

Harvest Date and Quality Conservation of Plums

F. Gasser, M. Kockerols, C. Heiniger, S. Gasser, Y. Kneubuehler, T. Eppler,
W. Naunheim and A.B. Nising
Agroscope Changins-Wädenswil, Research Station, ACW
Switzerland

Keywords: plums, *Prunus domestica*, picking date, ripening

Abstract

Cultivars of plums, which in relation to their picking date cover the whole plum season in Switzerland, were picked at 3-4 different times in order to determine the influence of fruit ripeness on qualitative changes after picking, sensory quality and susceptibility to decay. As was to be expected, there was a relatively large reduction of fruit firmness in all cultivars the later the harvesting date. Fruit firmness was reduced further during the shelf life of 7 days. The sugar content remained stable, while acidity decreased by 5–10%. The sugar-acid ratio increased slightly, but sufficient to be significant for the sensory evaluation, as the harvesting date was delayed. The later the harvesting date, the higher was the proportion of unsaleable fruit. The cultivar and the amount of precipitation before and during harvesting had a strong influence on susceptibility to decay. The minimum acceptance values for the internal quality parameters were attained by most of the cultivars only at later harvesting dates, although their susceptibility to decay was then higher. The sensory evaluation showed that sweetness and firmness were less decisive attributes than acidity.

INTRODUCTION

Plums (*Prunus domestica*) tend to be harvested too early, in order to prevent decay and to make them capable of being transported. At the point of sale, therefore, the fruit are often only just ripe enough to be consumed. Fruit harvested later, although better tasting, are more susceptible to decay. Thus, the question arises as to whether or not an optimal harvest date could be defined to balance sensory quality and susceptibility to decay. In tests of 11 (2008) and 9 (2007) cultivars, each of which had been harvested at three or four different dates, tests have been carried out to determine the susceptibility to decay (“Monilia” test) and sensory quality of the fruit (“shelf life” test).

MATERIALS AND METHODS

The cultivars ‘Tegera’, ‘Vanette’, ‘Cacaks Schöne’, ‘Topstar’, ‘Topking’, ‘Cacaks Fruchtbare’, ‘Toptaste’, ‘Fellenberg’, ‘Jojo’, ‘Tophit’ and ‘Elena’, which cover the whole plum season in this sequence, were used for the tests. Fruits were grown in the ACW orchards in Wädenswil, Switzerland, and the crop load complied with the requirements of the quality programme QS33, a programme from the NorthWest of Switzerland which aims at the production of plums with a diameter of more than 33 mm. Each cultivar was picked at various picking dates (3 to 4) in accordance with the following schedule:

1. Picking date (PD 1): Before the commercial picking date
2. Picking date (PD 2): Corresponding to the commercial picking date
3. Picking date (PD 3): Optimum sensory picking date
4. Picking date (PD 4): Optimum sensory picking date. A fourth harvest was picked when the second and third picking dates were relatively early.

The fruit quality was assessed after picking and after the subsequent shelf life as described in Table 1. After the shelf life, the fruit were assessed by 7-12 tasters in relation to sweetness, acids and firmness in accordance with the “just-about-right” test principle. The test persons had to say whether an attribute such as the firmness was just right, too low or too high. The tasting also included a question on intent to purchase (yes, possibly

or no). In parallel to the shelf life test, 66 fruit were assessed for susceptibility to decay using the so-called “Monilia” test. The fruit were stored individually on fruit trays with 66 spaces and examined visually for decay and damage (tears, holes, bruising). The total of decayed and damaged fruit represented the unsaleable fruit. The conditions for the shelf life and Monilia tests for the two years of testing are listed in Table 2.

RESULTS

Quality Changes in Relation to Picking Date

For all of the cultivars tested in the two test years, the qualitative changes in relation to picking date were similar, as shown in Figure 1, using the ‘Jojo’ cultivar as an example. Fruit firmness and acidity were reduced the later the picking date. Conversely, the sugar-acid ratio increased the later the picking date. During the shelf life of 7 days, the firmness of the flesh reduced relatively markedly, the acid content remained constant or reduced slightly and the sugar content remained the same or increased slightly. As a result of the changes during the shelf life, the sugar-acid ratio usually increased slightly. As shown in Figure 2, the cultivars tested varied greatly in relation to their sugar-acid ratios. Furthermore, for all cultivars, the ratio increased with later picking dates, a circumstance which was important for the sensory assessment.

Susceptibility to Decay in Relation to Picking Date

The later the picking date, generally the higher was the proportion of unsaleable fruit (the total of damaged and decayed fruit in the year 2008, Fig. 3) and the proportion of decayed fruit in the year 2007 (Fig. 4). As well as the cultivar’s characteristics, precipitation before and during the harvest influenced susceptibility to decay, so a comparison of the cultivars in relation to susceptibility to decay must be interpreted with a measure of caution. On the other hand, the overview of the two test years shows that obviously some cultivars, such as ‘C. Schöne’, were susceptible to decay while others, such as ‘Vanette’, ‘Jojo’ or ‘C. Fruchtbare’ produced significantly better results. In 2008, the ‘Vanette’ and ‘C. Schöne’ cultivars were compared for susceptibility when picked with and without stalks. Fruit picked with stalks showed around 8% less decayed fruit after the shelf life than the fruit picked without stalks. The reason for this difference could be the tearing of the fruit flesh when the stalk was pulled out.

Sensory Quality in Relation to Picking Date

As can be seen in Figure 5, the assessment of the fruit in relation to sweetness, acidity and flesh firmness was better the later the picking date. The assessments of sweetness and acidity were in line with the analytical values obtained for sugar, acids and sugar-acid ratio shown above (Fig. 1). The most decisive attribute for the overall sensory assessment of the fruit, expressed in the form of intent to purchase, was acidity. Sweetness and fruit firmness seemed to be far less important. In both test years, the intent to purchase correlated best with the assessment of acids (Table 3). Firmness of flesh only became a decisive factor for the sensory assessment when the fruit was distinctly too hard or too soft.

In the just-about-right method used for the tasting, the minimum acceptance value for a sensory attribute is attained when at least 60% of the assessments fall into the category “just right”. The minimum acceptance value of 60% was obtained for some cultivars only at the later picking dates at which, however, their susceptibility to decay was important. In the comparison of the acceptance values for the sensory attributes, it can be seen that the evaluation of the fruit in relation to intent to purchase was less severe than for the other attributes, especially acidity (Fig. 5). This may be related to the fact that the intent to purchase is associated less with sensory assessment than the experience of the tasters buying fruit in everyday life.

Finally it was interesting to see whether there are cultivars of plums which can be picked at a satisfactory quality which do not show an excessive susceptibility to decay.

Obviously some of the cultivars which satisfied these conditions and showed a good sensory quality, with at least 60% of the assessments in relation to “intent to purchase” in the categories “good” or “possibly”, even at earlier picking dates, such as ‘C. Fruchtbare’, ‘Tophit’, ‘Vanette’ and ‘Topking’ (Fig. 6).

DISCUSSION

From a methodological point of view, it should be noted that the selection of experimental conditions, including time and temperature, for the shelf life and *Monilia* tests have a significant influence on the results. That could be demonstrated through the comparison of the results for the susceptibility to decay in the two tested years. In 2007, the amount of decay was significantly higher than in 2008 probably also because of more rigorous test conditions. In practice, shelf life conditions in relation to length of time and temperature can be very different depending on whether, for example there is sale in progress and how fast the fruit is sold. In this aspect, the results of our tests do not primarily reflect what happens in practice, but serve simply as a relative comparison of cultivars and picking dates.

Susceptibility to decay depends largely on the cultivar’s characteristics (intrinsic factors) as well as external conditions such as growing method, pesticide treatment and climatic conditions (extrinsic factors). The structure of the skin represents an important intrinsic factor which, through the skin’s barrier properties, has a significant influence on their susceptibility to decay. It is hypothesised that the wax coating becomes thinner with increasing ripeness and volume of the fruit and micro-cracks occur. These are factors that make the penetration of harmful micro-organisms such as *Monilia laxa* easier (Knoche and Peschel, 2007).

In practice, the picking date is often not determined primarily by the sensory fruit quality but rather by weather and market conditions. If there is the threat of bad weather or if the demand in the market is high, the fruit are often picked earlier than the optimum time. It would be ideal if the optimum picking date could be determined by objective and easily measurable parameters. Our research in recent years has shown that the quality parameters, which are usually investigated, such as sugar concentration, fruit firmness or acidity, are subject to large fluctuations from year to year and are hardly suited to this purpose. Additionally, the postharvest development of these parameters can be very different, which makes their appropriateness as ripeness parameters questionable. The measurement of the colour of the fruit flesh in the ‘Jojo’ cultivar carried out in 2008 showed, however, that this parameter could be, at least in some cultivars, of interest for the determination of the picking date (Table 4). The intensity of the colour and the proportion of red colour in the fruit flesh increased the later the picking date. These results are in good agreement to those of the work carried out by Usenik et al. (2008), where the concentration of anthocyanin and the fruit skin colour were analysed in relation to the picking date.

It should also be noted that plum cultivars differ in the length of their harvest window: in 2008, earlier cultivars such as ‘C. Schöne’, ‘Tegera’ or ‘Topstar’, had picking windows of 7-9 days while the later cultivars, such as ‘Jojo’, ‘Elena’ or ‘Tophit’, had picking windows of 13-20 days. In practice, that means that there is a risk that the earlier cultivars will be picked too late, because the quality changes occur in a relatively short time. The fruit quality changes occur more slowly in the later cultivars, so there is a risk that these plums will be picked too early. As can be seen in Figure 5, there is a particularly strong correlation between sensory qualities and picking date in the late cultivars.

Literature Cited

- Knoche, M. and Peschel, S. 2007. Deposition and strain of the cuticle of developing European plum fruit. *J. Amer. Soc. Hort. Sci.* 132(5):597-602.
- Usenik, V., Stampar, F. and Veberic, R. 2008. Anthocyanins and fruit colour in plums (*Prunus domestica* L.) during ripening. *Food Chem.* 114:529-534.

Tables

Table 1. Quality assessment of plums.

Quality criterion	Measurement method
Flesh firmness	Measured with a TA2i Texture Analyzer (Stable Mircor Systems): 2 mm compression, 6.7 mm/s traverse motion, probe diameter 11 mm. Results expressed in weight per mm traverse motion (g/mm).
Appearance of fruit flesh	Visual assessment of browning and glassiness. Determination of fruit flesh colour in Jojo cultivar (L^* , a^* , b^*) with Minolta Chroma Meter CR-310.
Soluble solids	Determination in fruit juice (from frozen samples) of soluble solids with Atago Pr32 refractometer ($^{\circ}$ Brix).
Total acids	Determination in fruit juice (from frozen samples) of titratable total acids with Mettler DL67 titrator (expressed as g/litre maleic acid) (titration with 0.1 M sodium hydroxide to pH-value of 8.1).
Sugar/acid ratio	Calculated by the division of the sugar content by the acid content and multiplied by factor 10.

Table 2. Test conditions for shelf life and Monilia tests.

Test	Number of fruit per test	Test conditions	
		2007	2008
Shelf life test (determination of quality changes)	500 g fruit in PET dishes with lids and ventilation slots	5 or 10 days at 20°C	4 days at 1°C, 1 night at 10°C (heated), 3 days at 20°C
Monilia test (determination of susceptibility to decay)	66 individual fruit laid on plastic (polypropylene) fruit tray	5 or 10 days at 20°C	3 days at 3°C, 4 days at 20°C

Table 3. Correlation coefficient between intent to purchase and assessment of sensory quality parameters.

Sensory attribute	Correlation coefficient (intent to purchase against assessment of sensory quality parameters)	
	2007 (tasting after harvest and before shelf life)	2008 (tasting after shelf life)
	Sweetness	0.35
Acids	0.61	0.85
Firmness	0.35	0.67

Table 4. Development of fruit flesh colour of ‘Jojo’ in 2008 in relation to picking date and during shelf life.

Picking date	Before/after shelf life (B/A)	Mean L*	Mean a*	Mean b*	Mean from coefficient ab
1	A	50.02	-5.61	26.19	102.20
2	B	53.18	-4.30	28.58	98.54
2	A	46.74	-0.17	25.62	90.36
3	B	47.24	-0.70	28.79	91.35
3	A	43.39	1.62	24.68	86.49

Figures

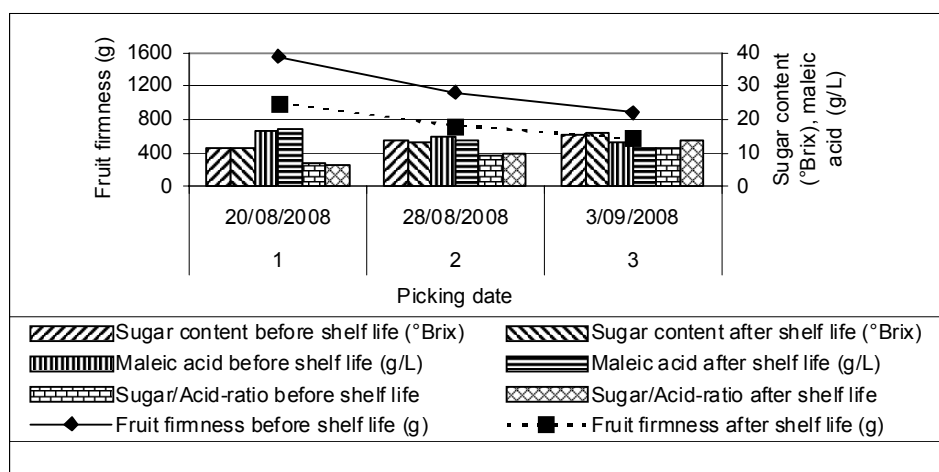


Fig. 1. Changes in fruit quality during shelf life in ‘Jojo’ cultivar in 2008 in relation to picking date.

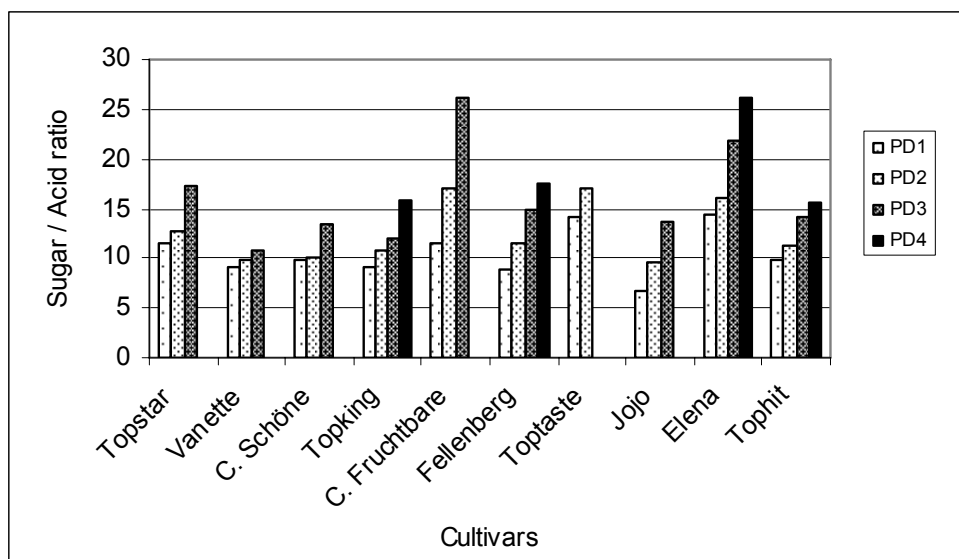


Fig. 2. Sugar-acid ratio after shelf-life in relation to cultivar and picking date (PD) in 2008.

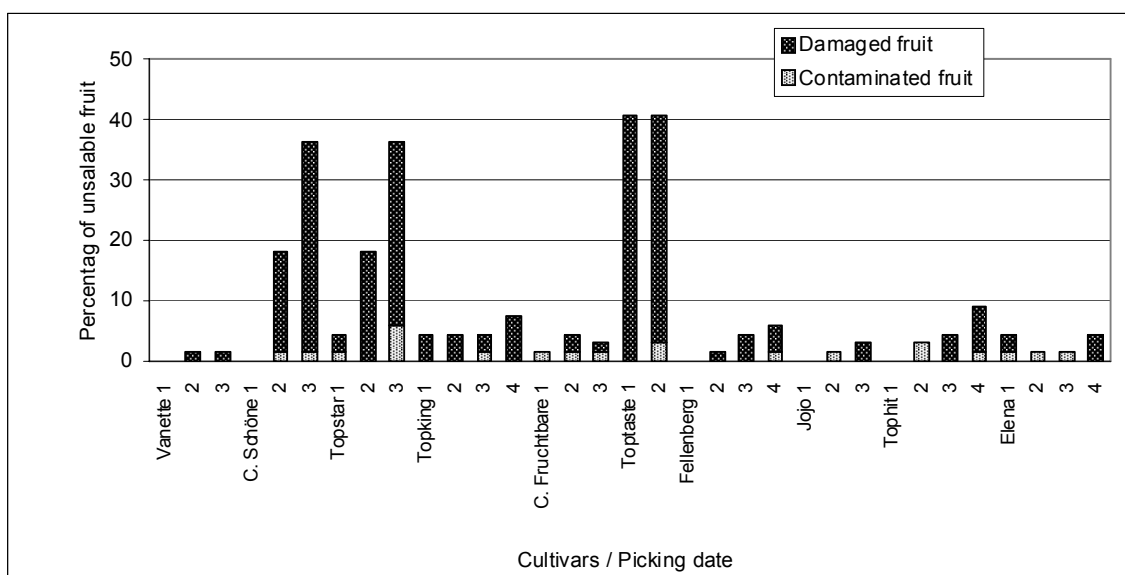


Fig. 3. Proportion of decayed and damaged fruit in 2008 in relation to cultivar and picking date (PD) (Monilia test).

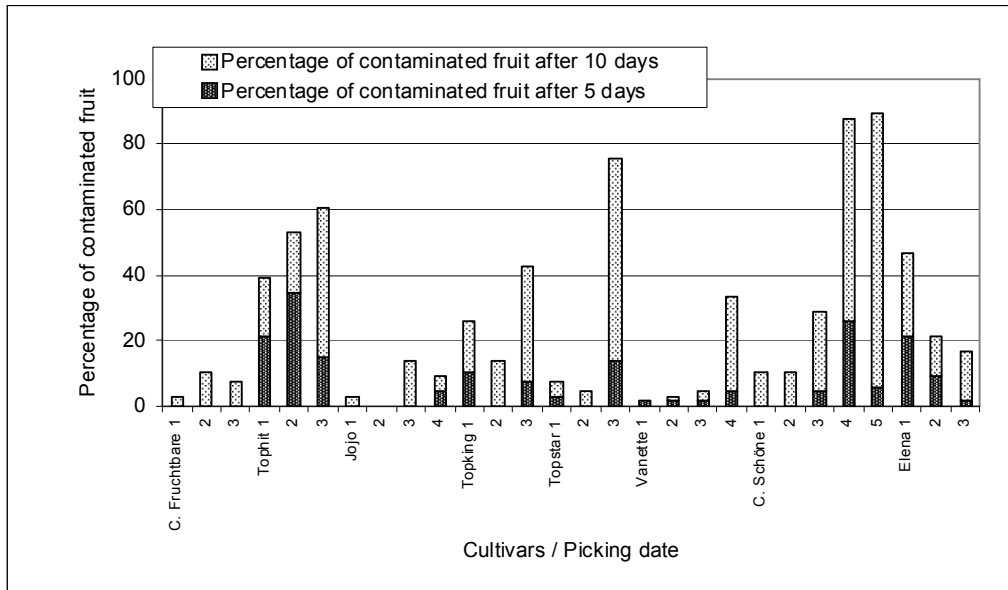


Fig. 4. Proportion of decayed fruit in 2007 in relation to cultivar and picking date (PD) (Monilia test).

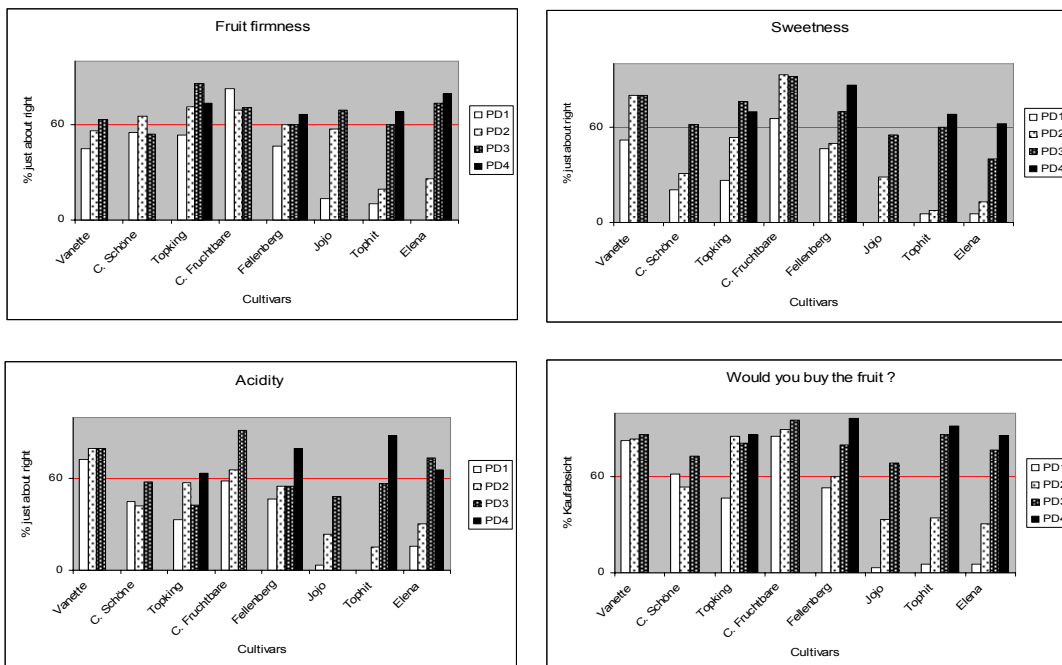


Fig. 5. Sensory assessment of plums in 2008 in relation to cultivar and picking date (PD).

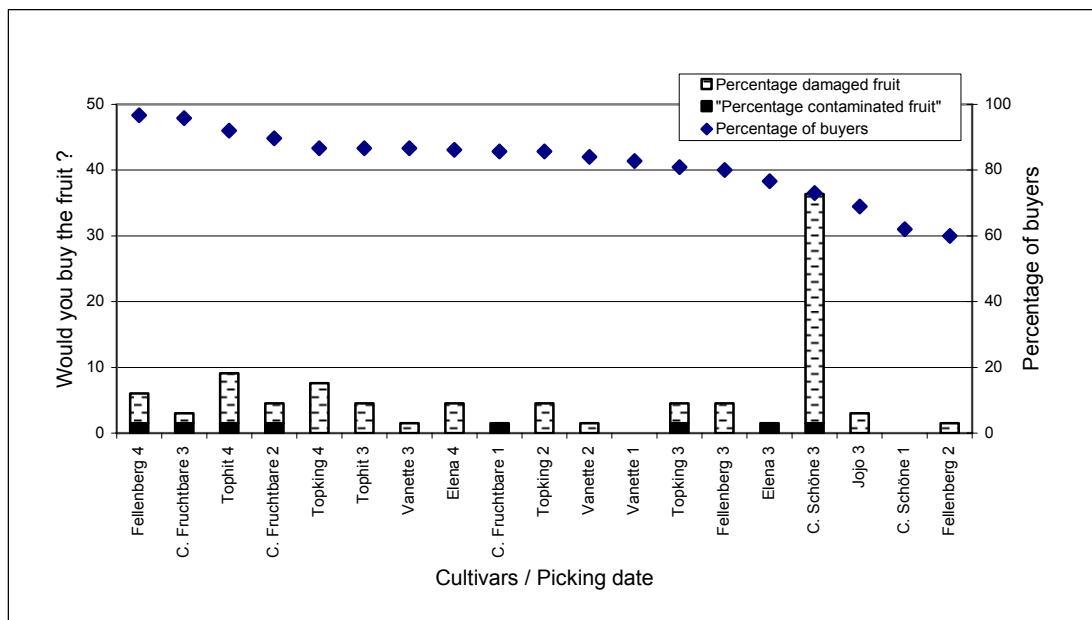


Fig. 6. Ranking of plum cultivars and picking dates by sensory quality (intent to purchase).