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Change in colour and physicochemical quality of carrot juice mixed with other fruits

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Abstract

The aim of the study was to determine the changes in physico-chemical parameters (vitamin C, total phenolic compounds and antioxidant capacity) of the carrot juice samples in mixed juices of apple, banana and peach.

The total phenolic content was measured by Folin-Ciocalteu reagent assay while the Vitamin C was determined using 2,6-dichlorophenolindophenol titration.

Carrot juice, apple, banana, peach and mixed juices were prepared in different proportions.

The colour changing from the different juice samples was measured by lightness values (L*), redness values (a*) and yellowness (b*) values. The result indicated the change in Hunter parameters, L* and b*.

The vitamin C values have varied from 30.3 mg/100 g for peaches to 3.1mg/100g for carrots, respectively. The total phenolic content ranged from 438.8±6.05 mg GAE/ 100 g, for apples and 65.2±0.85 mg GAE/ 100 g for carrots.

The overall study indicated that colour is an important parameter to optimize carrot juice samples in mixed juices of apple, banana and peach.

Keywords: carrot juice, polyphenol, physico-chemical parameters, colour.

1. Introduction

The health benefits associated with drinking juice fruits on a daily basis are related to the ingestion of bioactive components such as essential vitamins, minerals and polyphenolic compounds. According to Nicoli 1999, an epidemiological study indicates that diets rich in fruits and vegetables are associated with a lower risk of several degenerative diseases [1].

There are many varieties of apples, Florina are the most well-known apples in the region of Suceava. Apples (*Malus domestica*) are among the most important sources of polyphenolic antioxidants, which are present in this fruit as flavonols (predominantly quercetin), flavanols and their oligomers and polymers [2].

Furthermore, natural compounds in fruits and vegetables such as polyphenols, flavonoids and tannins have shown very promising results in combating bacteria, fungus and viral infections [3]. According to the Harmanescu M.,et all., 2006 who studied the total content of polyphenols in commercial fruit juices, the highest total polyphenol content was identified for turbid apple juice and the lower content in polyphenols was identified for apple clear juice [4].

Carrots *(Daucus carota)* are major vegetables in diets worldwide mainly due to their pleasant flavor and perceived health benefits (it is good for eye disorders, skin care, nervous disorders, indigestion), which have been associated with their vitamin, mineral and dietary fiber content.

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Carrot juice is rich in vitamin A, beta-carotene, minerals such calcium, potassium, and it is easier to digest than raw or cooked vegetables only.

The specific objectives of this study were to examine the changes in physicochemical quality attributes of simple and mixed juices.

Properties such as content of vitamin C, acidity, colour, proximate analysis, total soluble solids (TSS) content, pH, total acidity, the total polyphenolic content and the colour of carrot juice mixed with different levels of apple juice, peach juice and banana juice, were determined to compare the best quality between eight different juices..

2. Materials and Methods

*2.1. Plant material:*Mature fruit samples of apple (*Mallus pumilla),* peach *(Prinus persica),* banana *(Musa acuminate)* and carrot (*Daucus carota*), approximately 1 kg each were purchased from a local market in May 2012.

They were peeled, destined, and sliced prior to juicing in a robot type fruit squeezer. Carrot, apple, peach and banana juices were prepared fresh and the juices were mixed in different proportions. Each type of juice sample was stored in previously labeled plastic containers at 4°C.

*2.2. Chemicals:*All chemicals used for experiments were of analytical grade and procured from Sigma Merck, Aldrich and Fluka. Deionizer water was used. Absorption determination for total polyphenols content was made using UV–VIS spectrophotometer.

2.3. Chemical analyses: The determination of moisture in fruits was effectuated according to the European Standard EN ISO 665/2000 by the drying process in a drying chamber at the temperature of 103 °C.

Vitamin C in sample fruits and juices was determined using 2, 6-dichlorophenolindophenol titration. The vitamin C contents of fruit juices were reported as mg/100 ml.

pH is a measure of the acidity or basicity of a solution. It is defined as the co logarithm of the activity of dissolved hydrogen ions (H+). The pH of the juices was evaluated using a digital pH meter at 27ºC.

Total polyphenol content was determined using the Folin Ciocalteu method [5]. The fruit juice aliquot (0.2 mL) was added to 1.5 mL of freshly prepared Folin Ciocalteu reagent (1:10, v/v, with water). The mixture was allowed to equilibrate for 5 min and then mixed with 1.5 mL of 60 g/L sodium carbonate solution. After incubation at room temperature for 120 min, the absorbance of the mixture was read at 760 nm using the respective solvent as blank. The results were expressed as mg of gallic acid equivalents (mg GAE). The correlation coefficient (r^2) for the calibration curve was 0.9954.

Total soluble solids (TSS) and ***the refractive index*** were assayed using the refractometric method, with an Abbe refractometer and corrected to the equivalent reading at 20^0C (AOAC, 1995).

Acidity was determined by titrating samples with 0.01M NaOH solution up to pH 8.2, and was expressed as malic acid per 100 g juices [6].

Density was determined using the picnometry method, as described by Solange Vandresen et al., 2009, the juice was placed into a calibrated picnometer and the density was calculated by dividing the measured mass by the known volume [6]

Water activity of juice fruits was evaluated with the device Aqua Lab.

2.4. Colour evaluation: The colour of the juice was determined using a reflectance colorimeter based on the L^*, a^* and b^* values [7].

The colour parameters corresponding to the uniform color space CIELAB were obtained directly from the apparatus. Within the uniform space CIELAB, two color coordinates, a* and b*, as well as a psychometric index of lightness, L*, are defined. In this system, a* takes positive values for reddish colours and negative values for greenish ones, whereas b* takes positive values for yellowish colours and negative values for bluish ones. L* is an approximate measurement of luminosity, which is the property according to which each colour can be considered as equivalent to a member of the grey scale, between black and white, taking values within the range of 0-100 Chroma (C*) is the attribute that allows the determination of the degree of difference to be determined in comparison with a grey color with the same lightness for each hue, so it is considered to be the quantitative attribute of colorfulness.

Hue angle (H*) is the attribute according to which colours have been traditionally defined as reddish, greenish, etc. [8].

For all experiments, the previously described mixtures containing carrot juice were used in the colour evolution assays, using the measurements at time 0 as standard. This 0 time corresponded to the first measurement, which was made 1 min after the apple had been juiced and the other juices mixed.

Before each use, the instrument was standardized to a white tile of known L, a, and b values.

Each value is the mean of three (n= 3) independent determinations.

2.4. Statistical analysis: Four different carrot fruit juice blends (apple: 50 carrot: 50; apple: 70 carrot: 30; apple: 30 carrot: 50 peach: 20 and apple: 30 carrot: 50 banana: 20, v/v) were used with a factorial experiment design for statistical analysis and for sample juices and three sample replicates.

Student's test was used for the statistical evaluation and the results (n = 3) are expressed as mean ± STD, $P < 0.05$ was considered as significant.

3. Results and discussion

3.1. Physico-chemical indicators of fruits: Table 1 shows the values obtained for physico-chemical characteristics of fruit used to obtain fruit juices.

The result shows that the moisture content varies between 68.15± 0.96 % from banana and 78.1± 0.78% from Florina, however, acquired results are very similar to the scientific literature found data.

Water migration phenomena and the resulting moisture content change in food products affect their shelf-life through undesirable modifications of their physical, sensory and microbial qualities [9].

The highest vitamin C values were identified for peaches 30.3 mg/100 g and the lower vitamin C values were obtained for carrots 3.1mg/100g respectively. The acid ascorbic content in *Jonathan* variety samples after 16 weeks of storage at 8°C was 1.98, the ascorbic acid content has decreased by 82.1%, compared to the blank (week 0), [10]. The content of vitamin C decreases with fruit maturation, having a maximum value at the beginning of preripening phenophase and a minimum value in full ripening [11].

The polyphenol content increases with fruit maturation for apple Florina, having a maximum value in full ripening [11].

Apple total phenolic content was 438.8±-6.05 (GAE)/ 100 g. These results are in the range of values found by J. Lachman et al., 2006 [12].

The experimental results for the carrot total phenolic content were *65.2*±0.85 (GAE)/ 100 g. The same behaviour was found by E.M. Goncalves et al., 2010 [13].

The average total soluble solid (TSS) ranges between 7.9±0.5 ^{o}brix for carrots and 12.2±1.5 ^{o}brix for banana.

The acidity of the fruits varies between 0.13 mg/100g from carrots and 0.24 mg/100g from apples.

3.2. Physico-chemical indicators of juice fruits: In the fruit juice beverages tested, the ascorbic acid content ranged from 5.54 in carrot juices, to 48.5.9 mg/100 ml in apple-carrot-banana ratio (30:50:20, v/v), (table 2).

Table 2 shows that the pH values of carrot juice (5.98) were higher than apple juice (3.11). A lower pH fruit juices indicates a more sour juice with high acidity. It can be concluded that the apple juice is less sour than carrot juice.

According to Rosnah *et al*. (2006), pH is related to the acidic taste of juice [14]. The pH value of apple juice mixed with different levels of carrot juice, peach juice and banana juice increased with the decrease of titratable acidity.

The minimum decrease (7.14 %) in acidity was showed in apple juice blended with carrot and banana juice S8.

pH, Acidity, a_w, TSS and density of the four blends were slightly different due to different apple-carrot juice ratios or apple-carrot, peach, banana juice (*Table 2*).

TSS of juice blends with higher apple-carrot ratio (70:30, v/v) was higher than that of juice blends of lower apple-carrot ratio of 50:50 and 30:50:20. All juice blends demonstrated the same pattern of increasing pH, decreasing acidity and decreasing TSS compared to apple juice.

Total polyphenol content of different juice blends (apple-carrot ratio of 50:50, 70:30 and 30:50:20 apple-carrot-peach or banana, v/v) varied from

110.3±10.5 to 75.2±3.21 mg GAE/100ml juice (Table 2).

Therefore, apple - carrot juice polyphenol can serve as a potential food antioxidant.

The results were compared with those obtained by other researchers and in the same orchard by Jingfei Gao et al. (2012) [7] who examined the effects of ultrasound treatment on the changes in physicochemical quality attributes, of carrot juice acidified with three different levels of apple juice, some differences can be observed namely pH, TSS (higher in the present work).

It was observed that the maximum refraction index (1.369) was recorded in the peach juice.

The physico-chemical results for untreated juice carrots are in agreement with Vandresen S. et al. (2009) [6], who evaluated the rheological behavior of untreated and pasteurized carrot juices and the influence of temperature on their physico-chemical properties.

Table 1. Physico-chemical indicators of fruit

Botanical name	**Common name**	**Moisture (g/100 g)1**	**Vit C mg/100 g**	**Acidity mg/100g**	**TP (mg GAE/100g)**	**TSS %**
Daucus carota	carrots	82.3± 0.6	3.1±0.57	0.13±0.07	65.2±0.85	8.1±0.17
Mallus pumilla	Florina	78.1± 0.78	25.8±8.87	0.24±0.09	438.8±6.05	11.9±0.7
Musa acuminata	banana	68.15± 0.96	12.21±0.81	0.22±0.07	52.21± 0.6	12.2±1.5
Prinus persica	peaches	74.13± 0.86	30.3±0.65	0.20±0.08	71.52±0.71	11.6±1.1

TP =Total Polyphenol content (mg GAE/100 g)
TSS=Total soluble solids %

Table 2. Physico-chemical parameters of natural fresh juice (with pulp) samples (average ± STD)

	Samples	***Vit C mg/100 ml***	***pH***	***TP (mg GAE/100ml)***	***TSS %***	***RI***	***Acidity (mg malic acid/100ml)***	***Density (gcm^{-3})***	***a_w***
S1	carrot	5.54±0.54	5.98±0.01	325.2±5.17	7.31	1.3516	0.10±0.01	1.025±0.001	0.940
S2	Apple	18.08±0.62	3.11±0.01	352.6±8.87	12.9	1.3254	0.14±0.01	1.016±0.001	0.945
S3	peach	33.38±0.72	4.1±0.03	52.35±2.67	9.73	1.369	0.11±0.01	1.021±0.001	0.940
S4	banana	3.24±0.99	4.86±0.03	112.21±3.07	10.02	1.3521	0.10±0.01	1.022±0.001	0.942
S5	Mixture carrot: 50 apple: 50	15.98±0.90	4.72±0.03	110.3±10.5	10.09	1.343	0.11±0.01	1.022±0.001	0.940
S6	Mixture carrot: 30 apple: 70	21.07±0.67	3.69±0.03	158.3±10.5	10.57	1.335	0.12±0.01	1.022±0.001	0.940
S7	Mixture carrot: 50 apple: 30 peach: 20	42.1±0.31	4.10±0.01	110.3±10.5	10.43	1.312	0.12±0.01	1.025±0.001	0.940
S8	Mixture carrot: 50 apple: 30 banana:20	48.5±0.62	5.15±0.01	95.2±3.21	10.21	1.323	0.13±0.01	1.026±0.001	0.945

TP =Total Polyphenol content (mg GAE/100 ml)
TSS=Total soluble solids %;RI = Refraction index (at 20ºC)

Table 3. Pearson correlation of physicochemical parameters of juice samples

	Vit C	*pH*	*TP*	*TSS %*	*RI*	*Acidity*	*Density*	*a_w*
Vit C	1							
pH	-0.204	1						
TP	-0.488	-0.04	1					
TSS %	0.233	-0.871**	0.081	1				
RI	-0.487	0.295	-0.151	-0.495	1			
Acidity	0.544	-0.646	0.233	0.803*	-0.702	1		
Density	0.343	0.737*	0.395	-0.702	-0.134	-0.381	1	
a_w	0.22	-0.178	0.276	0.569	-0.407	0.694	-0.289	1

Table4. Quality parameters of juice

	Samples	*Colour*				
		L^*	a^*	b^*	H^*	C^*
S1	Apple	63.69±2.48	6.24±0.75	19.78± 1.58	-46.25±2.05	20.7±1.85
S2	carrot	54.6±2.31	11.76±1.31	35.70 ± 2.58	-50.36±2.23	18.66±2.02
S3	peach	55.6±2.02	6.51 ± 0.31	54.03 ± 2.12	83.12 ± 2.25	54.42 ± 2.31
S4	banana	78.2±1.31	7.25±0.85	27.85± 1.38	-48.79±2.18	21.7±2.11
S5	Mixture apple: 50 carrot: 50	51.21±2.42	15.26±1.21	30.21± 2.68	-40.15±2.21	25.6±2.16
S6	Mixture apple: 70 carrot: 30	57.02±2.28	13.54±1.54	28.51± 1.98	-42.13±2.15	27.92±2.64
S7	Mixture apple: 30 carrot: 50 peach: 20	53.96±2.07	10.76±1.21	12.1667±1.45	-47.6±1.95	16.26±2.01
S8	Mixture apple: 30 carrot: 50 banana:20	56.83±2.36	10.7±0.98	15.0±1.25	54.63±2.31	18.46±2.14

Table 3 shows the correlation matrix obtained for each pair of variables. The highest negative correlation has been observed in the case of total soluble solids with pH (r=-0.871), followed by acidity with total soluble solids (r=-0.803), while the highest positively correlation has been observed in the case of density with pH (r = 0.737). The rest of the correlation is negligible.

Table 4 describes the parameter changes in colour according to the different proportions in which they were blended in the fruit juices studied.

The L*, a*, b* and H values were used to characterize the colour changes in carrot, juice blends with different levels of apple juice, peach juice and banana juice.

Colour did not change significantly in relation to the ratio of mixed juices (Table 4). Another colour parameter studied was the lightness, L*, which is a colorimetric parameter extensively used to characterize the variation of colors in foods during processing. In contrast, an increase slightly in red green value (a*) and a decrease in lightness (L*) and blue yellow value (b*) was observed in apple juice blends with carrots, peach and banana compared with the apple juice.

These data indicated that there was more red than green in the final colour for the other juice samples.

4. Conclusion

This work confirms the existence of important differences between carrot juice acidified with different levels of apple juice, peach juice and banana juice, regarding vitamin C and total phenolic contents.

When the ratio of carrot-banana-apple-carrot juice was 50:30:20, the juice TP (95.2) was lower, and the pH (5.15) was highest. The juice blend of the lower carrot-apple ratio (30:70) had the highest TP (158.3) and TSS (10.57), and lower pH (3.69) compared to the other blends with the highest amount of carrot juice.

Higher amounts of these nutritionally important compounds were observed in juice blends of apple-carrot-peach or banana ratio 30:50:20, v/v.

Compliance with Ethics Requirements

Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human and/or animal subjects (if exists) respect the specific regulations and standards.

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