia terapotensis. Journal of Natural products, 64: 892-895.

Basu, A.; Nguyen, A.; Betts,N.M. and Lyons, T.J. (2014). Strawberry as a functional food: an evidence-based review. Critical Reviews in Food Science and Nutrition, 54: 790–806.

Beh, L.; Zakaria, Z.; Beh, B.; Ho, W.; Yeap, S. and Alitheen, N. (2012). Comparison of total phenolic content and antioxidant activities of freeze-dried commercial and fresh fruit juices. Journal of Medicinal Plants Research, 6(48):5857-5862.

Bindon, K.; Varela, C.; Kennedy, J.; Holt, H. and Herderich, M.(2013). Relationships between harvest time and wine composition in Vitis vinifera L. cv. Cabernet Sauvignon 1. Grape and wine chemistry. Food Chemistry, 138: 696–1705.

Boas, A.; Henrique, P.; Lima, L. and Neto, A. (2014). Antioxidant activity, anthocyanins and organic acids content of grape juices produced in southwest of minas gerais, Brazil. Ciênc. Agrotec., Lavras, 38(5):480-486.

Buendia, B.; Gil, M.I.; Tudela, J.A.; Gady, A.I.; Medina, J.J.; Soria, C.; Lopez, J.M. and Tomas-Barberan, F.A. (2010). HPLC-MS analysis of proanthocyanidin oligomers and other phenolics in 15 strawberry cultivars. Journal of Agricultural and Food Chemistry, 58: 3916–3926.

Chandra, D.; Choi, A.; Kim, Y. and Kim, J. (2015). Physicochemical, microbial and sensory quality of fresh-cut red beetroots in relation to sanitization method and storage duration. Ital. J. Food Sci., 27: 208-220.

De Carvalho, J.; Maia, R. and De-Figueredo, W. (2007). Development of a blended non-alcoholic beverage composed of coconut water and cashew apple juice containing caffeine, J. Food Qual., 30: 664-681.

Dormana, H.J.; Koşara, M.; Başerb, K. and Hiltunena, R. (2009). Phenolic profile and antioxidant evaluation of Mentha x piperita l. (peppermint) extracts. Natural Product Communications, 4(4): 457-590.

El-Bastawesy Amal M., Hareedy Lobna A. and El-Malky W. A. (2008). Production and evaluation of nutraceutical vegetable juice blends. Arab Univ. J. Agric. Sci., Ain shams Univ., Cairo, 16(2): 389-597.

Elbandy, M. A.; Abed, S. M.; S. S. Gad, A. and Abdel-Fadeel, M. G. (2014). Aloe vera gel as a functional ingredient and natural preservative in mango nectar. World Journal of Dairy & Food Sciences, 9(2):191-203.

Gerard, K.A. and Roberts, J.S. (2004). Microwave heating of apple mash to improve juice yield and quality. Food Science and Technology, 37:551-557.

Goupy, P.; Hugues, M.; Biovn, P. and Amiot, M.J. (1999). Antioxdant composition and activity of barley (Hordeum vulgare) and malt extracts and of isolated phenolic compounds. J. Sci. Food Agric., 79: 1652-1634.

Hassan, N.A; El- Halwagi, A.A. and Sayed, H.A. (2012). Phytochemicals, antioxidant and chemical properties of 32 pomegranate accessions growing in Egypt. World Applied Sciences Journal, 16 (8): 1065-1073.

Hossain A.; Begum P.; Zannat M.S.; Rahman M.H.; Ahsan M.; Islam S.N. (2016). Nutrient composition of strawberry genotypes cultivated in a horticulture farm. Food Chemistry, 199:648–652.

Hussain, I.; Zeb, A. and Ayub, M. (2011). Evaluation of apple and apricot blend juice preserved with sodium benzoate at refrigeration temperature. World J. Dairy & Food Sci., 6 (1): 79-85.

Hwang, P.; Wu, C.; Gau, S.; Chien, S. and Hwang, D. (2010). Antioxidant and immune stimulating activities of hot water extract from seaweed Sargassum hemiphyllum. J. Mar. Sci. Tech-Japan, 18:41-46.

Imtiyaz, A.; Wani, M.; Bhat1, Y.; Abid, F.; Lone, A.; Shaiq, A.; Ganaie, M. and Dar, G. (2012). Screening of various pomegranate (Punica granatum L.) selections of Kashmir valley. African Journal of Agricultural Research, 7(30): 4324-4330.

Karacam, C.; Sahin, S. and Oztop, M. (2015). Effect of high pressure homogenization (microfluidization) on the quality of Ottoman Strawberry (F. Ananassa) juice. LWT - Food Science and Technology, 64: 932-937.

Kaur, C. and Kapoor, H. (2002). Anti-oxidant activity and total phenolic content of some Asian vegetables. International J. of Food Sci. and Tech., 37:153-161.

Knockaert, G.; Roeck, A.D.; Lemmens, L.; Buggenhout, S.V.; Hendrickx, M. and Loey, A.V. (2011). Effect of thermal and high pressure processes on structural and health related properties of carrots *(Daucus carota)*. Food Chemistry, 125: 903–912.

Lima, M. D.; Silani, I. S.; Toaldo, I. M.; Corrêa, L. C.; Biasoto, A. C.; Pereira, G. E.; Bordignon-Luiz, M. T. and Ninow, J. L. (2014). Phenolic compounds, organic acids and antioxidant activity of grape juices produced from new Brazilian varieties planted in the Northeast Region of Brazil. Food Chemistry, 161: 94–103.

Lindley, M.; Beyts, P.; Caanales, I. and Borrego, F. (1993). Flavor modifying characteristics of the intense sweetener neohesperidin dihydrochalcone. J. Food Sci., 58: 592-599.

Loon, Y.H.; Wong,J.W.; Yap, S.P.; Kah, H. and Yuen, K.H.(2005). Determination of flavonoids from *Orthosiphon stamineus* in plasma using a simple HPLC method with ultraviolet detection. Journal of Chromatography B, 816:161–166

Mahdavikia, F. and Saharkhiz, M. (2015). Phytotoxic activity of essential oil and water extract of peppermint (*Mentha × piperita L. CV. Mitcham*). Journal of Applied Research on Medicinal and Aromatic Plants, 2:146–153.

Németh, E. (2012). Medicinal plants. Cultivated Plants Primarily as Food Sources, 2: 80-88.

Neyestani, T. (2008). Polyphenols and immunity. In: Wild-type food in health promotion and disease prevention: the columbus concept. De Meester, F and Watson, R., eds. Humana Press Inc., Totowa, NJ. Pp 413-434.

O'Grady, L.; Sigge, G.; Caleb, O. and Opara, U. (2014). Bioactive compounds and quality attributes of pomegranate arils (Punica granatum L.) processed after long-term storage. Food Packaging and Shelf Life, 2: 30-37.

Profir, A. and Vizireanu, C. (2013). Evolution of antioxidant capacity of blend juice made from beetroot, carrot and celery during refrigerated storage. The Annals of the University Dunarea de Jos of Galati Fascicle. Food Technology, 37(2): 93-99.

Ranganna, S. 1979. Fruits and Vegetables Analysis. Manual of analysis of fruit and vegetable products. Tata. Mc. GrawHill, Pub. Co. Ltd, New Delhi. India.

Rizk, A. (2011). Technological and chemical studies on some vegetable and fruit products. Ph.D. Thesis, Food Sci. Dept., Fac. of Agric., Benha Univ., Egypt.

Sapeia, L. and Hwaa, L. (2014). Study on the kinetics of vitamin C degradation in fresh strawberry juices. Procedia Chemistry, 9: 62-68.

Schonenberger,P.; Giorgi1,D. and Ducruet, J. (2012). Filtration of grape juice sediments: A new application for cross-flow filters. Wine & Viticulture Journal March/April: 28-33.

Segovia-Bravo, K.A.; Guignon, B.; Bermejo-Prada, A.; Sanz, P.D. and Otero,L. (2012). Hyperbaric storage at room temperature for food preservation: A study in strawberry juice. Innovative Food Science and Emerging Technologies, 15:14–22.

Steel, R.; Torrie, J. and Dickey, D., 1997. Principles and procedures of Statistics: A Biometrical Approach, 3rd ed., McGraw-Hill, New York, NY.

Thamilselvi, C., Krishnakumar, T., Amutha, S. (2015). Preparation and quality evaluation of lime based herbal blended RTS beverage. Asian J. Dairy and Food Res., 34 (1): 54-58.

Trombino, S., Serini, S., Nicuolo, F., Celleno, L., Ando, S., Picci, N., Calviello, G., and Palozza, P. (2004). Antioxidant effect of ferulic acid in isolated membranes and intact cells: Synergistic interactions with alpha-tocopherol, beta-carotene, and ascorbic acid. J. Agric. Food Chem., 52:2411–2420.

Vijayanand, P., Deepu, E. and Kulkarni, S. (2015). Physico chemical characterization and the effect of processing on the quality characteristics of Sindura, Mallika and Totapuri mango cultivars. J. Food Sci. Technol., 52(2):1047–1053.

Wani, I.A.; Bhat1, M. Y.; Lone, A.A. ; Ganaie, S.A.; Dar, M. A. ; Hassan, G. I.; Mir, M. M. and Umar, I. (2012). Screening of various pomegranates (*Punica granatum L.*) selections of Kashmir valley. African Journal of Agricultural Research, 7(30): 4324-4330.

Wong, P.; Yosof, S.; Ghazali, H.M. and Cheman, Y.B. (2002). Physico-chemical characteristics of Roselle. Nutrition and Food Sci., 32: 68-73.

Xu, C.; Yagiz, Y.; Zhao, L.; Simonne, A.; Lu, J. and Marshall, M. (2017). Fruit quality, nutraceutical and antimicrobial properties of 58 muscadine grape varieties (*Vitis rotundifolia Michx.)* grown in United States. Food Chemistry, 215: 149–156.

Youssef, M.; El kady, A. and Nagy, K. (2015). Effect of engineering treatments on extraction of roselle juice. Middle East Journal of Agriculture Research, 04(04):697-706.

Zhuang, X.; Lu, Y. and Yang, G. (1992). Extraction and determination of flavonoids in ginkgo. Chin. Herb. Med., 23: 122-124.

تحسين المركبات الحيوية والنشاط المضاد للأكسدة لخلطات نكتار الفاكهة باستخدام بعض مستخلصات النباتات الطبية

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ظهر اهتمام عالمي كبير بتطور تصنيع واستهلاك الأغذية الوظيفية بسبب تزايد ظهور الدلائل الطبية على الأهمية الصحية لتلك الأغذية. لذلك تم خلط بعض عصائر الفاكهة للحصول على نكتار فواكه ذو خصائص وظيفية وقيمة غذائية عالية. تم خلط نسب مختلفة (10، 15، 20%) من مستخلصات النباتات الطبية (الزنجبيل، الكركية، النعناع والصبار) والتي تعتبر مصدرا غنيا بالمركبات الحيوية النباتية والتي تم خلطها مع نكتار الفواكه المختارة لتحسين القيمة الحيوية والنشاط المضاد للأكسدة والنكهة والخواص الوظيفية لهذه الخلطات. تم تقدير الخواص الفيزيوكيميائية والمركبات النشطة حيويا والنشاط المضاد للأكسدة لخلطات نكتار الفواكه التي تم اختيارها وقد دلت النتائج المتحصل عليها ان خلطات نكتار الفواكه قد تميزت بزيادة النشاط المضاد للأكسدة عن نكتار الفاكهة الفردية. حيث كان النشاط المضاد للأكسدة لكل المستخلصات الطبية يتراوح من 30.450 الى 94.69% وتميزت مستخلصات الكركدية والنعناع بانها ذات أعلى نشاط مضاد للأكسدة (94.698 و84.273% على الترتيب). تم فصل وتعريف 12 مركب من الفلافونيدات و26 مركب من الفينولات بواسطة التحليل الكروماتوجرافى من مستخلصات النباتات الطبية، وكان الهسبريدين هو المركب السائد من الفلافونيدات في كل المستخلصات بتركيز 5119.542 و2729.49 و2399.185 و815.495 مجم /100جم من مستخلصات الكركدية والنعناع والصبار والزنجبيل على التوالى، بينما كان الكلوروجنيك والكاتيشين (1659.769 و1008.031 مجم/100جم على التوالى) هما المركبان السائدان فى المركبات الفينولية. وقد زادت المستخلصات الطبية من محتوى مركبات الفينولات والفلافونيدات لخلطات نكتار الفواكه وكذلك زاد محتوى المركبات الحيوية ذات الأهمية الصحية لهذه الخلطات وعامة مستخلصات الكركدية والنعناع كانت أكثر فاعلية من مستخلصات الصبار والزنجبيل. وعموما أدى خلط الفاكهة إلى زيادة النشاط المضاد للأكسدة نتيجة للتأثير التكاملي لهذه الفواكة كما أدت إضافة المستخلصات الطبية الى خلطات نكتار الفواكه الى زيادة محتواها من المركبات النشطة حيويا وزيادة النشاط المضاد للأكسدة لهذه الخلطات. لذا يوصى بانتاج هذة الخلطات السابق ذكرها حيث انها غير مكلفة اقتصاديا و يمكن تطبيقها من الناحية العملية.