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Characterisation of peach juices obtained from cultivars Redhaven, Suncrest and Maria Marta grown in Italy

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Abstract

The compositions of three peach juices obtained from the cultivars Redhaven, Suncrest and Maria Marta, respectively, were studied. The fruits were grown in the Emilia-Romagna region (Italy). The juices were characterised by pH, CIE L^*, a^*, b^* colour values, soluble solids, individual carbohydrates, organic acids, and phenolic compounds. Univariate analysis disclosed some significant differences among the compositions of the varietal peach juices. Principal component revealed clear group structures in the data matrix, the most relevant variables being glucose, fructose, sorbitol, malic acid, L^* and b^*-values. Suncrest peach juice was clearly distinguished from Redhaven and Maria Marta juices.

Keywords: Organic acids; Peach juice composition; Phenols; *Prunus persica*; Sugar; Statistical analysis

1. Introduction

The general concern about the use of additives in food processing has stimulated great attention on the marketing of foods with natural ingredients, including functional and health-related food products (Clydesdale, Kolasa, & Ikeda, 1994; Raj & Clancy, 1995). Varietal fruit juices with a high content of bioactive compounds may represent speciality products. Bioactive substances of food origin can be defined as food components which may exert regulative activities in the human organism, irrespective of their potential nutritive functions.

Carbohydrates, organic acids and phenolic compounds are among the major constituent of peach juice (Chapman, Horvat, & Forbus, 1991; Fernández de Simón, Pérez-Ilzarbe, Hernández, Gómez-Corovés, & Estrella, 1992; Joshi & Bhutani, 1995; Macheix, Fleuriet, & Billot, 1990; Wang, Gonzalez, Gbur, & Aselase, 1993). These compounds are useful to monitor the quality of peach fruits during ripening (Chapman & Horvat, 1990; Moing et al., 1998; Wang et al., 1993) and they contribute to the nutritional quality of both fresh fruits and juices (Esti et al., 1997; Meredith, Robertson, & Horvat, 1989; Robertson, Meredith, & Scorza, 1988; Southgate, Johnson, & Fenwick, 1992; Wills, Scriven, & Greenfield, 1983). In particular, fruits contain sugars, such as fructose, glucose and sucrose, which are the main source of energy. The level of human blood glucose depends on the type of sugar consumed, being highest for glucose, followed by sucrose and fructose (Miller, Colagiuri, & Brand, 1986). Information regarding the content of individual sugars in fruits would help dieticians to plan diets for diabetics. Moreover, fructose has been reported to be 1.8 times sweeter than sucrose (Doty, 1976), while glucose is reported to be less sweet than sucrose (Pangborn, 1963). On the other hand, malic and citric acids are correlated with the sensory perception of sourness (Esti et al., 1997). Some phenolic compounds may have potential health benefits due to their antioxidant properties (Johnson, Williamson, & Musk, 1994; Rice-Evans, Miller, & Paganga, 1996). In addition, there is a close relationship between the browning potential of peach fruits and their phenolic composition (Cheng & Crisosto, 1995; Lee, Kagan, Jaworski, & Brown, 1990). Carbohydrates, organic acids and phenolic compounds are also useful markers for evaluating the conditions of fruit processing and

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storage (Bengoechea et al., 1997; Lee et al., 1990; Rodíguez, Villanueva, & Tenorio, 1999) and the authenticity of fruit juices (Corradini, Cristalli, & Corradini, 1994; Elkins & Heuser, 1988; Pilando & Wrolstad, 1992). It is well known that varietal, geographical, seasonal, and maturity differences, as well as processing conditions, greatly affect the composition of both fruits and juices.

The main area of peach production in Italy is the Emilia-Romagna region, which accounted for up to 38% of the national fruit production in 1994 (Regione Emilia-Romagna, 1998). Moreover, the major fruit processing companies are located in this region as well. While information on the peach fruits grown in Italy is available, knowledge of peach juice composition, in terms of individual sugars, organic acids and phenolic compounds, is limited.

The objective of this work was to study the physico-chemical properties of three peach juices obtained from cultivars (Redhaven, Suncrest and Maria Marta) grown in the Emilia-Romagna region. This work focused on peach due to the economic interest of its juice in Italy.

2. Material and methods

2.1. Samples

Fruits of one mid-season (Redhaven), and two late-maturing (Suncrest and Maria Marta) peach cultivars (*Prunus persica* L. Batsch) were obtained from APOFRUIT (Cesena, FC, Italy). The first two cultivars are widely popular, while Maria Marta has recently been introduced. For each cultivar, three batches of 20 fruits, with the same diameter, were random sampled at commercial ripeness and processed in three replicates. The juice extraction was carried out in the laboratory under a flow of CO_2 to prevent oxidation. The fruits were processed by a juice extractor (Ovatio 3, Moulinex, Paris, France) into mash, then homogenised using a domestic blender (mod. 1738, Braun, Kronberg; Germany) and centrifuged at 1500 ***g*** for 15 min at +4 °C (mod. 4239R, ALC International, Milano, Italy) to collect the supernatant. The juices were stored at −18 °C before being analysed in duplicate.

2.2. Analytical determinations

The firmness of peach fruits was measured using a fruit pressure tester mod. FT327 (Facchini FG, Alfonsine, RA, Italy), while the juices were characterised by the following parameters: pH, CIE L^*, a^* b^* colour parameters, soluble solids (digital refractometer PR-101, Atago, Tokyo, Japan), total polyphenols by spectrophotometry (Somers & Verette, 1988). Individual carbohydrates and organic acids (Castellari, Versari, Spinabelli, Galassi, & Amati, 2000) and phenolic compounds (Castellari, Spinabelli, & Amati, 2000) were analysed by HPLC, as previously described. The colour of peach juices was measured by a chromameter CR-300 (Minolta, Ramsey, NJ), using the reflectance mode with 2° observer angle. Samples were measured against a white ceramic reference plate ($L^*=97.43$, $a^*=-0.13$, $b^*=+1.68$). Values of the L^* (brightness or lightness: 0 = black, 100 = white), a^* ($-a^*$ = greenness, $+a^*$ = redness), and b^* ($-b^*$ = blueness, $+b^*$ = yellowness) colour coordinates (CIE, 1986) were recorded.

2.3. Statistical analysis

The range, mean and standard deviation (mean ±S.D.) were determined. Analysis of variance (ANOVA) and mean comparisons by Least Significant Difference test at 5% level were performed using Statistica 5.1 (StatSoft™, Tulsa, OK). Parameters which violated the assumption of ANOVA were evaluated by the non-parametric Kruskel–Wallis *H* test and reported as range (min–max). To gain insight of the data structure, a multivariate analysis was performed. Principal Component Analysis, a pure display method, reduced the number of variables in the data matrix and selected the most discriminating parameters (Lewi, 1992).

3. Results and discussion

3.1. Fruit juice composition

The composition of peach juices showed significant differences among cultivars in terms of glucose, fructose, sorbitol, citric and malic acids, pH, L^*, a^*, catechin, isoquercetin, caffeic and chlorogenic acid content (Table 1). The three major sugars in peach juices were sucrose, fructose and glucose. High levels of natural sugars might obviate the necessity of adding sugars during fruit processing. Each variety showed a typical glucose content, this being lowest in Maria Marta juice. On the other hand, the Suncrest had significantly high glucose, fructose, sorbitol, malic acid and a^* values, with low citric acid and L^* values. Instead, the Redhaven showed high citric, chlorogenic acid and isoquercetin contents.

The malic/citric acids ratio of Suncrest juice was different from the other two cultivars. According to the literature (Moing et al., 1998) three hypotheses can be drawn to explain this result; they concern malate and citrate synthesis, catabolism and compartmentation. Chapman and Horvat (1990) and Meredith et al. (1989) agreed that malic acid increases while citric acid decreases during ripening. Low values for quinic and succinic acids were recorded for all juices.

No significant differences among cultivars were found for °Brix and total sugars, the two commonly used method to evaluate the quality of fruits and juices. This emphasises the importance of individual sugars, citric and malic acids as quality markers. The contribution of total sugars to total soluble solids (°Brix) was minimum for the cultivar Maria Marta. This was probably due to the presence of undetected polyhydroxylated compounds.

The compositions of peach juices obtained from Redhaven and Suncrest were consistent with information from the literature (Bengoechea et al., 1997; Byrne, Nikolic, & Burns, 1991; Fernández de Simón et al., 1992; Lee et al., 1990; Wills et al., 1983). As far as we know, compositional data on the peach juice from cultivar Maria Marta are provided for the first time.

In this study, fructose, quinic acid, pH value, total polyphenols, catechin and caffeic acid showed an asymmetrical distribution in the analysed peach juices. These findings confirmed that non-Gaussian distribution of fruit juice parameters may occur (Martin & Martin, 1996).

3.2. Principal components analysis

PCA was applied to the data for detecting the most important factors of variability and to describe the relationship between variables and observations. The interdependence of the variables was investigated by the analysis of correlation (Table 2). Sixteen pairs of variables were highly correlated, the greatest correlation being between fructose and glucose ($r = 0.96$), as well as CIE L^* and b^*-values ($r = 0.90$). Moreover, L^* and b^*-values showed a good correlation with fruit firmness. However, a lack of relationship between the colour of fruits and sugars and/or acid contents occurred. Kader, Heintz, and Chordas (1982) found that the a^*-value is a reliable measure of peach fruit maturity. According to Génard, Souty, Holmes, Reich, and Breuils (1994), the colour parameters are highly correlated only to each other; thus, the peach colour cannot easily be used to predict other parameter of quality at harvest.

PCA generated a reduced set of variables that accounted for most of the variability in the original data. The VARIMAX normalised procedure for eigenvector rotation resulted in five principal components (PCs) with eigenvalues $\geqslant 1$ ($PC_1 = 4.7$, $PC_2 = 2.7$, $PC_3 = 2.3$, $PC_4 = 1.5$ and $PC_5 = 1.3$, respectively), which explained up to 78% of the total variance. Thus, the dimensionality of data was reduced from 16 partially correlated variables to five uncorrelated PCs with almost 22% loss of variation. The statistical weights of variables were different (Table 3).

PCA was then used, as an unsupervised method, to examine the similarity among varietal peach juices. Each sample was plotted using the first and second PC factors, which retained 46% of the total variance (Fig. 1). A clustering of varietal peach juices partially

Table 1
Composition of varietal peach juices and significance level for statistical evaluation

Parameter	Peach cultivar[c]			P-level[d]
	Redhaven	Suncrest	Maria Marta	
Sucrose (g kg^{-1})[a]	73±4.8	67±6.7	69±8.4	n.s.
Glucose (g kg^{-1})[a]	10±1.4 B	12±1.4 C	8±1.1 A	***
Fructose (g kg^{-1})[b]	10–15	12–17	9–11	***
Sorbitol (g kg^{-1})[a]	3.1±0.9 A	4.8±1.4 B	2.7±0.9 A	***
Total sugars (g kg^{-1})[a]	98–8.2	98±6.8	90±9.0	n.s.
°Brix[a]	12±0.8	13±1.7	13±1.7	n.s.
Citric acid (g kg^{-1})[a]	3.7±0.8 B	2.5±0.8 A	3.7±0.8 B	***
Malic acid (g kg^{-1})[a]	3.6±0.8	5.4±1.4	3.7±1.2	***
Quinic acid (g kg^{-1})[b]	1.4–2.5	0.1–2.4	1.0–2.7	n.s.
Succinic acid (g kg^{-1})[a]	0.4±0.2	0.3±0.2	0.4±0.1	n.s.
pH[b]	3.3–3.6	3.3–3.4	3.3–3.6	***
L^*[a]	46±3.8 B	42±2.3 A	46±3.2 B	***
a^*[b]	−0.9–1.7	2.9–4.7	−0.3–4.0	***
b^*[a]	27±3.7	25±1.7	28±4.0	n.s.
Firmness (kg cm^{-2})[a]	3.4±1.3	4.0±1.3	3.0±1.0	n.s.
TPP-UV (mg kg^{-1})[a]	735±57	754±75	688±166	n.s.
TPP-FOL (mg kg^{-1})[b]	733–1036	757–1040	316–1490	n.s.
Catechin (mg kg^{-1})[b]	20–34	20–25	20–32	***
Chlorogenic acid (mg kg^{-1})[a]	19±6.8 B	13±2.9 A	12±7.4 A	***
Caffeic acid (mg kg^{-1})[b]	1.3–1.8	1.0–1.8	0.5–1.5	***
Isoquercetin (mg kg^{-1})[a]	7.1±1.1 B	5.2±1.4 A	6.0±1.1 A	***

[a] Mean±S.D. Group comparisons by means of parametric LSD test (d.f. $_{2,\ 24}$).
[b] Min–max. Group comparisons by means of non-parametric Kruskal–Wallis H test (d.f. $_{2,\ 27}$).
[c] A–C means within rows with changed letter are significantly different according to the LSD test ($P \leqslant 0.05$).
[d] NS, non-significant at $P \leqslant 0.01$. ***, Significant at $P \leqslant 0.01$.

Table 2
Correlation matrix of peach juice variables. Absolute linear correlation ⩾|0.50| are marked in bold

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Sucrose	1.00															
2. Glucose	−0.15	1.00														
3. Fructose	−0.09	**0.96**	1.00													
4. Sorbitol	0.16	**0.71**	**0.80**	1.00												
5. °Brix	0.19	−0.20	−0.12	0.24	1.00											
6. Total sugars	**0.77**	**0.51**	**0.56**	**0.67**	0.10	1.00										
7. Citric acid	0.13	−0.22	−0.22	−0.26	−0.19	−0.04	1.00									
8. Malic acid	−0.01	**0.50**	0.49	**0.62**	0.08	0.34	−0.26	1.00								
9. Succinic acid	0.13	−0.30	−0.27	−0.38	−0.01	−0.09	0.39	−0.41	1.00							
10. *L**	0.35	−0.40	−0.38	−0.31	0.12	0.02	−0.04	−0.30	0.08	1.00						
11. *a**	−0.03	0.31	0.38	**0.57**	0.17	0.24	**−0.50**	0.46	−0.29	**−0.50**	1.00					
12. *b**	0.23	−0.37	−0.30	−0.20	0.11	−0.03	−0.13	−0.16	0.04	0.90	−0.27	1.00				
13. Firmness	−0.27	0.29	0.32	0.20	0.01	−0.02	0.09	0.16	0.17	**−0.71**	0.23	**−0.65**	1.00			
14. TPP−UV	−0.08	0.30	0.32	0.22	0.28	0.12	−0.06	0.01	0.00	0.03	−0.17	−0.17	0.03	1.00		
15. Chlorogenic acid	0.18	0.17	0.07	−0.11	−0.01	0.19	0.23	−0.09	0.19	0.02	**−0.53**	−0.25	−0.09	0.47	1.00	
16. Isoquercetine	0.32	−0.18	−0.14	−0.10	0.17	0.15	0.03	−0.31	0.31	0.34	−0.36	0.32	−0.04	0.13	0.25	1.00

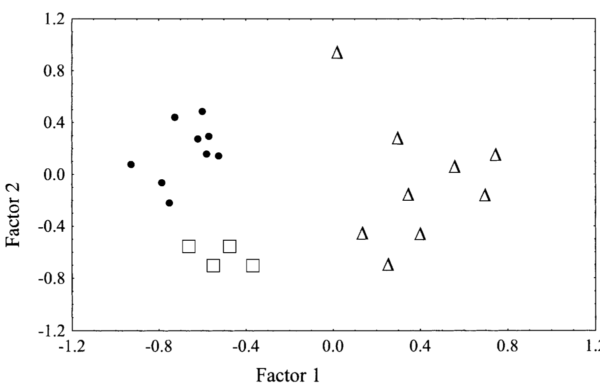

Fig. 1. Positions of principal components (PC) scores on the first two PC axes for the peach juices of the cultivars Redhaven (Δ), Suncrest (●), and Maria Marta (□).

occurred. In fact, Suncrest peach juices grouped along the first factor (negative half), while there was a lack of distinction between juices from Redhaven and Maria Marta. The Suncrest juices were separated on the PC_1 axis because of their high glucose, fructose, sorbitol and malic acid contents while their dispersion along the PC_2 axis was a function of the low L^* and b^*-values and high firmness.

Table 3
Variables selected with factor loadings and explained variance (%) for the first five eigenvectors after Varimax rotation (bold loadings are ⩾|0.70|)

Parameter	Factor 1 (29.6%)	Factor 2 (16.9%)	Factor 3 (14.4%)	Factor 4 (9.2%)	Factor 5 (8.3%)
Sucrose	0.006	−0.251	−0.028	**0.906**	0.058
Glucose	**−0.856**	0.273	0.258	0.011	−0.184
Fructose	**−0.862**	0.270	0.209	0.091	−0.085
Sorbitol	**−0.839**	0.194	−0.045	0.291	0.234
°Brix	0.044	−0.006	0.051	0.152	**0.886**
Total sugars	−0.564	−0.016	0.088	**0.805**	0.003
Citric acid	0.452	0.230	0.206	0.291	−0.488
Malic acid	**−0.702**	0.119	−0.199	0.021	0.065
Succinic acid	0.612	0.249	0.196	0.329	−0.028
*L**	0.249	**−0.902**	0.135	0.163	0.076
*a**	−0.518	0.314	−0.615	−0.002	0.327
*b**	0.167	**−0.873**	−0.128	0.119	0.122
Firmness	−0.037	**0.870**	−0.025	−0.024	0.083
TPP-UV	−0.232	0.046	**0.783**	−0.125	0.351
Cholorogenic acid	0.038	0.053	**0.832**	0.164	−0.152
Isoquercetin	0.304	−0.176	0.369	0.412	0.279

4. Conclusions

The composition of peach juices was affected by the type of cultivar to a large extent. The results of this study might improve the diversification of fruit juices and their quality control. Despite of the short-term of this study, it may be useful to food technologists, horticulture researchers and nutritionists. A long-term study is required to estimate the interaction between the environmental variability and the cultivation conditions on the composition of peach fruits and juices.

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