Understanding Tree Fruit Quality Based on Consumer Acceptance

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Abstract

In recent years, we have been developing stone fruit quality indexes based on consumer acceptance and fruit market life with the main goal of increasing fruit consumption. To reach this goal we have taken the following steps: First, we conducted soluble solids concentration (SSC) and titratable acidity (TA) surveys, which indicated the potential fruit quality range for these cultivars within the industry. Second, we investigated the potential role of preharvest factors on these quality attributes. Third, we segregated cultivars according to a trained panel's perception of the predominant sensory attributes: sweetness, sourness, and fruit flavor and aroma intensity. Finally, we used the above data to design large "in store" consumer tests within each sensory classification group. After completion of these steps, the industry will have the solid information it needs to propose a flavor code classification with fruit quality standards specific to each potential sensory classification group.

INTRODUCTION

After solving the internal breakdown (IB) or chilling injury (CI) problem and lack of ripening issues (Crisosto, 1997;2000, Crisosto et al., 1999;2004a), a detailed research program focusing on understanding flavor and consumer acceptance for different tree fruit cultivars should be pursued (Crisosto, 2002;2003a). As production of new cultivars with different flesh colors, flavors, soluble solids concentrations (SSC), and titratable acidities (TA) is increasing in California and in other areas of the world (Byrne, 2003; Neri et al., 1996, Liverani et al., 2002 and Hilaire, 2003), understanding the relationship between SSC, TA, and texture and consumer acceptance is more critical. Early work associated high consumer acceptance of fruit with high soluble solids concentration (SSC) in sound peaches (Bruhn et al., 1991). However, the role of titratable acidity, SSC: TA and/or peach, nectarine or plum flavor in consumer acceptance has not been well established. SSC and TA in tree fruit are determined by several factors such as cultivar (Ravaglia et al., 1996; Ventura et al., 2000), environmental conditions, canopy position (Crisosto et al., 1997), crop load, ripening, fruit maturity (Testoni, 1995; Crisosto et al., 1997), and rootstocks.

PROTECTING FRUIT FLAVOR DURING POSTHARVEST HANDLING

A preconditioning treatment to limit internal breakdown (IB) on a short term basis and allow flavor expression is being successfully carried out with consistent results under California and Chilean conditions (Crisosto, 2004a). Currently, there are several companies that offer a considerable volume of high quality fruit to domestic and overseas consumers using this controlled delayed cooling treatment as part of their delivery system. This new system allows the potential of delivering to retail stores tree fruit that are "ready to buy" with a low occurrence of internal breakdown symptoms and high consumer acceptance. Preconditioned fruit will extend fruit market life even when exposed to temperatures between 36 and 48ºF (temperature killing range) during postharvest handling. In general, a well applied preconditioning treatment extends market

life by about one to two weeks (Crisosto et al., 2004a). Due to physical and chemical changes occurring in the fruit during the preconditioning treatment, fruits are allowed to express their potential eating quality. A controlled preconditioning/preripening treatment induces fruit softening to the "ready to buy" stage (approximately 0.36 N for peaches). If the program is not properly monitored, decay development, shriveling, and excessive softening may become commercial problems. Fast cooling and maintaining temperature prior to and during shipment are essential to protect fruit quality from fast deterioration and a high refrigeration capacity may be needed for this program. The product should be packed to specific marketing requirements depending on customer desires, such as being stickered with PLU (tree-ripe codes) and packed in attractive display-ready pre-printed cartons that are either single layer or double layer in depth. An aggressive marketing and promotion program is required. Retailer and consumer education on the handling of preconditioned/preripened fruit is important to increase the demand for this new high quality fruit delivery system. A long term solution to the IB problem is the development of flavorful cultivars free of IB through breeding programs using conventional and molecular genetics techniques to assure high consumer acceptance.

PROPOSING QUALITY INDEX (ES)

Currently, we do not have enough reliable information from different peach cultivars over different seasons to justify the establishment of SSC as a single quality index. For example, we have such a diversity of potential flavors in our current 200+ peach cultivars that we cannot simplify this complex issue by choosing SSC without the support of solid research over a long period of time. Therefore, to define a high quality eating fruit, we are following these steps: First, conduct an industry quality survey of initial fruit quality attributes. This information will reveal the range of fruit quality attributes within the industry. Second, preliminary studies on the role of preharvest factors in relation to these parameters should be continued. It is very important to realize the cultivar quality potential, thus, our suggested quality indexes will be attainable by these industries. Third, utilize a trained panel to identify the predominant sensory attributes for peach cultivars such as sweetness, sourness, peach flavor and aroma intensity and determine the interrelationship among them. Understanding the role of these quality attributes in consumer acceptance is important to design the "in store" consumer tests to propose a quality index(es). These "in store" consumer tests should be designed based on the results of the trained panel and the industry survey. After the completion of this program, the tree fruit industry will have more information to determine if the establishment of this/these index(es) will help to consistently deliver fruit of high eating quality.

From our previous sensory work using a single fruit technique and "in store" consumer tests, we determined that our current cultivars can be classified into three groups according to their consumer acceptance. In the first group, consumer acceptance was related to ripe soluble solids concentration (RSSC) and ripe titratable acidity (RTA). Consumer acceptance for these cultivars increased rapidly as RSSC increased reaching ~90%. The cultivars in this group had high acidity (>0.8%) and were predominantly early season with some mid-late season cultivars (Crisosto et al., 2004b; Hilaire and Mathieu, 2004). In the second group of cultivars, consumer acceptance was significantly related to RSSC but not to RTA within the quality attribute ranges used for this test. Consumer acceptance for these cultivars increased rapidly as RSSC increased, reaching ~90%, and then it reached a plateau (Fig. 1) above which it became insensitive to any additional increase in RSSC (saturation point) (Crisosto and Crisosto, 2005). Unfortunately, the saturation point was cultivar dependent, thus, the RSSC to satisfy a minimum of 85% of the consumer population varied between cultivars making it very difficult to propose a minimum RSSC across cultivars. In the third group of cultivars, consumer acceptance was also related to RSSC but in this case consumer acceptance did not reach a plateau with increased RSSC and consumer acceptance reached nearly 100% at the highest level of RSSC tested (Fig. 2). This acceptance level is very high compared to other

commodities such as table grapes (Crisosto and Crisosto, 2002b) and kiwifruit (Crisosto and Crisosto, 2001) using the same single fruit technique and similar consumer populations. Similar levels of consumer acceptance using the "in store" consumer test were obtained on 'Brooks' and 'Bing' cherries (Crisosto et al., 2003a & b).

THE FLAVOR CODE

In our previous sensory work we also found that consumer acceptance was highly related to consumers that chose the "neither like nor dislike" option rather than disliked the fruit (Crisosto and Crisosto, 2005). For example, the fact that 33% of the consumers picked the "neither like nor dislike" option, while only 4.2% disliked the fruit suggested that a large number of consumers may be confused. We believe that clear identification and consistent delivery of fruit groups based on their flavor components may help this confused consumer group to make a decision about whether or not they like the fruit and increase consumption. For this reason and the fact that in the last decade a large number cultivars with new notable flavor characteristics and high antioxidant capacity have been released, we tested the hypothesis that cultivars could be consistently segregated based on their predominant sensory characteristics: sweetness, sourness, flavor and aroma intensity (peach, nectarine, plum) using our trained panel. Principal component analysis (PCA) was used to segregate cultivars into different organoleptic groups (Crisosto and Crisosto, 2006). The perception of the four sensory attributes (sweetness, sourness, peach or nectarine flavor intensity, and peach or nectarine aroma) was reduced to three principal components, which accounted for 92% for peaches and 94% for nectarines of the variation in the sensory attributes of the tested cultivars. By plotting the cultivars sensory attributes in the two most important principal components (PC1 and PC2), they were segregated into four groups named balanced, tart (sour), peach aroma/flavor, and sweet (Fig. 3). Our results support our hypothesis that cultivars can be consistently segregated into groups dominated by a specific flavor component such as sweetness, tartness, or strong peach flavor, or peach aroma. Cultivars plotted in between all four sensory vectors were classified in the balanced group. This proposed classification of cultivars into flavor groups and development of a minimum quality index within each group rather than proposing a single generic minimum quality index based on RSSC across cultivars should be pursued. This cultivar flavor classification will help to match ethnic preferences and enhance current promotion and marketing programs. Furthermore, representative cultivars from each organoleptic group could be used to describe biochemical compounds related to the perception of their specific sensory attributes. After identification of these compounds, a candidate gene approach could be used to develop marker(s) to establish an early breeding (seedling) program screening for specific flavors.

FINAL COMMENTS

- The expression of chilling injury symptoms (lack of flavor, mealiness, flesh browning, and uneven ripening) and lack of ripening are the main cause of fruit rejection by consumers.
- Our "in store" consumer tests indicated that high consumer acceptance is attained with our mid-season cultivars when fruit are free of internal breakdown and "ready to eat" prior to consumption.
- Higher consumer acceptance was attained on cultivars with a predominant flavor than traditional ones. Thus, developing and releasing new cultivars with a characteristic flavor component is desirable to increase consumption.
- Cultivars were classified into three groups according to consumer acceptance and their quality attributes. Consumer acceptance was mainly related to RSSC and RTA but it was cultivar dependent.
- A classification of cultivars into flavor groups prior to developing a minimum quality index should be pursued.
- The use of proper cultural practices and the careful determination of the harvest date should be applied properly to assure that fruit express their quality attributes and the

majority of fruit would exceed any proposed minimum quality index.
- Intensive research to identify cultivars' important sensory attributes, "in store" consumer acceptance, industry quality potential, and the role of preharvest factors (orchards and climatic conditions) to meet these potential quality standards should be studied further.

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Figures

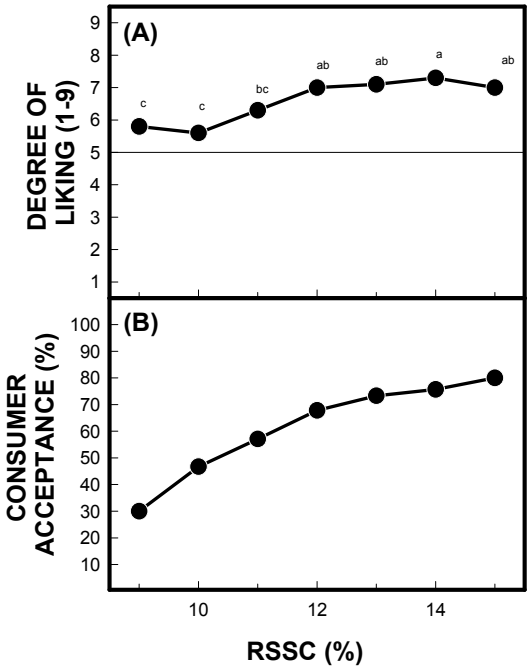

Fig. 1. Relationship between 'Elegant Lady' peach ripe soluble solids concentration (RSSC) and (A) consumer degree of liking measured on 9-point hedonic scale (1-dislike extremely, 5-neither like nor dislike and 9-like extremely) or (B) percentage consumer acceptance. Different letters within a given RSSC level indicate a significant difference between means by LSD 0.05.

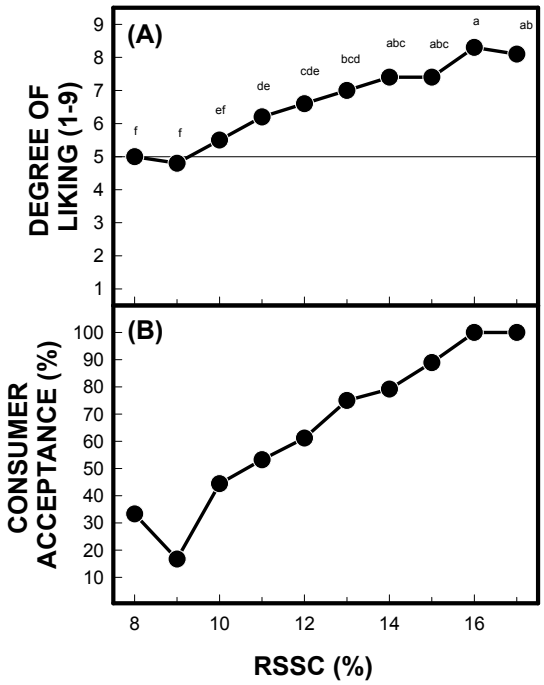

Fig. 2. Relationship between 'Ivory Princess' peach ripe soluble solids concentration (RSSC) and (A) consumer degree of liking measured on 9-point hedonic scale (1-dislike extremely, 5-neither like nor dislike and 9-like extremely) or (B) percentage consumer acceptance. Different letters within a given RSSC level indicate a significant difference between means by LSD 0.05.

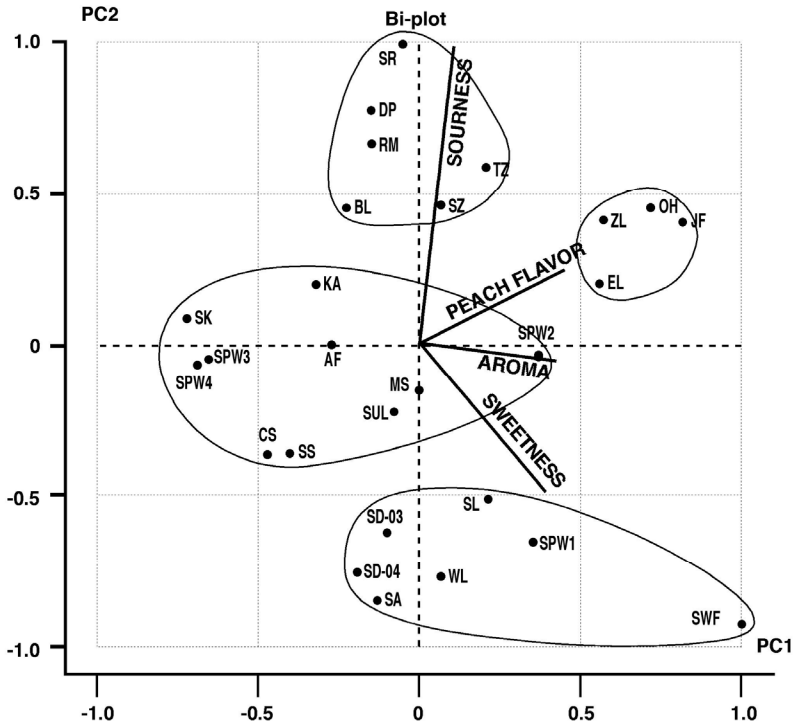

Fig. 3. Segregation of 23 peach cultivars originating from different breeding programs according to their organoleptic characteristics as perceived by a trained panel and determined by Principal Component Analysis (PCA). PC1 (44%) is plotted on the X-axis and PC2 (33%) on the Y-axis with the vectors representing the loadings of sensory data along with the principal component scores.