Phenology and Fruit Quality of Nine Sweet Cherry Cultivars in South Patagonia

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Abstract

Sweet cherry (*Prunus avium* L.) production has developed since the earliest plantings in 1970 in Los Antiguos (Argentina) and the latest in 1990 in Chile Chico (Chile). During the last few years, new cultivars have been introduced in the region, but there are no records about their phenology and fruit quality. The aim of this study was to characterize nine sweet cherry cultivars ('Bing', 'Van', 'Kordia', 'Lapins', 'Sunburst', 'Napolitana', 'Rainier', 'Newstar' and 'Sweetheart') growing in these areas by phenological and fruit quality aspects such as weight, caliber, soluble solids content (SSC), firmness, titratable acidity (TA) and color (L*, C* and h*). Phenology was determined from first bloom to harvest. For postharvest fruit quality determinations, three samples of 100 fruit of each cultivar were collected at harvest from commercial orchards (2 to 6 orchards per cultivar). Means were statistically analyzed with a GLM procedure and Tukey test. Significant differences were found in all characteristics ($p<0.05$). The most promising cultivars for the region, due to their late ripening and fruit quality, were 'Sweetheart', 'Lapins', 'Kordia', 'Bing' and 'Van'. The first three varieties were harvested in mid-January, while 'Bing' and 'Van' were harvested in late December. Firmness (Durofel index) was 87.3 for 'Sweetheart', 77.5 for 'Van', 75.4 for 'Lapins', 72.5 for 'Kordia' and 70 for 'Bing'. TA (% malic acid) was 0.66 for 'Bing', 0.58 for 'Kordia', 0.5 for 'Van', 0.48 for 'Sweetheart' and 0.44 for 'Lapins'. SSC (°Brix) was 21.0 for 'Sweetheart', 21.9 for 'Van', 20.0 for 'Kordia', 16.8 for 'Lapins' and 15.5 for 'Bing'.

INTRODUCTION

Sweet cherries (*Prunus avium* L.) are commercially cultivated in more than 40 countries worldwide. The southern hemisphere (mainly Chile, South Africa, Australia and Argentina) contributes only 2.6% of the world's production (FAO, 2005). Although this seems to be a very small proportion, it is important economically for local development because of harvest and counter season marketing advantages.

Sweet cherry production in the Los Antiguos (Argentina) – Chile Chico (Chile) valley (46°19' southern lattitude, 250 m above sea level) (Fig. 1) has been developed since the earliest plantings in 1970. The area under cherry cultivation is about 312 ha and requires "low input" management due to the low incidence of pests and diseases. The harvest period occurs late in the season (December–January) and usually avoids competition with other southern hemisphere cherry production, including that in other regions of both countries. Thus, selecting later maturing cultivars is important.

The wholesale market requires cherries with good shipping and handling characteristics. This is especially important for this region, due to the distance to the main markets in the northern hemisphere. In recent years, new cultivars have been introduced in the Los Antiguos – Chile Chico valley to extend the marketing period, but there are no records of their phenology or fruit quality characteristics for marketing and transport.

The aim of this study was to characterize the phenology of nine sweet cherry cultivars growing in Los Antiguos – Chile Chico and to determine their fruit quality characteristics for marketing and transport.

MATERIALS AND METHODS

Plant Material

The sweet cherry cultivars tested in the Los Antiguos – Chile Chico valley were 'Bing', 'Van', 'Kordia', 'Lapins', 'Sunburst', 'Napolitana', 'Newstar', 'Rainier' and 'Sweetheart'. All trees were more than 4 years old, grafted on P. *mahaleb* and trained in the vase system. Water was provided by furrow irrigation and nutrients by hand fertilization, with doses based on foliar analysis. Weeds were chemically controlled, and no pesticides were used between bloom and harvest.

Phenology

Phenology was determined every three days from 20th September to the end of harvest. The periods considered were: first bloom (20% open flowers), full bloom (50% open flowers) and petal fall (Fig. 2). The harvest period (Fig. 3) was considered when cherries developed adequate quality characteristics (soluble solids content [SSC], firmness and color parameters) for the export market.

Quality Parameters

At harvest, three samples of 100 fruits from each cultivar were hand picked from each commercial orchard (two to six orchards per cultivar) and measured within the same day of sampling at a fruit temperature of 20°C.

Fruit quality characteristics were determined as follows:

- Fresh weight of individual fruit (g) using a digital scale;
- Caliber (equatorial diameter, mm) using a manual caliper;
- Firmness was determined non-destructively using the Durofel Index (ID) (Hilaire et al., 2000) on two opposite cheeks in the equatorial zone, using a hand held durometer (Durofel, Agrotechnologie, France) with a 0.25 mm tip.
- Color (L*, C* and h*): ground color was measured on two opposite cheeks in the equatorial zone, using a colorimeter (Minolta CR-400 Chroma Meter, Konica Minolta Sensing Inc., Osaka, Japan). Lightness (L*), hue angle ($h^*=\tan^{-1} b^*/a^*$) and chroma ($C^*=\sqrt{a^{*2}+b^{*2}}$) values were measured for describing visual color appearance, where a*: green to red and b*: blue to yellow (CIE, 1976).

From each sample, 40 cherries were hand-pitted and reduced to pulp using a home blender. The cherry juice was used for analysis of soluble SSC and titratable acidity (TA). TA, as % malic acid, was determined by titration to pH 8.2 with 0.1 N NaOH on a solution of 5 g of fruit pulp, diluted with 50 ml of distilled water, while SSC, expressed as °Brix, was determined with a Milwaukee MR32ATC Refractometer.

Statistical Analysis

Quality parameter means were statistically analyzed by the General Linear Model procedure as a completely randomized experiment and comparisons were carried out using Tukey's multiple range test (SAS Inc., Cary, N.C.).

RESULTS AND DISCUSSION

Phenology

Flowering started on 28 September with 'Lapins' and finished a month later (Fig. 2). Flowering of 'Lapins', which had the longest flowering period (18 days), 'Rainier' and 'Van' coincided with the flowering period of 'Bing', a self-sterile cultivar and were good pollinizers for this cultivar. As 'Bing' is the main (40%) cultivar in the region, it is important to have its pollination period overlap with cultivars having good fruit quality. 'Newstar', 'Lapins', 'Sunburst' and 'Sweetheart' are self-fertile, and pollinizers for 'Napolitana' and 'Kordia' were not considered in this study.

Considering all cultivars in the study, harvest lasted 30 days, beginning on 23 December with 'Bing' and finishing with 'Sweetheart' (Fig. 3). This may allow

continuity and also a long marketing period, with the potential to extend marketing up to the end of February with postharvest practices such as modified atmosphere packages. By that time, there are no other sweet cherries in the world market.

Weight and Caliber

Fruit weight and size are very important characteristics for commercial market value (Vittrup Christensen, 1995; Kappel et al., 1996). In this study, 'Sweetheart', 'Sunburst', 'Lapins' and 'Kordia' were the heaviest, ranging from 10.4 to 9.5 g, while 'Napolitana' was clearly the lightest (6.7 g) (Table 1). This was consistent with fruit caliber, with the first four cultivars having diameters of more than 26 mm and the latter having a mean diameter of 22 mm. These two parameters were positively correlated (r^2=0.8672, $p<0.05$). Although these are not exceptionally large sizes, it must be considered that these are mean data, and they do not take into account weight and diameter distributions.

Firmness

Firmness (ID) is usually relevant to consumer acceptance (Cliff et al., 1996). It is also an important characteristic for cherries grown in this region because firmer fruit may withstand longer shipping periods. 'Sweetheart' was the firmest cultivar (87.3) (Table 1), while the least firm were 'Newstar' (55.8), 'Sunburst' (58.5) and 'Rainier' (66.5), which were below the optimum firmness of 70 (Kappel et al., 1996).

Soluble Solids Content (SSC) and Titratable Acidity (TA)

All cultivars had SSC above 15 °Brix (Table 1), which is considered to be acceptable for sweet cherry (Kappel et al., 1996). 'Napolitana', 'Van', 'Sweetheart', 'Newstar' and 'Lapins' have a SSC/TA ratio above 35. These parameters are related to flavor intensity, with higher SSC and TA accounting for better acceptability (Cliff et al., 1996).

Color (L*, C* and h*)

'Rainier', which is considered to be a bicolor cherry, differed from all the others in L* (47.7) and h* (38.9) (Table 1). 'Rainier' also had a larger C*, but no significant differences were found between it and 'Lapins', 'Kordia', 'Bing', 'Sunburst' and 'Napolitana' ($p>0.05$).

CONCLUSIONS

Fruit quality indices such as firmness and flavor are very important to consumer perceptions. Because cherries have a relatively short fresh market season, late ripening high quality cherries are an important alternative for a region that is located so far from the main markets (European countries).

Based on the data presented in this paper, taken during a single season, the most promising cultivars for the region were 'Sweetheart', 'Lapins', 'Kordia', 'Van' and 'Bing' due to their late ripening and/or fruit quality characteristics. These cultivars showed good fruit quality attributes for long distance shipping, with firmness values above 70, a 1-month harvest period, and a 2-month potential marketing period when postharvest techniques are applied.

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Tables

Table 1. Mean values of fruit quality parameters evaluated for nine sweet cherry cultivars in the Los Antiguos – Chile Chico valley.

Variable	Sweetheart	Lapins	Kordia	Bing	Van	Newstar	Sunburst	Napolitana	Rainier
Weight (g)	10.4 a [3]	9.8 ab	9.54 abc	8.16 bc	8.55 abc	8.88 abc	10.23 ab	6.68 c	9.15 abc
Caliber	27.06 a	26.3 ab	26.75 ab	24.47 bc	26.12 abc	25.16 ab	26.4 ab	22.29 c	27.10 a
Firmness [1]	87.33 a	75.38 b	72.5 bc	70 b	77.5 ab	55.8	58.5 cd	75.0 ab	66.5 bc
TA [2]	0.48 bc	0.44 c	0.58 abc	0.66 a	0.5 bc	0.48 bc	0.51 bc	0.54 b	----
SSC (°Brix)	21 ab	16.8 bc	20 abc	15.5 cd	21.9 ab	18.5 bc	17.75 bc	26.0 a	18.0 bc
SSC/TA	43.62 a	38.62 ab	30.88 abc	23.54 c	43.8 a	38.54 ab	34.88 b	47.32 a	----
L*	30.78 b	32.27 b	31.24 b	32.73 b	25.69 b	32.0 b	32.3 b	33.51 b	47.74 a
Chroma	25.14 b	29.73 ab	26.62 ab	28.69 ab	14.31 b	21.6 b	24.92 ab	32.85 ab	45.63 a
Hue angle	12.81 b	16.03 b	14.84 b	17.18 b	9.61 b	13.91 b	15.44 b	20.38 b	38.91 a

[1]Higher values indicate firmer fruit. Values obtained with a Durometer instrument.
[2]Titratable Acidity (% malic acid).
[3]Different letters within the same row indicate significant differences ($p<0.05$).
---- = missing data

Figures

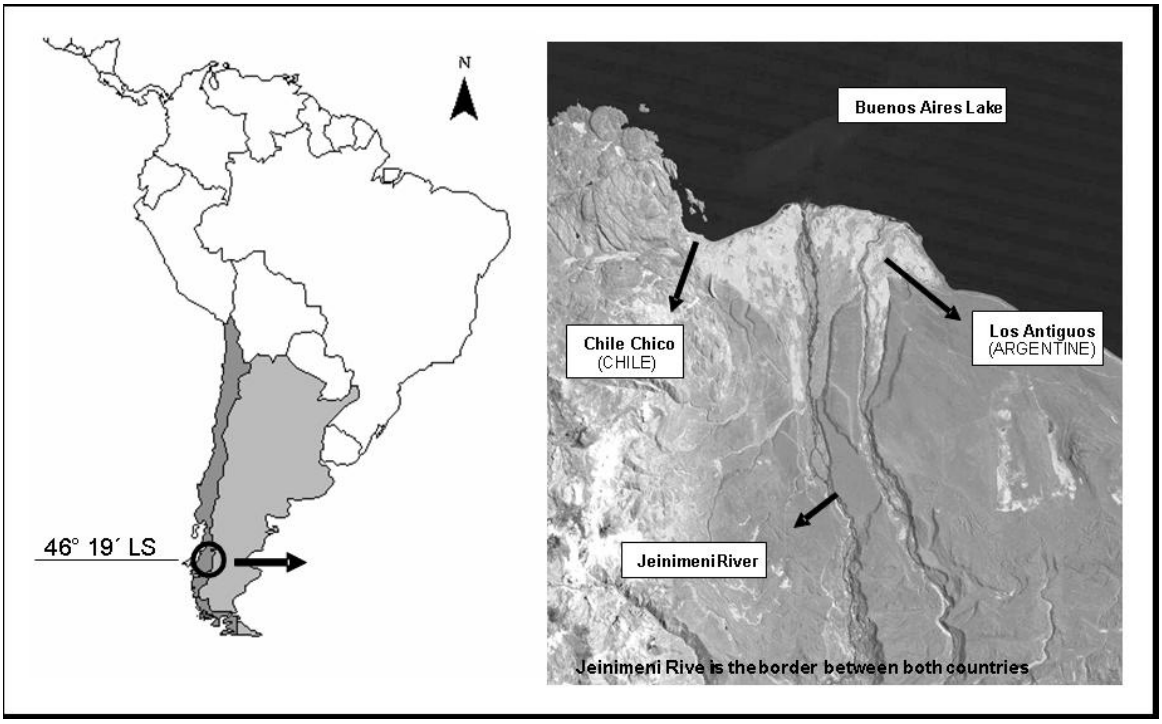

Fig. 1. Location of Patagonia and the area under study (Los Antiguos – Chile Chico).

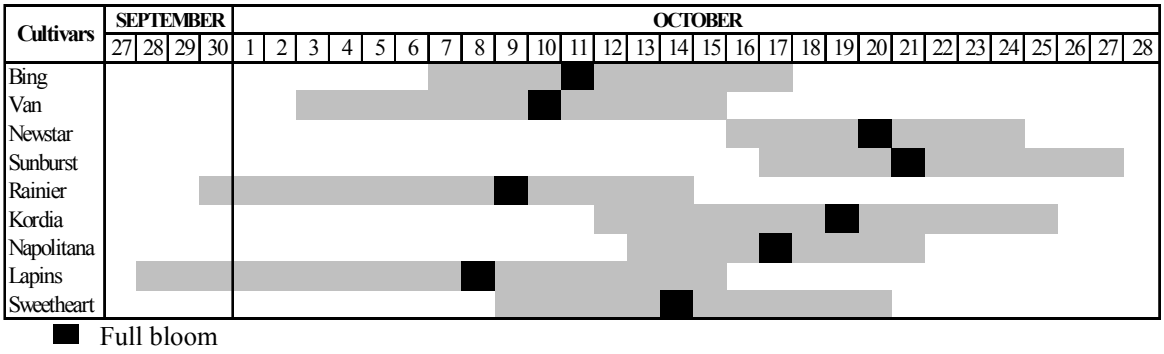

Fig. 2. Flowering period (first bloom to petal fall) for nine sweet cherry cultivars in the Los Antiguos – Chile Chico valley.

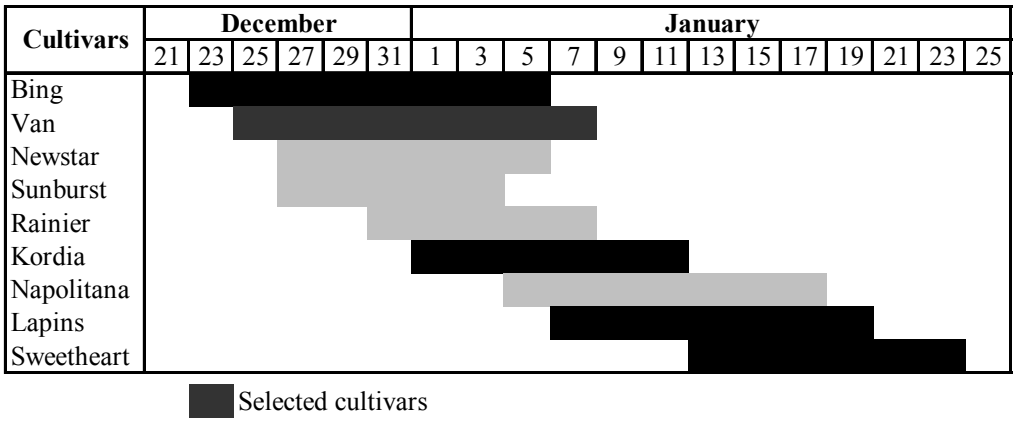

Fig. 3. Harvest period for nine sweet cherry cultivars in the Los Antiguos – Chile Chico valley.