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Segregation of plum and pluot cultivars according to their organoleptic characteristics

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Abstract

Cultivar segregation according to the sensory perception of their organoleptic characteristics was attempted by using trained panel data evaluated by principal component analysis of 12 plum and four pluot cultivars as a part of our program to understand plum minimum quality. The perception of the four sensory attributes (sweetness, sourness, plum flavor intensity, plum aroma intensity) was reduced to three principal components, which accounted for 98.6% of the variation in the sensory attributes of the tested cultivars. Using the Ward separation method and PCA analysis (PC1 = 49.8% and PC2 = 25.6%), plum and pluot cultivars were segregated into groups (tart, plum aroma, and sweet/plum flavor) with similar sensory attributes. Fruit source significantly affected cultivar ripe soluble solids concentration (RSSC) and ripe titratable acidity (RTA), but it did not significantly affect sensory perception of plum flavor intensity, sourness, sweetness, and plum aroma intensity by the trained panel on fruit harvested above their physiological maturity.

Based on this information, we recommend that validation of these organoleptic groups should be conducted using "in store" consumer tests prior to development of a minimum quality index within each organoleptic group based on ripe soluble solids concentration (RSSC). This organoleptic cultivar classification will help to match consumer preferences and enhance current promotion and marketing programs.

Keywords: Sensory attributes; PCA; Ripe fruit quality attributes; Minimum quality index

1. Introduction

In the last decade, plum per capita consumption has remained the same or even decreased in the USA (Anon., 2004) and some European countries (Liverani et al., 2002). In the USA, plum consumption is lower than in European countries declining from 0.64 kg per capita per year in 2001 to 0.50 kg per capita per year in 2004. In Italy, plum consumption varies from 1.2 to 0.90 kg per capita per year according to geographic location; for example, 1.2 kg for Italian consumers that live in the central area, 1.14 kg for consumers in the northwestern area and 0.90 kg for consumers in the south and islands (Macchi, 2006). On both continents, consumers' complaints included "off flavor", lack of ripening, astringent, flesh browning and textural characteristics associated with low quality and chilling injury symptoms (Ceponis and Cappellini, 1987; Streif, 1989; Taylor and Jacobs, 1993; Taylor and Rabe, 1995; Abdi et al., 1998; Crisosto et al., 1999; Plich, 1999; Argenta et al., 2003). At the same time, costs of production are increasing while prices are not. Postharvest handling practices with an emphasis on temperature management recommendations to avoid plum chilling injury have been proposed as part of the solution in California (Mitchell, 1987; Crisosto et al., 1999) and in other areas of the world (Streif, 1989; Taylor and Rabe, 1994). Ripening protocols at the shipping and receiving end have been developed, promoted and established as an attempt to enhance flavor or even give an added value to plums (Crisosto, 2005).

The creation and establishment of a generic minimum quality index based on ripe soluble solids concentration (RSSC) and/or ripe titratable acidity (RTA) as an approach to protect consumers and increase consumption is being pursued by several postharvest physiologists and private companies. However, it has been claimed that for some plums titratable acidity, characteristic flavor, aroma, astringency and texture become as important

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as RSSC in determining consumer acceptance. The interaction between RSSC and RTA has been well illustrated for a high acid, early dark plum (Crisosto et al., 2004), i.e. within the same RSSC range (10.0–11.9%) combined with three RTA ranges (RTA $\leq$ 0.60%, RTA 0.61–0.99%, and RTA $\geq$ 1.00%) the mean degree of liking by consumers decreased significantly ($p < 0.0001$) as the RTA range increased, 6.2, 5.3 and 3.3, respectively. This relationship has also been reported for early grapes (Nelson et al., 1963; Crisosto and Crisosto, 2002), cherries (Kappel et al., 1996; Crisosto et al., 2003) and 'Hayward' kiwifruit (Crisosto and Crisosto, 2001; Marsh et al., 2004).

Other approaches to fuel consumption have been taken by plant breeders, who are developing and introducing new plum and plum type (pluot) cultivars with different chemical and sensory characteristics than current commercial plum cultivars. Pluots are interspecific hybrids of complex crosses of plum and apricot with predominantly plum parentage typically with smooth skin. Thus, in the last decade a large number of cultivars with notable flavor characteristics, i.e. strong plum flavor, a blend of apricot and plum flavors, very sweet and high antioxidant capacity have been released (Wills et al., 1983; Tomas-Barbera et al., 2001).

In this study, we tested the hypothesis that plum and plum type cultivars could be consistently segregated based on their predominant sensory characteristics: sweetness, sourness, flavor and aroma intensity (plum), using a trained panel (Crisosto et al., 1998, 2003, 2006). As plums and pluots are currently reaching new domestic and overseas markets with diverse consumer ethnic groups, this proposed organoleptic classification may help to match fruit flavor characteristics to consumers' specific flavor characteristic requirements, i.e. sweet, balanced sweet/tart, strong plum flavor and/or aroma, tart, etc., thus enhancing marketing and promotion activities.

Our sensory research program involved the following steps: verify the variability of sensory attributes in current plum and pluot cultivars, segregate cultivars into organoleptic groups, validate organoleptic groups with consumer perception of sensory attributes, describe the chemical attributes of each organoleptic group, propose a minimum quality index within each organoleptic group, and understand the relationship between consumer preferences and these proposed organoleptic groups. In this work we reported information on the first two steps.

2. Materials and methods

2.1. Trained panel

Cultivar segregation studies focused on the organoleptic description of 12 plum and four pluot cultivars (Table 1) were carried out by a trained panel of nine (2003) or 10 (2004) trained judges selected for their taste acuity (O'Mahony, 1986; Lawless and Heymann, 1998). Four sources (orchards) per cultivar were used for nine plum and one pluot cultivar and only one source per cultivar for three plum and three pluot cultivars. Plum and pluot cultivars with diverse quality attributes, (low and high acidity, high soluble solids concentration (SSC) and strong plum flavor) originating from different breeding programs were selected for this study. Training sessions were conducted to instruct the judges on measuring the perception of sweetness, sourness, plum flavor intensity and plum aroma intensity using references (O'Mahony, 1986). At each session, judges evaluated no more than a maximum of eight cultivar-source combinations for aroma and taste attributes. All testing was carried out at room

Table 1
Means (X) and standard deviations (S.D.) of ripe soluble solids concentration (RSSC) and ripe titratable acidity (RTA as percent malic acid) for plum and pluot cultivars from one to four different sources per cultivar

	Cultivar code	Plant breeding program	RSSC[a] (%)		RTA[a] (%)	
			X	S.D.	X	S.D.
Plum cultivar						
Betty Anne	BA	Zaiger	16.8	0.4	0.43	0.16
Blackamber	BK	USDA/UC	12.4	1.2	0.36	0.14
Catalina[b]	CA	Krause	16.7	0.6	0.38	0.08
Earliqueen	EQ	Zaiger	9.0	0.9	0.87	0.21
Fortune	FO	USDA	11.8	1.9	0.70	0.18
Friar[b]	FR	Weinberger	17.2	0.7	0.18	0.04
Hiromi Red	HR	Zaiger	13.6	1.7	0.62	0.22
Joanna Red	JR	Zaiger	11.0	2.3	0.45	0.13
October Sun	OS	Chamberlin, Sr. (Met. Life Ins.)	19.8	1.3	0.29	0.03
Purple Majesty	PM	Bradford	13.7	0.6	0.81	0.22
Royal Zee	RZ	Zaiger	11.2	1.3	0.42	0.10
Simka[b]	SI	Kazarian	14.3	1.4	0.59	0.02
Pluot cultivar						
Dapple Dandy[b]	DD	Zaiger	19.1	1.1	0.40	0.02
Flavor Grenade[b]	FG	Zaiger	16.9	0.2	0.42	0.04
Flavorich	FLR	Zaiger	17.0	1.3	0.58	0.13
Flavorosa[b]	RS	Zaiger	12.4	1.5	0.43	0.13

[a] RSSC and RTA measured on ripe fruit (8.8 N) using a penetrometer with an 8 mm tip.
[b] One source per cultivar.