

## Evaluation of apple fruit quality within the EU project Hidras

Beurteilung der Fruchtqualität beim Apfel im Rahmen des EU-Projektes Hidras

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### Abstract

The EU project Hidras (High Quality Disease Resistant Apples for a sustainable agriculture, QLK5-CT-2002-01-01492) aims to identify genetic factors controlling apple fruit quality with the objective of increasing the acceptability of disease resistant apples. At Agroscope Changins-Wädenswil (ACW) we are performing expert panel tests and consumer tests. The consumer inquiry during the public fair BEA 2005, end of April 2005 in Bern, Switzerland, resulted in comprehensive information on consumption trends in apple for different age groups. This work is coordinated with partners in Poland and Belgium. All the age groups considered flavour, juiciness and firmness as very important quality criteria for apples. The preference of apples to other fruit such as pears, bananas or citrus is more significant with adults and especially elder people. However, apple was the most favourite fruit species for all age classes. Almost one third of the adults prefer an apple to other snacks. On the other hand, children prefer chips and popcorn and only 12% prefer an apple to other snacks.

The overall appearance and eating quality of scab resistant varieties (Ariane, Topaz and Goldrush) and non-resistant varieties (Gala, FAW 5878 and La Flamboyante) evaluated by the same consumers confirmed, that the resistant varieties were competitive in respect to fruit quality with the non-resistant varieties.

**Keywords:** apple, breeding, consumer test, scab resistance, fruit quality

### Introduction

The success of newly developed disease resistant apple varieties is largely dependent on their fruit quality. The introduction of high quality disease resistant apple varieties is widely considered an effective approach to reduce the use of fungicides in sustainable orchard management strategies. The focus of the current EU project Hidras is put on the identification of genetic factors controlling apple fruit quality. The project consists of nine different work packages (WP), where different European partners participate (Fig .1). The common aim is to develop high quality disease resistant varieties for a sustainable cultivation (Gianfranceschi und Soglio, 2004). Quality encompasses the food characteristics that satisfy expectations. To increase our knowledge on the consumer requirements as well as the sensory and instrumental quality, Work package 7 focuses on these aspects. At Agroscope Changins-Wädenswil (ACW) we have performed expert panel tests as well as a consumer test. The purpose of the expert panel tests was to characterise 20 different varieties and selections in a sensory profile. In order to gather information on the consumption habits of consumers and on their perception of different apple samples a consumer query and test were performed including different age groups. The aims of the consumer tests within the Hidras project are as follows:

Identification of fruit quality traits preferred by the European consumers

To compare disease resistant varieties and progenitors to well-accepted commercial varieties

To correlate sensory evaluations with instrumental analysis

Define quality parameters determining the success of new apple varieties

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## HiDRAS

High-Quality Disease Resistant Apples for a Sustainable Agriculture  
Contract N° QLK5-CT-2002-01-01492

Project Partners:	Work Packages:
<ul style="list-style-type: none"><li>• University of Milan (I): Coordination</li><li>• University of Bologna (I)</li><li>• Plant Res. International, Wageningen (NL)</li><li>• INRA Angers (F)</li><li>• Federal Centre for Breeding Research on Cultivated Plants, Dresden (D)</li><li>• ETH Zürich and Agroscope Changins-Wädenswil (CH)</li><li>• East Malling Research (UK)</li><li>• Research Center Gembloux (B)</li><li>• Research Center Skierniewice (PL)</li><li>• Warsaw Agriculture University (PL)</li><li>• Research Centers S. Michele and Laimburg (I)</li></ul>	<ul style="list-style-type: none"><li>WP 1: Phenotypic assessments of fruit quality traits</li><li>WP 2: Genotyping of individuals from pedigree and segregating progenies</li><li>WP 3: Software development (genetic mapping)</li><li>WP 4: Identification and characterisation of genes with fruit modulated expression</li><li>WP 5: Development of new molecular markers</li><li>WP 6: Identification and characterisation of QTL alleles determining fruit quality</li><li>WP 7: Consumer tests</li><li>WP 8: Marker assisted selection</li><li>WP 9: Database</li></ul>

**Figure 1:** Partners and work packages of the HiDRAS-Project

## Material and Methods

### Expert panel test

Expert panel tests were performed 2 months and 4 months after harvest including shelf life tests (10 days at 20°C). The following varieties were included in the tests. In brackets their resistances are indicated: Ariane (Vf), FAW 5878, FAW 10429 (Vf), FAW 11907 (Vf), Fuji Kiku 8, Iduna, Otava (Vf), Rubens, Sonya, Braeburn Hillwell, Elstar Elshof, FAW 11303 (Vf, MR, FR), FAW 8244 (Vf, PI2), Goldrush (Vf), Mairac, Santana (Vf), Delblush and the standard reference cultivars were Idared and Royal Gala. Nine of the 20 tested cultivars carry one or more disease resistance genes.

We focus on the test that has been performed in two series, after 2 months of storage in regular cold store at 1°C on the 9<sup>th</sup> and on 10<sup>th</sup> of December 2004 and after 2 months of storage + 10 days at 20°C on the 16<sup>th</sup> and on 17<sup>th</sup> of December 2004.

On average 13 panellists took part. The panellists had to evaluate the following characteristics:

External: background colour, over colour, aroma intensity.

Internal: odour: acidity, sweetness, other fruit aroma, fresh cut grass

Taste and texture: firmness, juiciness, taste sweet, taste sour, ripening stage, astringency, overall quality.

### Consumer test

Within the work package 7 we performed a consumer survey and test at the public fair BEA 2005 in Bern on April 29 and 30, 2005. Three scab resistant varieties: Ariane®, Goldrush and Topaz and three susceptible varieties, FAW 5878, Royal Gala and La Flamboyante were included. The reference standard cultivars were Royal Gala for the non resistant and Topaz for the resistant group. 203 persons took part. The questionnaires were adapted specifically for the different age groups:

adults (16+), young people (13-15 and 9-12) and for children (6-8). Among the adults (126 persons) there were 77 female and 49 male participants. Varieties were tasted in randomized order. A hedonic nine point scale ( 1= I fully dislike to 9 = I fully like) was used. All the fruits originated from the same plot at the research orchard Güttingen near the lake of Constance. The fruits originated from trees in their third leaf. The fruits were kept in CA store (1-1.5°C, 3 % CO<sub>2</sub>, 1 % O<sub>2</sub>, r.H. 90-95 %) up to two weeks before the test and then in a regular cold store at 1 °C. The fruits were analysed for firmness, sugar content and acidity using a Pimprenelle robotic machine (Tab.2 ).

**Table 1:** Varieties included in the consumer test (\*= scab resistant)

<b>Variety</b>	<b>Origin</b>	<b>Fruit characteristics</b>
FAW 5878	Wädenswil, Switzerland (Idared x Maigold) x Elstar	Medium size, firm, juicy, subacid
La Flamboyante	Changins, Switzerland (Gala x Maigold)	Medium to large size, firm, juicy, slightly acid
Royal Gala	New Zealand Kidds Orange x Golden Delicious	Medium size, firm, juicy, sweet
Goldrush*	Illinois, USA Golden Delicious x Coop 17	Medium size, yellow, very firm, juicy, balanced
Ariane*	Angers, France Progenitors were Florina, Prima, Golden Delicious and others	Small to medium size, firm, juicy, subacid
Topaz*	Strizovice, Czech Republic Rubin x Vanda	Medium size, firm, juicy, slightly acid

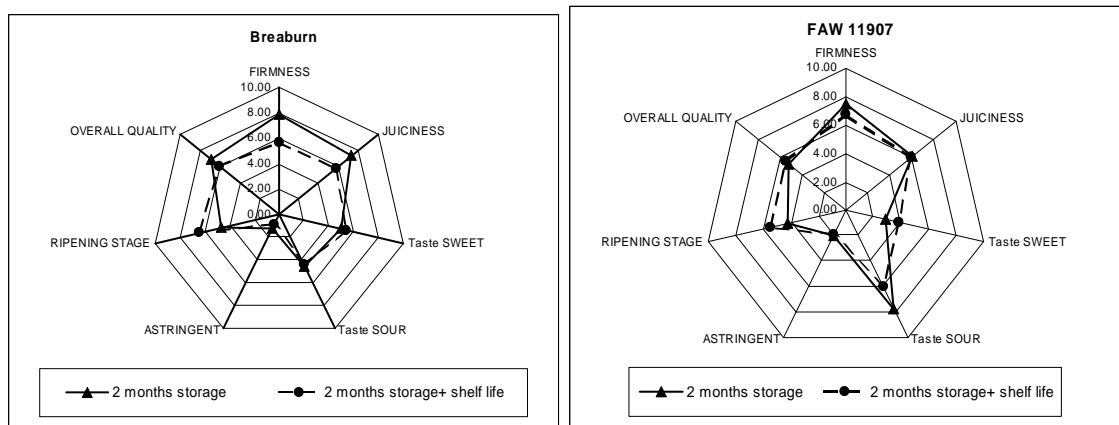
## Results and Discussion

### Expert Panel Test

The expert panel rated the tested varieties for overall eating quality between Braeburn Hillwell as the best and Royal Gala as the poorest (Table 2). In Table 2 the perception after 2 month of regular cold store storage without shelf life test is displayed. There is no clear-cut segregation between scab resistant and scab susceptible varieties. However, it can be concluded that several scab resistant varieties tend to be softer and lower in sweetness than most of the non-resistant ones. There is a challenge for apple breeding to develop firmer and sweeter disease resistant varieties.

**Table 2:** Results of the expert panel test on December 9 and 10 2004 with fruit from regular cold store.

Variety (* = scab resistant)	FIRMNESS	JUICINESS	Taste SWEET	Taste SOUR	ASTRINGENT	RIPENING STAGE	OVERALL QUALITY
Braeburn Hillwell	7.8	7.3	5.0	4.6	1.3	4.7	6.9
FAW 5878	5.7	7.2	5.9	4.8	1.2	5.0	6.5
Delblush	6.1	6.9	6.7	4.7	0.4	6.1	6.4
Civni	4.6	6.2	6.2	4.0	1.5	6.0	6.3
FAW 10429*	4.7	6.9	5.7	4.5	1.7	6.1	5.8
Goldrush*	8.2	6.5	4.1	6.5	2.2	4.3	5.7
Fuji Kiku 8	6.3	7.3	6.5	1.8	0.8	6.4	5.6
Elstar Elshof	2.2	6.6	6.5	4.8	0.5	7.1	5.5
Sonya	5.3	7.3	8.1	1.0	0.7	7.5	5.3
FAW 11907*	7.5	6.1	2.9	7.8	2.0	4.2	5.2
Santana*	2.5	6.5	4.9	4.8	1.6	6.8	5.1
Iduna	4.9	5.3	2.6	8.2	2.2	3.6	4.9
FAW 8244*	2.6	4.0	5.8	4.6	0.6	7.1	4.8
La Flamboyante	6.2	6.7	3.2	6.9	0.9	4.8	4.7
Ariane*	5.0	5.3	3.0	7.2	2.5	4.3	4.6
Idared	3.8	6.0	4.8	4.6	1.6	6.8	4.6
FAW 11303*	8.9	5.4	3.3	6.2	2.2	3.2	4.5
Topaz*	2.2	6.0	4.7	5.9	1.5	7.1	4.5
Otava*	2.6	5.0	3.9	6.2	1.9	6.9	4.4
Royal Gala	2.7	4.8	6.2	1.9	2.0	7.5	3.6



**Figure 2:** Spider plots from the expert panel test of Braeburn and FAW 11907 to characterise the fruit quality

Sensory profiles as shown in Figure 2 are a valuable tool to describe new advanced selections of breeding programmes such as FAW 11907 in comparison with successful commercial varieties

such as Braeburn. The spider plots display the sensory perception after 2 month of storage as well as with additional shelf life test.

### Consumer test

The varieties FAW 5878 and La Flamboyante exhibited the best eating quality (Table 3). Among the scab resistant varieties, Ariane resulted to have the best quality and over all, it was selected as the most appealing variety. Royal Gala, a commercially well known apple variety, has been judged as appealing, but it did not convince in terms of eating quality. Unsatisfactory fruit were mainly found in the scab resistant varieties Topaz and Goldrush, but also with Gala. Topaz was probably not firm enough and Goldrush rather too firm for some consumers, whereas Gala may lack some acidity as can be deduced from the analytical values displayed in Table 3.

**Table 3:** Consumer test: Sensory and analytical results (n = 203)

#### Sensory evaluation

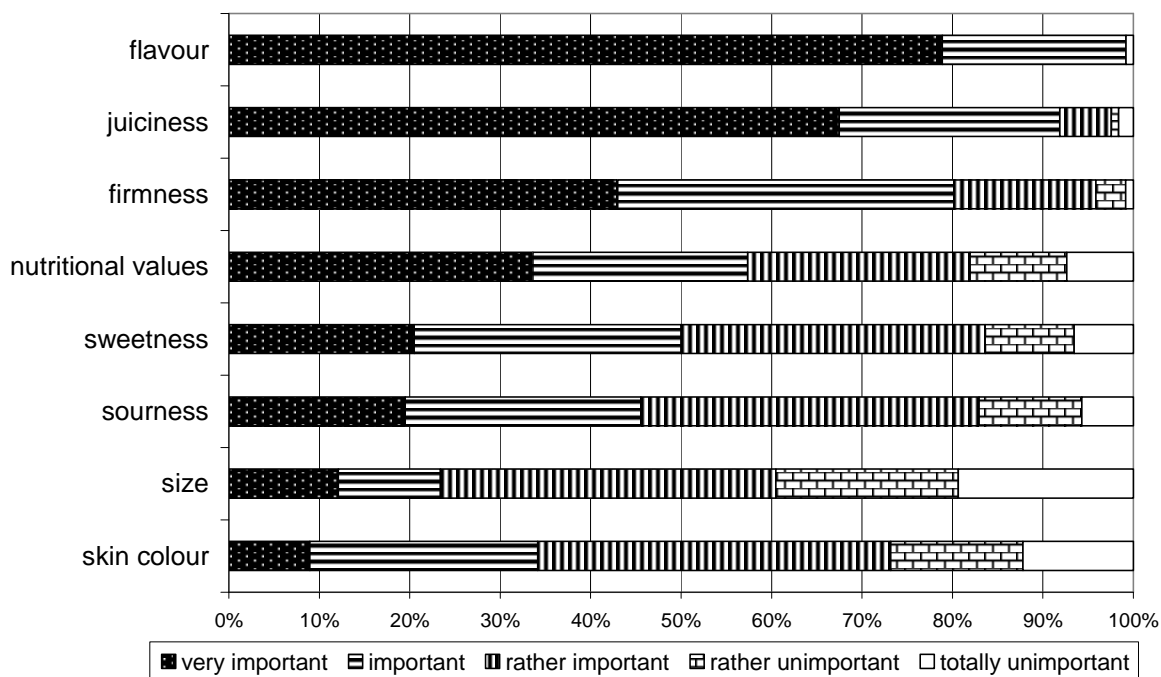
	LA FLAMBOYANTE	GOLDRUSH	TOPAZ	FAW 5878	ARIANE	GALA
<b>Appearance</b> (1-9)	<b>7.1 ± 1.7 b</b> <i>2 - 9 1 - 9</i>	<b>5.6 ± 2.2 d</b> <i>1 - 9 1 - 9</i>	<b>6.2 ± 2.2 c</b> <i>1 - 9 2 - 9</i>	<b>7.7 ± 1.6 a</b>	<b>7.8 ± 1.5 a</b>	<b>7 ± 1.7 b</b>
<b>Eating quality</b> (1-9)	<b>7.4 ± 1.7 ab</b> <i>2 - 9</i>	<b>6.8 ± 2.2 c</b> <i>1 - 9</i>	<b>5.9 ± 2.4 d</b> <i>1 - 9</i>	<b>7.5 ± 1.6 a</b> <i>3 - 9</i>	<b>7.0 ± 1.9 bc</b> <i>1 - 9</i>	<b>6.1 ± 2.1 d</b> <i>1 - 9</i>
<b>Appearance</b>						
Quality good	70	40	54	82	87	71
Rating satisfactory (%)	27	40	31	14	11	24
unsatisfactory (%)	3	20	15	3	2	5
<b>Eating quality</b>						
Quality good	72	65	47	76	67	47
Rating satisfactory (%)	24	23	32	21	27	40
unsatisfactory (%)	3	13	21	2	6	12

#### Fruit Analyses (Pimprenelle)

<b>Fruit weight (g)</b>	<b>193 ± 28 a</b> <i>143 - 239</i>	<b>171 ± 34 ab</b> <i>141 - 256</i>	<b>163 ± 15 ab</b> <i>140 - 196</i>	<b>185 ± 35 a</b> <i>128 - 236</i>	<b>130 ± 21 c</b> <i>105 - 189</i>	<b>148 ± 12 b</b> <i>132 - 167</i>
<b>Firmness (kg/cm<sup>2</sup>)</b>	<b>7.8 ± 1 b</b> <i>6.3 - 9.4</i>	<b>9.7 ± 0.6 a</b> <i>8.8 - 10.9</i>	<b>5.4 ± 0.5 e</b> <i>4.4 - 6.2</i>	<b>6.5 ± 0.6 d</b> <i>5.7 - 7.8</i>	<b>7.8 ± 0.5 b</b> <i>7 - 8.6</i>	<b>7.1 ± 0.5 c</b> <i>6.2 - 7.6</i>
<b>Sugar (°Brix)</b>	<b>13.6 ± 0.9 b</b> <i>12.4 - 15.3</i>	<b>15.2 ± 1.2 a</b> <i>13.2 - 17.2</i>	<b>12.6 ± 0.4 c</b> <i>11.8 - 13.2</i>	<b>13.6 ± 0.9 b</b> <i>12.6 - 15.3</i>	<b>12.3 ± 0.5 c</b> <i>10.7 - 13</i>	<b>12.3 ± 0.4 c</b> <i>11.6 - 13</i>
<b>Malic Acid (g/l)</b>	<b>6.5</b>	<b>8.1</b>	<b>5.1</b>	<b>5.3</b>	<b>6.2</b>	<b>3.6</b>

Mean values and standard deviation. Different letters after the values means significant difference. (SPSS, LSD-test, p<0.05). Below the mean values the range of values is displayed in italic.

Participants confirmed in the inquiry that eating an apple as a snack is very popular. 31% of the adult participants eat preferably sweets, while 29% prefer apples. The most important quality traits to consumers are a good flavour and juiciness (Figure 3). Compared to the adult participants, young people judged sweetness and skin colour as more important, whereas nutritional values were less important. According to Kuhn and Thybo (2001) children (aged 9-13 years) tend to respond more positively to attributes such as sweetness and flavour of apples than adults who tend to respond to texture and sourness. In all age groups, apple is the favourite fruit and its appreciation increases with age.



**Figure 3:** Importance of apple characteristics, consumer survey, BEA Bern, Switzerland, April 2005, people > 16 years old, n=126

Leumann et al. (2004) found that for a majority of the consumers interviewed at a Swiss supermarket Coop near Zürich, eating quality was more important than the production method such as organic or integrated production.

## Conclusions

Sensory profiling is a valuable tool to evaluate the market potential and success of apple varieties and advanced selections from breeding programmes. The expert panel test reported here has shown that disease resistant apples are competitive with non-resistant varieties. However, some of them lack firmness and sweetness.

Consumers consider apples as a healthy snack. It should exhibit a good flavour and it should be juicy. The older the consumers the more they prefer apples to other snacks. Children and young people know much less about apples but they respond positively if apples are properly presented and suitable education is made. There is potential for increasing the apple consumption of young people. FAW 5878 and La Flamboyante were rated best among the varieties tested by consumers. Of the scab resistant varieties, Ariane was preferred to the others. Moreover, Ariane was considered the most attractive variety of all six. Gala, being attractive and very successful in the marketplace could not convince in respect to eating quality. In general there was no significant difference in appreciation of scab resistant versus non-resistant varieties. Therefore we conclude that there is scope for the successful introduction of high quality disease resistant varieties.

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