Food Quality and Preference 32 (2014) 317–329

Contents lists available at ScienceDirect

Food Quality and Preference

journal homepage: www.elsevier.com/locate/foodqual

Preference mapping of apple varieties in Europe

J. Bonany [a,*], C. Brugger [b], A. Buehler [b], J. Carbó [a], S. Codarin [c], F. Donati [d], G. Echeverria [e], S. Egger [b], W. Guerra [f], C. Hilaire [c], I. Höller [f], I. Iglesias [e], K. Jesionkowska [g], D. Konopacka [g], D. Kruczyńska [g], A. Martinelli [i], C. Petiot [j], S. Sansavini [d], R. Stehr [k], F. Schoorl [l]

[a] IRTA-Mas Badia, E-17134 La Tallada, Spain
[b] Agroscope Changins-Wädenswil Research Station ACW, Schloss 1, P.O. Box, 8820 Wädenswil, Switzerland
[c] CTIFL-Lanxade, 28 Route des Nebouts, 24130 Prigonrieux, France
[d] University of Bologna, Viale Fanin, 44, 40127 Bologna, Italy
[e] IRTA-Lleida, Av. Alcalde Rovira i Roure, 191, 25198 Lleida, Spain
[f] Research Centre for Agriculture and Forestry Laimburg, Laimburg 6, I-39040 Posta Ora (BZ), Italy
[g] Research Institute of Horticulture, Konstytucji 3 Maja 1/3, 96-100 Skierniewice, Poland
[i] Consorzio Italiano Vivaisti, Stat. Romea n. 116, 44020 S. Giuseppe di Comacchio (Ferrara), Italy
[j] NOVADI, 23 rue Jean Baldassini F-69364 Lyon Cedex 07, France
[k] Obstbau Versuchs-und Beratungszentrum Jork, Moorende 53, 21635 Jork, Germany
[l] WUR-PPO, Lingewal 1, 6668 LA Randwijk, Netherlands

ARTICLE INFO

Article history:
Received 13 September 2012
Received in revised form 25 September 2013
Accepted 27 September 2013
Available online 7 October 2013

Keywords:
Apple
Varieties
Consumer acceptance
Preference mapping
Consumer segmentation
European countries

ABSTRACT

A consumer test carried out in 7 different European countries compared 3 standard apple varieties to 8 new ones. A total of 4290 consumers took part in the test. Data from this test was used to develop a preference map for apple. The preference map was constructed with 3 main dimensions (1 – sweetness, fruitiness, flowery attributes, 2 – acidity, firmness, 3 – juiciness and crispness). Consumers were segmented in 6 clusters according to their preferences. The 6 clusters were grouped into two main mega clusters A (68% of consumers) and B (32% of consumers). Megacluster A (Clusters 1, 2, 5 and 6) was characterized by preferring sweet apples. Clusters 2 and 5 (41% of consumers) liked sweet apples independently of their acidity and firmness and moderate positive values on dimension of juiciness and crispness. Cluster 1 (21% of consumers) had an optimal point in positive values of the sweetness dimension, moderate negative value for acidity and firmness and moderate positive value for juiciness and crispness. Cluster 6 (6% of consumers) besides preferring sweet varieties disliked acid-firm varieties. As to regard to megacluster B (Clusters 3 and 4) (32% of consumers), they preferred varieties that were acidic-firm and juiciy and crisp with values in the mid range of the sweetness dimension. In spite of the difficulties in translating preference dimensions into standard practical values for fruit quality and the fact of being a punctual measurement of consumer behaviour, this preference map could be of practical use of different actors on the fruit value chain like marketers and breeders.

1. Introduction

Many of the European countries do not achieve minimal recommended intake of fruit and vegetables proposed by FAO/WHO (Robertson et al., 2004). Increase fruit consumption is therefore a public health objective (WHO, 2003) that has been translated into several campaigns of promotion of fruit consumption (Department of Health. The NHS Plan – A plan for investment, 2000 and Center for Disease Control, 2002 cited in Gilmer, 2005; Lock, Pomerleau, Causer, Altmann, & McKee 2005; Subar et al., 1995) but also research projects promoted from the European Union to diminish barriers to fruit consumption that could hamper the achievement of minimal fruit intake.

A possible barrier for increased fruit consumption is insufficient fruit quality (Briz et al., 2008; Cohen, Stoddard, Sarouhkhanians, & Sorensen, 1998; Yeh et al., 2008). On apple, in the recent years, a new generation of apple cultivars with improved fruit quality are now making their way into the markets after their release ('PINK LADY® Cripps Pink cov', 'KANZI® Nicoter cov', 'ARIANE cov', among others). Many of these new apple varieties have a improved texture, higher soluble solids and higher total titratable acidity than currently cultivated varieties like 'GOLDEN DELICIOUS' or 'JONAGOLD', the two most cultivated varieties in Europe.

On the other hand, to increase fruit consumption it could be helpful to know what the preferences of the consumers are and

* Corresponding author. Tel.: +34 972780275; fax: +34 9727801517.
E-mail address: joan.bonany@irta.cat (J. Bonany).

0950-3293/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.foodqual.2013.09.010

how these consumers are segmented with regard to those preferences. Targeting consumer preferences can lead to more satisfied consumers which in turn can result in increased fruit consumption. Consumer preference mapping is the technique most widely used in the food and beverage industries to evaluate the preferences of the consumers and the segmentation of these consumers on homogeneous groups. Additionally, this methodology provides information on what are the food attributes that explain consumer preference. On fruit this technique has been used on apples (Allan-Wotjas, Sanford, McRae, & Carby, 2003; Daillant-Spinnler, MacFie, Beyts, & Hedderley, 1996; Jaeger, Andani, Wakeling, & MacFie, 1998; Villatoro, López, Echeverria, Graell, & Lara, 2009) , pears (Harker, Gunson, & Jaeger, 2003; Jaeger, Lund, Lau, & Harker, 2003a) and kiwifruit (Jaeger, Rossiter, Wismer, & Harker, 2003b).

Consumer tests comparing consumer acceptance of different apple varieties have been carried out in the past in the United Kingdom, Denmark, Holland, Germany, Switzerland, Poland, France, and other European countries (Barendsee, 1993; Daillant-Spinnler et al., 1996; Ellinger, 1987; Höhn & Güggenbühl, 1999; Jaeger et al., 1998; Kellerhals et al., 1999; Konopacka, Jesionkowska, Rutkowski, Płocharski, & Tomala, 2006; Mante, 1973; Tomala, Barylko-Pikielna, Jankowski, Jeziorek, & Wasiak-Zys, 2009; van de Abeele & Reijnders, 1980).

In spite of numerous consumer tests, many of them, be either consumer tests comparing acceptance of varieties or using the methodology of consumer preference mapping, do not include the major apple varieties consumed in Europe and logically did not cover the newly released cultivars. Moreover, none of the tests involve consumers of a wide selection of European cities impeding a valid comparison among different areas in Europe.

A consumer test of 11 apple varieties carried out in different European countries was used as methodological tool to test the hypothesis that new cultivars with better quality attributes would increase fruit consumption. In a previous paper, Bonany et al., (2013), results on consumer eating quality acceptance as related to variety and demographic factors were reported. In this paper, focus is on the results of applying the preference mapping methodology on the same data set.

2. Materials and methods

2.1. Varieties included in the consumer test, origin of fruit samples and management to simulate fruit chain

Varieties included in the apple consumer test are listed in Table 1. The varieties selected for the apple consumer test were selected to represent on one side the most cultivated produced apple varieties in Europe (GOLDEN DELICIOUS' and JONAGOLD) and some newly introduced varieties (FUJI and PINK LADY® Cripps Pink cov) or in process of introduction (KANZI® Nicoter cov, JUNAMI® Milwa cov, WELLANT®, LIGOL, ARIANE cov', LIGOL, GOLDCHIEF® Goldpink cov or RUBENS® CIVni cov). On the other side, they were also selected because it was anticipated from knowledge of the varieties that they would provide a good representation of the sensory space (flavour and texture mainly). Fruits of these varieties were harvested from a single representative commercial orchard with standard management practices for each variety. Harvest dates and location and country of origin for each variety can also be found in Table 1.

Table 2
Temperature, O_2 and CO_2 concentration and Relative Humidity of cold storage rooms.

Variety	Temperature (°C)	O_2 (%)	CO_2 (%)	Relative humidity (%)
GOLDEN DELICIOUS	1.3	1.0	3.0	>95
JONAGOLD	na	na	na	na
FUJI	1.3	1.5	1.3	91–93
PINK LADY® Cripps Pink cov	2.1	4.6	0.9	92
ARIANE cov	1–1.5	1.5–2	<1.3	90–93
RUBENS® CIVni cov	1	1.2	1.5	na
KANZI® Nicoter cov	1.3	1.5	1.3	90–93
JUNAMI® Milwa cov	1	1.2	2.5	na
WELLANT® Cpro-47	1.5–2	1.3[a]	3	na
LIGOL	1.7	2.0	1.8–2.0	Up to 90
GOLDCHIEF® Gold Pink cov	1.5	2	3	90–95

[a] Some periods temporary higher concentration.

After harvest, fruits were sorted and stored under the appropriate conditions for each variety for long term storage. Locations for storage and detailed conditions are described in Table 2. All fruit samples were removed from cold storage on 15 January 2007 and transported to consumer test locations by means of refrigerated vehicle where they were held between 3 °C and 4 °C until 48 h prior utilization in consumer test. The last 48 h before the test was carried out, fruit samples were maintained at room temperature.

2.2. Fruit quality measurements

Fruit quality (Soluble Solids Content, SSC, °Brix; Total Titratable Acidity, TTA, g/L equivalent malic acid; Firmness, F, kg) on 25 fruits for all cultivars included in the test, was measured in different points in time throughout the simulation of the fruit chain: at harvest, at the end of the cold storage period, after the transportation to the location of the consumer test and just prior the moment of consumer test. Only this later measurement was used in the statistical analysis. The rest were used as quality control of the evolution of the different parameters. Starch Pattern Index was also measured at harvest time.

2.3. Trained panel sensory evaluation of fruit samples

Additionally to the fruit quality analysis, all varieties were subjected to a sensory evaluation by the AGROSCOPE trained panel in

Table 1
Varieties used for the apple consumer test.

Variety	Country were the variety was bred	Location of orchard	Harvest date
'Golden Delicious'	United States	Merano (Italy)	30/9/2006
'Jonagold'	United States	Wijk bij Duurstede (The Netherlands)	11/10/2006[a]
'Fuji'	Japan	Tramin (Italy)	16/10/2006
'Pink Lady®' Cripps Pink^{cov}	Australia	Nîmes (France)	2/11/2006
'Ariane^{cov}'	France	Saint Laurent des Vignes (France)	8/9/2006
'Rubens®' CIVni^{cov}	Italy	Randwijk (The Netherlands)	27/09/2006
'Kanzi®' Nicoter^{cov}	Belgium	Schenna (Italy)	6/10/2006
'Junami®' Milwa^{cov}	Switzerland	Randwijk (The Netherlands)	5/10/2006
'Wellant®' CPRO-47	The Netherlands	Randwijk (The Netherlands)	3/10/2006
'Ligol®'	Poland	Zalesie (Poland)	25/09/2006
'Goldchief®' 'Gold Pink^{cov}'	Italy	Coredo (Italy)	16/10/2006

[a] 2nd Pick.