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Research Article
Formulation and Evaluation of Some Healthy Natural Juice Blends

A.M.S. Hussein, N.A. Hegazy, M.M. Kamil and S.S.M. Ola

Department of Food Technology, National Research Centre, Dokki, P.O. Box 12311, Giza, Egypt

Abstract

Background: Fruit and vegetable juices are popular and healthful drinks for their nutritional value. Fresh juices contain antioxidants, vitamins and minerals that are essential to promote healthy life in human beings and they also play an important role in the prevention of many diseases. Blended Juice is one of the methods that is used to improve the nutritional quality of the final product, where it improve vitamins and minerals contents according to the kind and quality of fruits and vegetables used. **Objective:** This study aimed to prepare healthful fresh juices from different vegetable and fruit blends and assess the intensity of sensory attributes and the acceptability evaluation by consumers. **Methodology:** Five natural juice blends of different formulas were prepared and kept refrigerated for 9 days in glass bottles. Physicochemical analysis and sensory evaluation were determined for the prepared juice blends. Also, marginal changes in pH, total acidity, total soluble solids, viscosity and vitamin C content were measured. The antioxidant activity of fresh juice blends was also evaluated by using *in vitro* assays of ferric ion reduction power assay, $DPPH^{\bullet}$ and $ABTS^{\bullet+}$ scavenging capacities. The effect of juice storage for 3, 6 and 9 days on pH, acidity and vitamin C content was assayed. **Results:** The overall acceptability of blended juice of formulas 2, 3, 4 and 5 indicated the possibility to manufacture good and nutritional juices at commercial scale. The high antioxidant activity of fresh juice blends indicated that they could be used as a source of antioxidants and as functional drinks. These juice blends are recommended to people suffering from obesity, blood pressure, cancer, Alzheimer's and heart diseases, as they play a key role in preventing these diseases. **Conclusion:** Formulations of the studied blends of fruit and vegetables juices are good source of calcium, magnesium, iron and antioxidant activity (vitamin C, flavonoids and total phenols). Therefore, consumption of such juice blends will protect human body from several diseases.

Key words: Fruit, vegetable, juices, antioxidants, vitamins, minerals, heart diseases

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Corresponding Author: A.M.S. Hussein, Department of Food Technology, National Research Centre, Dokki, P.O. Box 12311, Giza, Egypt
Tel: 01224642449, 01016426755

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Fruits and vegetables are important to good health for all age categories, where they constitute one of the most important portions in a healthy diet[1]. Consuming fresh juices is increasing all over the world due to their freshness, high vitamins content, low caloric consumption and ability to reduce risk of many diseases[2]. They could be able to prevent from several diseases, i.e., heart diseases, cancer and diabetes. Fruit juice is a popular drink as it contains antioxidants, vitamins and minerals that are essential for human beings[3]. The high potassium and low sodium content of most juices help in maintaining a healthy blood pressure. Vitamin C is naturally present in juices which is essential for the body to form collagen, cartilage, muscle and blood vessels. It also helps in the absorption of iron[4]. Juice formulation is one of the methods that could be used to improve the nutritional quality of the juice. This method can improve the vitamin and mineral contents according to their fruits kind that is used[5]. Apart from nutritional quality improvement, blended juice can be served as appetizers.

Carrot (*Daucus carota*) juice consumption has been increased recently in many countries. Carrot juice is characterized by its high carotene, vitamins and minerals contents[6,7]. Carotene has been reported to exhibit free radical properties and effectiveness as biological antioxidant and anticancer[8]. Also, orange juice is one of the most sources of vitamin C. It is well known for its flavor and antioxidants. Lemon is a medicinal plant that characterized by its alkaloid contents which is effective as anticancer[9]. Moreover, crude extract of lemon (roots, stem and flowers) have antibacterial properties against clinically bacterial strains[10]. Also, flavonoids of citrus have effective biological activity, i.e., antibacterial, antifungal, antiviral, antidiabetic and anticancer[11,12].

Many studies recommended consuming higher amount of plant foods to decrease overall mortality, risk of obesity, diabetes, heart diseases and reduce weight. There is a growing interest to utilize from beetroot as a health promoting and functional food (disease preventing)[13]. The consumption of beetroot juice is able to lower Blood Pressure (BP) and consequently reduce the risk of cardiovascular diseases[14]. Supplementing beetroot juice with high nitrate content was used to improve physical performance of sportsman[15]. Where, beetroot contains high fiber content that helps to prevent constipation and a healthy digestive tract. Recent studies have provided that beetroot consumption improves clinical outcomes for several pathological diseases, i.e., type II diabetes, atherosclerosis and dementia[13]. Beetroot is a rich source of nutrients, i.e., manganese, magnesium, phosphorus, potassium, zinc, copper, selenium, thiamine, riboflavin, vitamin B6, pantothenic acid and choline. Pineapple (*Ananus comosus*) has attractive flavor and refreshing sugar-acid balance. It has been used as a medicinal plant[16]. Pineapple juice is also consumed as a canning industry byproduct or to obtain new flavors in beverages and other products[5]. Also, cantaloupe is associated with a reduced risk of obesity, overall mortality, diabetes and heart disease. Apples are widely consumed all over the world as a rich source of phytochemicals. Therefore, apples were characterized with their very strong antioxidant activity, decrease lipid oxidation, lower cholesterol and inhibit cancer cell proliferation. Epidemiological studies found that consumption of apples was able to reduce the risk of diabetes, asthma, cardiovascular disease and some cancers. Kiwifruit is also able to reduce the risk of heart disease, diabetes and cancer. Study on the effects of kiwifruits consumption on sleep problems of adults stated that kiwi consumption able to improve sleep onset, duration and efficiency in adults with self- reported sleep disturbances.

Flaxseeds are one of the oldest fiber crops in the ancient Egypt and China. Flaxseeds are a rich source of micronutrients, dietary fibers, manganese, vitamin B1 and alpha-linolenic acid (omega-3). Therefore, flaxseed is characterized by its healthy fat, antioxidants and fiber. Recently, it has been found that flaxseed can also help to reduce the risk of diabetes, cancer and heart disease. Honey is widely used for its therapeutic effects. It was found that, honey contains about 200 substances. Honey is contains primarily from fructose, glucose, fructo-oligosaccharides[17] and many amino acids, vitamins, minerals and enzymes[18]. Antioxidant capacity of honey is important in the treatment of many diseases for its phenolics, peptides and organic acids compounds. Ginger has been used in all over the world, since antiquity as a medicinal plant, i.e., cramps, rheumatism, sprains, arthritis, pains, muscular aches, sore throats, indigestion, hypertension, helminthiasis, dementia, fever, constipation, infectious diseases and vomiting[19]. Ginger is characterized also by its antimicrobial activity[20]. Wheat germ is representing approximately 2.5% of the total weight of the wheat kernel. It is rich in several minerals (iron, potassium and zinc), essential amino acids and vitamins (thiamin, riboflavin and niacin)[21]. Also, wheat germ is characterized by its palatable taste for its high oil and sugar contents. Generally, plant proteins have low biological value but protein that is isolated from defatted wheat germ meal has high nutritional value[22]. Where, proteins of wheat germ were found to consist of 34.5% albumin, 15% globulins, 10.6% gluten and 4.6% prolamine. Therefore, nutritional and functional properties of wheat germ proteins suggested using it in food products[23]. Also, Ostlund *et al.*[24] reported several potential health and therapeutic effects for wheat germ, where they stated that consumption of wheat germ had cholesterol lowering effect in human subjects. Also, wheat germ agglutinin is able to reduce diabetes (type II), weight management and cardiovascular diseases[25].

Bananas have several potential health benefits, i.e., lowering blood pressure, lowering the risks of cancer and improving heart health[26]. Lower-fat milks provide more calcium than whole milk. Skimmed milk has a similar amount of other bone friendly nutrients (like protein and phosphorus) when compared with whole fat milk. The objective of this study is to prepare natural juice blends that could be used as a functional drink and evaluate its acceptability.

MATERIALS AND METHODS

Materials: The fully matured, freshly harvested apple, kiwifruit, lemon, pineapple, cantaloupe, beetroot, carrot, orange, honey, ginger, flaxseeds, wheat germ, bananas and skimmed milk were procured from the local market (Dokki, Egypt).

Methods

Formulation of natural juice blends: Fruit and vegetable samples were picked and washed; then juices were prepared using a kitchen machine. Five blends of 100% natural juices were formulated as shown in Table 1 and then kept in glass bottles. Sodium benzoate (1 g L^{-1}) and citric acid (1 g L^{-1}) were added to all juices as preservatives. The juices were filled in 500 mL sterilized glass bottles, loosely copped and pasteurized in water bath at a temperature of 82.5°C. Samples were drawn for chemical analysis.

Physicochemical analysis: Moisture, protein, fat, crude fiber, ash and total solid contents of all used fruits and vegetables samples were determined according to the methods of AOAC[27]. Total Soluble Solids (TSS) were determined using a hand refractometer (ATAGO, Japan) and expressed as Brix value. Acidity was measured according to the method of AOAC[27] and expressed as percentage citric acid. Brix/acid ratio was calculated by dividing the total soluble solids on the total acidity values for each sample. The pH value was measured using Hanna pH-meter HI 9021 m Germany. Also, vitamin C content was determined according to AOAC[27] using 2,6 di-chlorophenol-indophenol. Viscosity was measured using HAAKE viscometers (Haake, Mess-Technik Gmbhu., Co., Germany), thermostatic bath was used to control working temperature within 25°C. Viscosity was determined in centipoises (cP) unit according to the method of Ibarz *et al.*[28].

Color determination: Color parameters (L*, a* and b*) of juice samples were determined using a spectro-colorimeter (Tristimulus colour machine) with the CIE lab color scale (Hunter, Lab Scan XE-Reston VA, USA) in the reflection mode. The instrument was standardized with white tile of Hunter Lab cooler standard (LX No. 16379): X = 72.26, Y = 81.94 and Z = 88.14 (L* = 92.46, a* = -0.86, b* = -0.16)[29].

Total phenolics and flavonoids contents: Total phenolics content of juice samples were determined using the method of Folin-Ciocalteu[30]. Results were expressed as gallic acid equivalent (mg GAE g^{-1} dry weight). Flavonoids contents of juice samples were determined using $AlCl_3$ method[31] and expressed as catachine equivalents (mg CAT g^{-1} fruit dry weight).

Table 1: Prepared formulas with their blending ratio

Ingredients	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5
Carrot (g)	125	-	-	-	-
Orange (g)	125	-	-	-	-
Lemon (g)	-	-	10	-	-
Apple (g)	-	250	-	-	-
Kiwifruit (g)	-	-	195	-	-
Cantaloupe (g)	-	-	-	300	-
Pineapple (g)	-	-	195	-	-
Beetroot (g)	-	-	-	80	-
Flaxseeds (g)	10	10	-	-	-
Honey (g)	10	10	-	20	-
Ginger (g)	10		-	-	-
Water (mL)	120	130	-	-	-
Wheat germ (g)	-	-	-	-	30
Banana (g)	-	-	-	-	200
Skimmed milk	-	-	-	-	170
Total weight (g)	400	400	400	400	400

Antioxidant activity: Antioxidant activity was determined using DPPH radical-scavenging assay and β-carotene-linoleic acid bleaching assay as reported by Grzegorczyk *et al.*[32] and Matthaus[33], respectively.

Free radical scavenging (DPPH): The DPPH radical-scavenging assay was carried out, as previously reported by Grzegorczyk *et al.*[32]. Various concentrations of ethanol extracts of tested samples (50, 100, 150 and 200 μg mL^{-1}) were added to 4 mL of 0.1 mM DPPH solution in methanol and the reaction mixture was shaken vigorously. After incubation for 30 min at room temperature the absorbance was recorded at 517 nm. The TBHQ was used as a reference in the same concentration range as the test extract. A control solution, without a tested compound was prepared in the same manner as the assay mixture. All the analyses were done in triplicate. The degree of decolorization indicates the radical-scavenging efficiency of the extract. The antioxidant activity of tested samples was calculated as an inhibitory effect (I%) of the DPPH radical formation as follows:

$$\text{Inhibition (\%)} = \frac{100 \times A_{517}\ \text{(control)-}A_{517}\ \text{(sample)}}{A_{517}\ \text{(control)}}$$

ABTS radical-scavenging assay: A 2, 2-azino-bis-3 (ethylbenzthiazoline-6-sulphonic acid) radical cation ($ABTS^{\bullet+}$) was produced by reacting ABTS (7 mM) and potassium pershulphate (2.45 mM) solutions in phosphate buffer solution pH 7.0, prepared 12 h before use and kept in the dark at room temperature. The concentration of ABTS radical solution was adjusted to an absorbance of 0.700 U at 732 nm, with the buffer-solution. Nine hundred microliters $ABTS^{\bullet+}$ solution and 10 μL of the assayed solution were added to both samples and standard solutions (ascorbic acid) prepared to calibration curve. Absorbance decrease at 732 nm was measured when $ABTS^{\bullet+}$ solution reached equilibrium. The scavenging capacity of free radicals was calculated applying the former equation.

The antioxidant activity expressed as ascorbic acid equivalents (AEAC) was obtained from the doses/response curve and was defined as the acid concentration that produces the same antioxidant effect (absorbance decrease) as the sample.

Ferric ion reducing antioxidant power (FRAP): The FRAP reagent consists of acetic acid-sodium acetate buffer (pH 3.6), tripyridyl-triazine (TPTZ) (1 mM) and $FeCl_3$ (2 mM). This mixture produces TPTZ-Fe^{+3}, a brown coloured complex. The standard calibration curve was made using $FeSO_4.7H_2O$ solutions ranging from 100-1000 μM. Both samples and the standard solutions were determined by adding 900 μL FRAP reactive, X μL sample or standard solution and (100-X) μL of distilled water. The absorbance was read at 593 nm.

Sensory evaluation: Sensory evaluation of juice samples was carried out through evaluating taste, odor, color, mouth feel, appearance and overall acceptability as described by Hussein and Shedeed[34].

Statistical analysis: The collected data was analyzed and presented as (Mean±Standard Deviation). Means were compared by the analysis of variance (one-way ANOVA), followed by LSD test ($p<0.05$) using SPSS software program.

RESULTS AND DISCUSSION

Chemical composition and mineral content of raw materials: Chemical composition of the selected natural juices materials were determined and presented in Table 2. The obtained results showed that moisture content of carrot, orange, lemon, apple, kiwifruit, cantaloupe, pineapple, beetroot, banana and skimmed milk ranged between 89.90-70%, while, flaxseeds, wheat germ and ginger decreased to 4.23, 11.50 and 15.06%, respectively. Also, flaxseeds, ginger, beetroot and wheat germ characterized by their higher crude fiber content where they reached to 8.12, 2.9, 2.0 and 1.54, respectively. Furthermore, wheat germ, flaxseeds, ginger and skimmed milk contained higher protein than other selected raw materials, where they reached to 32.0, 24.0, 5.30 and 3.50%, respectively.

Furthermore, minerals content of the selected natural fruits juices were evaluated and presented in Table 3. Result indicated that minerals were varied according to the source of juice, where calcium content of skimmed milk, wheat germ, carrot, kiwifruit and orange reached to 82, 44.2, 34, 34 and 30 mg/100 g, respectively. Wheat germ characterized by its highest content from iron, phosphorus, potassium and magnesium compared to other raw juice material, where they reached to 7.2, 968, 1026 and 275 mg/100 g, respectively. Also, banana contained higher iron, phosphorus and potassium, where it reached to 0.89, 88.38 and 382 mg/100 g, respectively. These results are in agreement with those reported by Gopalan *et al.*[35], Holland *et al.*[36] and Shirin and Prakash[37].

Total carotene and vitamins in raw materials: Carotenoids and vitamins are important micronutrients for human health[38].

Table 2: Chemical composition of natural raw juice materials (on wet basis)

Samples	Moisture (%)	Protein (%)	Fat (%)	Ash (%)	Fiber (%)	Carbohydrate (%)
Carrot	86.00	0.90	0.20	1.10	1.20	10.60
Orange	86.75	0.94	0.12	0.34	1.40	10.45
Lemon	87.60	0.70	0.20	0.22	2.80	8.48
Apple	83.00	0.26	0.17	0.35	2.40	13.82
Kiwifruit	89.00	1.35	0.56	0.52	2.35	6.22
Cantaloupe	87.00	0.84	0.19	0.19	0.90	10.88
Pineapple	85.00	0.54	0.12	0.26	1.40	12.68
Beetroot	84.00	1.68	0.18	1.13	2.00	11.01
Banana	70.00	1.44	0.29	3.60	0.40	24.27
Skimmed milk	89.90	3.50	0.60	0. 82	-	5.18
Flaxseed	4.23	24.00	38.00	3.42	8.12	22.23
Honey	25.00	0.56	0.31	0.48	0.30	73.35
Ginger	15.06	5.30	3.72	3.55	2.90	69.47
Wheat germ	11.50	32.00	9.37	4.74	1.54	40.85

Table 3: Mineral contents (mg/100 g) of natural raw juice materials

Samples	Ca	Fe	P	Na	K	Mg	Cu
Carrot	34	0.70	25	3.17	11.4	9.9	0.02
Orange	30	0.50	14	8.16	65.3	14.5	0.09
Lemon	26	0.60	12	2	138	8	0.07
Apple	6.0	0.30	25.2	1.18	151.1	6.49	0.11
Kiwifruit	34	0.31	34	3	312	17	0.13
Cantaloupe	9	0.21	15	16	266	12	0.09
Pineapple	13	0.29	8	1	109	12	0.03
Banana	7.19	0.89	88.38	1.60	382	35.62	0.078
Beetroot	16	0.79	38	77	305	23	0.22
Flaxseed	25	0.67	32	3.0	82.0	42.26	0.19
Ginger	15	0.80	35	12	415	45	0.55
Wheat germ	44.2	7.20	968	13.8	1026	275	0.39
Honey	18	0.50	35	25	480	23	0.56
Skimmed milk	82	0.32	95	58	141	12	0.03

Table 4: Carotenes and vitamins content of natural raw juice materials

Samples	Carotenes (mg/100 g)	Thiamine (mg/100 g)	Riboflavin (mg/100 g)	Niacin (mg/100 g)	Vitamin C (mg/100 g)
Carrot	8.33	0.04	0.02	0.20	4.0
Orange	1.44	0.08	0.04	0.28	64.0
Lemon	4.50	0.03	0.02	0.20	53.0
Apple	27.0	0.02	0.03	0.09	48.0
Kiwifruit	1.68	0.024	0.046	0.28	92.7
Cantaloupe	2.16	0.04	0.02	0.73	36.7
Pineapple	1.19	0.079	0.032	0.05	47.8
Beetroot	1.9	0.031	0.027	0.33	3.6
Flaxseed	-	0.97	0.75	3.08	0.6
Honey	0.19	5.50	6.10	0.12	2.4
Ginger	7.90	0.046	9.62	0.17	9.33
Wheat germ	0.062	2.20	0.60	7.80	ND
Banana	0.28	0.08	0.93	0.50	40.0
Skimmed milk	0.040	0.03	0.21	0.70	ND

Total carotene, thiamin, riboflavin, niacin and vitamin C contents of natural raw juice materials were evaluated and presented in Table 4. Comparing carotenes content of raw materials showed that carotenes were maximized in apple, carrot, ginger and cantaloupe, where they reached to 27, 8.33 and 7.9 mg/100 g, respectively. Also, comparing vitamin C content in natural raw juice materials indicated that, vitamin C was maximized in Kiwi fruit, orange and lemon, where they reached to 92.7, 64 and 53 mg/100 g, respectively. Table 4 showed that, vitamin B was maximized in honey (thiamine 5.5 mg/100 g), ginger (riboflavin 9.62 mg/100 g) and wheat germ (niacin 7.8 mg/100 g). These results were agreed with those reported by many previous studies[39,40].

Physical properties: The physicochemical characteristics of juice blends from the 5 formulas were summarized in Table 5. Total Soluble Solids (TSS) of all tested juice samples ranged between 13.7-17.1%. These values accepted with the standard TSS values of juice products which range between 10-20 brix. The pH values of juice blends ranged between

Table 5: Physicochemical properties of the prepared natural juice blends

Parameters	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	LSD at 0.05
Moisture (%)	79.82± 0.25[a]	78.86±0.34[a]	77.83±0.45[a]	77.61±0.32[b]	80.03±1.25[a]	2.422
Ash (%)	0.37±0.09[b]	0.28±0.01[c]	0.35±0.03[b]	0.42±0.05[a]	0.46±1.22[a]	0.051
Protein (%)	0.36±0.02[d]	0.60±0.04[c]	0.97±0.21[b]	1.14±0.18[a]	1.16±1.15[a]	0.092
Fat (%)	1.04±0.04[a]	1.08±0.05[a]	0.98±0.02[b]	0.03±0.005[d]	0.67±0.02[c]	0.082
Fiber (%)	1.44±0.65[b]	2.02±0.52[a]	0.64±0.33[c]	0.72±0.29[c]	0.55±1.83[d]	0.095
CHO	16.97±0.75[b]	17.16±0.77[b]	19.23±0.77[a]	20.08±0.82[a]	17.13±0.71[b]	1.552
pH	3.72±0.11[a]*	3.61±0.25[a]	3.22±0.30[a]	3.41±0.15[a]	3.18±2.01[a]	0.725
Acidity (%)	2.30±0.01[a]	2.21±0.0 1[a]	2.37±0.02[a]	1.90±0.01[b]	2.11±0.03[b]	0.251
TSS (%)	15.80±0.09[a]	16.10±0.11[a]	17.10±0.07[a]	13.70±0.08[b]	16.77±1.71[a]	1.625
TSS/Acidity	6.87±0.25[a]	7.29±0.36[a]	7.22±0.14[a]	7.21±0.29[a]	7.95±1.65[a]	1.421
TS (%)	18.18±0.19[a]	18.14±0.17[a]	14.17±0.15[c]	16.39±0.20[b]	16.10±2.11[b]	1.780
Viscosity (cP)	250.00±2.11[c]	210.00±1.56[d]	280.00±2.13[b]	300.00±3.05[a]	275.00±3.11[b]	7.658
Vitamin C (mg/100 g)	88.05±0.35[b]	19.50±0.55[e]	270.00±0.52[a]	45.45±0.65[c]	41.00±0.33[d]	2.441

Means within a row followed by the same letter(s) is not significantly different according to Duncan's multiple range test

Table 6: Total phenols and flavonoids contents and antioxidant activity of different formulas of juice blends

Parameters	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	LSD at 0.05
Total phenols (mg GAE/100 g)	89.33±2.85[a*]	51.92±1.42[d]	63.14±1.52[c]	76.61±2.13[b]	65.16±2.02[c]	5.352
Total flavonoids (mg CAT/100 g)	67.29±1.78[a]	47.84±1.22[c]	54.22±1.15[b]	64.02±1.46[a]	50.75±1.25[b]	4.552
Antioxidant activity						
ABTS (%)	83.50±2.17[a]	46.12±1.52[d]	55.13±1.65[c]	76.12±2.02[b]	47.25±1.66[d]	5.135
DPPH (%)	78.60±1.95[a]	40.17±1.11[e]	52.54±2.01[c]	71.37±2.15[b]	45. 54±1.77[d]	5.222
FRAP (%)	75.12±1.55[a]	42.61±1.09[d]	53.10±1.42[b]	73.13±1.18[a]	46.65±1.30[c]	3.821

Means within a row followed by the same letter(s) is not significantly different according to Duncan's multiple range test

3.18-3.72. Also, acidity (% as citric acid) and TSS/acidity ratio of all juice samples ranged between 1.90-2.37 and 6.87-7.95, respectively. These results are similar to that required for juice. The brix value and pH recorded for different juice blends are within the recommended ranges for juice to hinder microbial growth and maintain keeping the juice quality as stated[41]. Furthermore, all studied juice samples were accepted as a juice product where its viscosity ranged between 210-300 cp. Juice of different formulas was characterized by its high vitamin C and fiber contents which ranged between (19.50-270 mg/100 g) and (0.55-2.2%), respectively.

Total phenolics, total flavoinoids content and antioxidant activity of different natural juice blends: Antioxidant compounds (i.e., phenolics compounds) in food play a major role as a health protecting factor. Total phenols measured as Gallic Acid Equivalent (GAE) mg/100 g of juice and total flavonoids measured as catechen equivalent (mg CAT/100 g) were assayed in different juice blends. Table 6 showed that the highest total phenol contents (89.33 mg GAE/100 g) was found in formula 1, followed by formula 4 (76.61 mg GAE/100 g), formula 5 (65.16 mg GAE/100 g), formula 3 (63.14 mg GAE/100 g) and formula 2 (51.92 mg GAE/100 g), respectively. The same trend was observed in the total flavonoids contents in juice blends of different formulas, where they were 67.29, 64.02, 54.22, 50.75 and 47.84 mg CAT/100 g, in formulas 1, 4, 3, 5 and 2, respectively.

Free radical scavenging (DPPH) is one of the mechanisms for measuring the antioxidant activity. Table 6 shows the concentration of the compound required to scavenge DPPH radicals (%) in different formulas of juice blends. The DPPH radical values of formula 1 had the highest DPPH value (78.6%), while juice of formula 4, 3, 5 and 2 were remarkably lower as follows 71.36, 52.54, 45.54 and 40.17%, respectively. The obtained results agreed with those found by Wolfe *et al*.[42] who stated that citrus fibers have better quality due to the presence of associated bioactive compounds, such as flavonoids, poly phenols and carotenes.

Color quality: Color characteristic is one of the major parameters that affect the quality of the final product. Data in Table 7 represent color attributes of the five juices blends (formula 1-5). Color parameters of tested juice samples showed that formula 4 was darker than other tested juice samples, where it had the lowest lightness (L* = 10.27) and yellowness (b* = 9.55). While lightness (L*) value was maximized in formula 5 (68.67), then formula 1 (53.46) and slightly decreased in formula 3 and formula 2 to 49 and 38.25, respectively. The highest redness (a*) value was found in formula 4 (29.28) followed by formula 1 (21.11) and formula 2 (11.09). The highest yellowness value (b*) was also found in formula 1 (43.34) followed by formula 3 (31.17) and formula 2 (29.67).

Table 7: Hunter color parameters of different natural juice blends

Parameters	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	LSD at 0.05
L*	53.46±1.98[b*]	38.25±1.52[d]	49.000±1.17[c]	10.27±0.72[e]	68.67±1.65[a]	3.052
a*	21.11±1.12[b]	11.09±0.09[c]	1.290±0.03[e]	29.28±1.33[a]	3.91±0.08[d]	1.852
b*	43.34±1.88[a]	29.67±1.22[b]	31.170±1.42[b]	9.55±1.00[d]	27.18±1.17[c]	3.257
Saturation	48.21±1.96[a]	31.67±1.66[b]	31.200±1.36[b]	30.80±1.25[b]	27.46±1.15[c]	3.179
a/b	0.49±0.02[b]	0.37±0.02[c]	0.041±0.002[e]	3.07±0.05[a]	0.14±0.01[d]	0.072
Hue	87.29±2.33[a]	84.84±2.50[a]	52.220±2.02[c]	88.04±2.19[a]	75.65±2.55[b]	5.198
ΔE*	71.99±2.13[a]	49.66±1.99[c]	58.090±2.05[b]	32.47±1.65[d]	73.96±1.98[a]	4.378

Means within a row followed by the same letter(s) is not significantly different according to Duncan's multiple range test

Table 8: Sensory properties of different natural juice blends

Parameters	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	LSD at 0.05%
Color (10)	7.68±0.19[c]	9.55±0.21[a]	8.60±0.23[b]	8.40±0.19[b]	8.52±0.13[b]	0.75
Taste (10)	7.65±0.11[c]	9.60±0.14[a]	8.67±0.16[b]	8.50±0.15[b]	8.90±0.22[b]	0.83
Odor (10)	6.60±0.11[c]	9.15±0.15[a]	7.90±0.14[b]	7.82±0.11[b]	7.86±0.15[b]	1.09
Mouth feel (10)	6.32±0.12[c]	8.75±0.19[a]	7.35±0.13[b]	7.58±0.17[b]	7.65±0.21[b]	1.02
Appearance (10)	7.50±0.11[c]	9.62±0.16[a]	7.75±0.25[b]	7.65±0.32[b]	7.72±0.17[b]	0.96
Overall acceptability (10)	7.29±0.22[c]	9.50±0.15[a]	8.70±0.19[b]	8.20±0.09[b]	8.28±0.11[b]	1.11

Means within a row followed by the same letter(s) is not significantly different according to Duncan's multiple range test

Table 9: Effect of storage period on pH, titrable acidity and vitamin C content of different juice samples

Storage period	Formula 1	Formula 2	Formula 3	Formula 4	Formula 5	LSD at 0.05
Titrable acidity (%)						
0 days	2.30±0.02[a*]	2.21±0.01[b]	2.37±0.05[a]	1.90±0.01[c]	2.11±0.03[b]	0.1375
3 days	2.25±0.01[b]	2.23±0.01[b]	2.39±0.03[a]	1.96±0.01[d]	2.13±0.01[c]	0.1340
6 days	2.33±0.03[a]	2.24±0.03[b]	2.41±0.01[a]	1.99±0.02[c]	2.16±0.03[b]	0.1545
9 days	2.38±0.01[a]	2.30±0.02[a]	2.42±0.02[a]	2.09±0.01[b]	2.17±0.01[b]	0.1721
pH						
0 days	3.72±0.11[a]	3.61±0.25[a]	3.22±0.30[b]	3.41±0.15[a]	3.18±0.21[b]	0.480
3 days	3.70±0.01[a]	3.51±0.01[b]	3.18±0.06[c]	3.37±0.05[b]	3.16±0.02[c]	0.211
6 days	3.68±0.07[a]	3.47±0.05[a]	3.14±0.07[b]	3.22±0.09[b]	3.12±0.03[b]	0.323
9 days	3.65±0.04[a]	3.41±0.05[b]	3.11±0.07[c]	3.19±0.09[c]	3.11±0.05[c]	0.231
Vitamin C content (mg/100 g)						
0 days	88.05±0.35[b]	19.50±0.55[e]	270.00±0.52[a]	45.45±0.65[c]	41.00±0.33[d]	2.441
3 days	85.00±1.65[b]	17.00±1.25[e]	265.00±2.36[a]	43.00±0.11[c]	38.19±0.22[d]	4.805
6 days	80.00±3.12[b]	15.00±0.19[e]	260.00±2.17[a]	40.00±0.24[c]	35.72±0.19[d]	5.321
9 days	75.00±0.13[b]	13.00±0.27[e]	255.00±0.22[a]	37.00±0.15[c]	33.00±0.23[d]	3.516

Means within a row followed by the same letter(s) is not significantly different according to Duncan's multiple range test

Table 7 showed also that, mixing different raw materials caused a decrease in lightness (L*), redness (a*) and yellowness (b*) of all tested samples. This result could be due to the higher polyphenolic and flavonoid compounds and their antioxidant activities in raw materials as mentioned before.

Sensory properties: Sensory properties of juice has a great importance to evaluate consumer attitudes and their influence on food choice and acceptability. Therefore, juice samples of different formulas were evaluated sensorial and presented in Table 8. The obtained mean panel score and statistical analysis showed that, juice of formula 2 is characterized with its highest score in all the parameters (color, taste, odor, mouth feel, appearance and overall acceptability), followed by formula 3, 4 and 5. The least accepted one was formula 1.

Effect of storage period on pH, acidity and vitamin C content of different natural juice blends: Table 9 shows the effect of storage at refrigerated temperature for 9 days on the pH, acidity and vitamin C content in the five juice blends. During storage, pH was decreased significantly due to increase in titrable acidity as acidity[43]. Maximum pH reached to 3.72 in the formula 1. Ascorbic acid (vitamin C) was decreased also during storage in juice blends, probably could be due to the fact that ascorbic acid is sensitive to oxygen, light and heat. Maximum ascorbic acid (270 mg/100 mL juice) was recorded in lemon juice blended with kiwifruit and pineapples. These findings are in conformity with the study of Jain and Khurdiya[44] who reported that the Indian gooseberry juice contained the highest vitamin C (478.56 mg/100 mL juice). Mgaya Kilima *et al.*[45] reported that the roselle-fruit blends characterized with their high contents of vitamin C, anthocyanin and total phenol. These compounds were declined during storage at 28 and 4°C for 6 months. The loss of vitamin C and anthocyanin were more noticeable at 28°C. Therefore they recommended encouraging storage at 4°C when the products need to be stored for long time.

CONCLUSION

Formulations of the studied blends of fruit and vegetables juices are good source for calcium, magnesium, iron and antioxidant activity (vitamin C, flavonoids and total phenols). Therefore, consumption of such juices blends will protect human body from several diseases.

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REFERENCES

1. Jan, A. and E.D. Masih, 2012. Development and quality evaluation of pineapple juice blend with carrot and orange juice. Int. J. Scient. Res. Publ., 2: 1-8.
2. Rathnayaka, R.M.U.S.K., 2013. Antibacterial effect of malic acid against *Listeria monocytogenes*, *Salmonella enteritidis* and *Escherichia coli* in mango, pineapple and papaya juices. Am. J. Food Technol., 8: 74-82.
3. Aneja, K.R., R. Dhiman, N. K. Aggarwal, V. Kumar and M. Kaur, 2014. Microbes associated with freshly prepared juices of citrus and carrots. Int. J. Food Sci., 10.1155/2014/408085.
4. IFFJPU., 2011. Fruit juice nutrition and health-scientific review. International Federation of Fruit Juice Producers Union (IFFJPU).
5. De Carvalho, J.M., G.A. Maia, R.W. de Figueiredo, E.S. de Brito and S. Rodrigues, 2007. Development of a blended nonalcoholic beverage composed of coconut water and cashew apple juice containing caffeine. J. Food Qual., 30: 664-681.
6. Di Giacomo, G. and L. Taglieri, 2009. A new high-yield process for the industrial production of carrot juice. Food Bioprocess Technol., 2: 441-446.
7. Day, L., M. Xu, S.K. Oiseth, Y. Hemar and L. Lundin, 2010. Control of morphological and rheological properties of carrot cell wall particle dispersions through processing. Food Bioprocess Technol., 3: 928-934.
8. Filotheou, A., K. Nanou, E. Papaioannou, T. Roukas, P. Kotzekidou and M. Liakopoulou-Kyriakides, 2012. Application of response surface methodology to improve carotene production from synthetic medium by *Blakeslea trispora* in submerged fermentation. Food Bioprocess Technol., 5: 1189-1196.
9. Gardner, P.T., T.A.C. White, D.B. McPhail and G.G. Duthie, 2000. The relative contributions of vitamin C, carotenoids and phenolics to the antioxidant potential of fruit juices. Food Chem., 68: 471-474.
10. Kawaii, S., Y. Tomono, E. Katase, K. Ogawa and M. Yano *et al*., 2000. Quantitative study of flavonoids in leaves of *Citrus* plants. J. Agric. Food Chem., 48: 3865-3871.
11. Burt, S., 2004. Essential oils: Their antibacterial properties and potential applications in foods: A review. Int. J. Food Microbiol., 94: 223-253.
12. Ortuno, A., A. Baidez, P. Gomez, M.C. Arcas, A. Garcia-Lidon and J.A. Del Rio, 2006. *Citrus paradisi* and *Citrus sinensis* flavonoids: Their influence in the defence mechanism against *Penicillium digitatum*. Food Chem., 98: 351-358.
13. Clifford, T., G. Howatson, D.J. West and E.J. Stevenson, 2015. The potential benefits of red beetroot supplementation in health and disease. Nutrients, 7: 2801-2822.
14. Coles, L.T. and P.M. Clifton, 2012. Effect of beetroot juice on lowering blood pressure in free-living, disease-free adults: A randomized, placebo-controlled trial. Nutr. J., Vol. 11. 10.1186/1475-2891-11-106.
15. Zafeiridis, A., 2014. The effects of dietary nitrate (beetroot juice) supplementation on exercise performance: A review. Am. J. Sports Sci., 2: 97-110.
16. Pavan, R., S. Jain and A. Kumar, 2012. Properties and therapeutic application of bromelain: A review. Biotechnol. Res. Int., 10.1155/2012/976203
17. Chow, J., 2002. Probiotics and prebiotics: A brief overview. J. Renal Nutr., 12: 76-86.
18. White, J.W., 1979. Composition of Honey. In: Honey: A Comprehensive Survey, Crane, E. (Ed.). Heinemann, London, pp: 157-192.
19. Ali, B.H., G. Blunden, M.O. Tanira and A. Nemmar, 2008. Some phytochemical, pharmacological and toxicological properties of ginger (*Zingiber officinale* Roscoe): A review of recent research. Food Chem. Toxicol., 46: 409-420.
20. Onyeagba, R.A., O.C. Ugbogu, C.U. Okeke and O. Iroakasi, 2004. Studies on the antimicrobial effects of garlic (*Allium sativum* Linn), ginger (*Zingiber officinale* Roscoe) and lime (*Citrus aurantifolia* Linn). Afr. J. Biotechnol., 3: 552-554.
21. Brandolini, A. and A. Hidalgo, 2012. Wheat germ: Not only a by-product. Int. J. Food Sci. Nutr., 63: 71-74.
22. Ge, Y., Y. Ni, H. Yan, Y. Chen and T. Cai, 2002. Optimization of the supercritical fluid extraction of natural vitamin E from wheat germ using response surface methodology. J. Food Sci., 67: 239-243.
23. Zhu, K.X., H.M. Zhou and H.F. Qian, 2006. Proteins extracted from defatted wheat germ: Nutritional and structural properties. Cereal Chem., 83: 69-75.
24. Ostlund, Jr. R.E., S.B. Racette and W.F. Stenson, 2003. Inhibition of cholesterol absorption by phytosterol-replete wheat germ compared with phytosterol-depleted wheat germ. Am. J. Clin. Nutr., 77: 1385-1389.

25. Van Buul, V.J. and F.J.P.H. Brouns, 2014. Health effects of wheat lectins: A review. J. Cereal Sci., 59: 112-117.
26. Holmes, B., 2013. Go bananas. New Scientist, 218: 39-41.
27. AOAC., 1995. Official Methods of Analysis of the Association of Official Analytical Chemists. 15th Edn., Association of Official Analytical Chemists Inc., Arlington, Virginia, USA.
28. Ibarz, A., C. Gonzalez and S. Esplugas, 1994. Rheology of clarified fruit juices. III: Orange juices. J. Food Eng., 21: 485-494.
29. Sapers, G.M. and F.W. Douglas Jr., 1987. Measurement of enzymatic browning at cut surfaces and in juice of raw apple and pear fruits. J. Food Sci., 52: 1258-1285.
30. Singleton, V.L., R. Orthofer and R.M. Lamuela-Raventos, 1999. Analysis of total phenols and other oxidation substrates and antioxidants by means of Folin-Ciocalteu reagent. Methods Enzymol., 299: 152-178.
31. Lamaison, J.L., C. Petitjen-Freytet and A. Carnat, 1990. Rosmarinic acid, total hydroxyacinnamic derivative contents and antioxidant activity of medicinal Apiaceae, Borraginaceae and Lamiaceae. Ann. Pharma. Franc., 48: 103-108.
32. Grzegorczyk, I., A. Matkowski and H. Wysokinska, 2007. Antioxidant activity of extracts from *in vitro* cultures of *Salvia officinalis* L. Food Chem., 104: 536-541.
33. Matthaus, B., 2002. Antioxidant activity of extracts obtained from residues of different oilseeds. J. Agric. Food Chem., 50: 3444-3452.
34. Hussein, A.M.S. and N.A. Shedeed, 2011. Production of good quality drinks from some Egyptian berry fruits varieties. Model. Meas. Control, 72: 26-37.
35. Gopalan, C., B.V. Ramasastry and S.C. Balasubramanian, 1991. Nutritive Value of Indian Foods. National Institute of Nutrition, Hyderabad, pp: 47.
36. Holland, B., I.D. Unwin and D.H. Buss, 1991. Vegetables, Herbs and Spices: Fifth Supplements to McCance and Widdowssons. HMSO, London.
37. Shirin Adel, P.R. and J. Prakash, 2010. Chemical composition and antioxidant properties of ginger root (*Zingiber officinale*). J. Med. Plant Res., 4: 2674-2679.
38. Castenmiller, J.J. and C.E. West, 1998. Bioavailability and bioconversion of carotenoids. Ann. Rev. Nutr., 18: 19-38.
39. Nicolle, C., N. Cardinault, O. Aprikian, J. Busserolles and P. Grolier *et al*., 2003. Effect of carrot intake on cholesterol metabolism and on antioxidant status in cholesterol-fed rat. Eur. J. Nutr., 42: 254-261.
40. Hashimoto, T. and T. Nagayama, 2004. Chemical composition of ready to eat fresh carrot. J. Food Hyg. Soc. Japan, 39: 324-328.
41. Aina, J.O. and A.A. Adesina, 1999. Suitability of frozen indigenous tropical fruits for jam processing. Adv. Food Sci., 21: 15-18.
42. Wolfe, K., X. Wu and R.H. Liu, 2003. Antioxidant activity of apple peels. J. Agric. Food Chem., 51: 609-614.
43. Bhardwaj, R.L. and S. Pandey, 2011. Juice blends-a way of utilization of under-utilized fruits, vegetables and spices: A review. Crit. Rev. Food Sci. Nutr., 51: 563-570.
44. Jain, S.K. and D.S. Khurdiya, 2009. Ascorbic acid content and non-enzymatic browning in stored Indian gooseberry juice as affected by sulphitation and storage. J. Food Sci. Technol., 46: 500-501.
45. Mgaya Kilima, B., S.F. Remberg, B.E. Chove and T. Wicklund, 2015. Physiochemical and antioxidant properties of roselle mango juice blends; effects of packaging material, storage temperature and time. Food Sci. Nutr., 3: 100-109.