Evaluating Berry Firmness and Total Soluble Solids of Newly Released Highbush Blueberry Cultivars

W.Q. Yang and J. Harpole
Oregon State University
North Willamette Research & Extension Center
Aurora, OR 97002
USA

C.E. Finn
USDA-ARS
Horticultural Crops Research Unit
Corvallis, OR 97330
USA

B.C. Strik
Department of Horticulture
Oregon State University
4017 ALS
Corvallis, OR 97331
USA

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Abstract

Berry firmness and total soluble solids (TSS) of three newly released highbush blueberry cultivars ('Draper', 'Liberty', and 'Aurora') were evaluated in the 2005 growing season against three popular commercial highbush cultivars ('Duke', 'Bluecrop', and 'Elliott') grown in the Northwest during and after cold storage at temperatures between 1 to 4°C. These experiments were conducted using berries from the first pick in a variety evaluation plot at the North Willamette Research and Extension Center. Berry firmness was determined with a FirmTech II firmness tester. After cold storage durations of 1, 2, and 3 weeks, berries were taken out and acclimated at room temperature. Berry firmness and TSS then were determined every three days until berries were considered unmarketable. At week 1, 'Draper' and 'Duke' had the highest firmness in the first three days, and 'Elliott' and 'Liberty' had the lowest firmness during the 12 days sitting at room temperature. 'Liberty' had the highest TSS among all cultivars. At week 2, 'Duke' had the highest firmness while 'Elliott' had the lowest firmness during the 12-day period. For TSS level, 'Bluecrop' was the lowest and 'Elliott' and 'Liberty' were the highest. At week 3 during the 12-day test period, the cultivars with the highest and lowest firmness were 'Duke' and 'Elliott' respectively. TSS in 'Liberty' was still among the highest, and 'Bluecrop' and 'Liberty' had the lowest TSS level among all cultivars. If shelf-life is measured by berry firmness at room temperature, the shelf-life of 'Duke' and 'Draper' were very similar. 'Aurora' had a shelf-life better than 'Elliott'; however 'Liberty' had a shelf-life no better than 'Bluecrop'.

INTRODUCTION

Blueberries are a rapidly growing commodity in Oregon. About 5,000 acres of blueberries were harvested with a value of more than 60 million dollars (US) in 2007. More than 35 percent of the production was marketed fresh in Oregon in 2007. With a steady increase in demands for fresh blueberries worldwide, new blueberry cultivars with good storage qualities are desired for the needs of the expanding domestic and international markets. In 2003, three new blueberry cultivars ('Draper', 'Liberty', and 'Aurora') were released by Dr. James Hancock (Michigan State University) after being evaluated in the USDA-OSU variety evaluation trial block at the North Willamette Research and Extension Center (NWREC; Aurora, OR, USA) (Hancock, 2006). Although these new blueberry cultivars have good quality attributes such as color, size, and firmness compared to standard highbush cultivars, we do not know how they will perform under regular cold storage and their shelf-life when packed in standard commercial clamshells.

'Duke', 'Bluecrop', and 'Elliott' are three popular commercial highbush blueberry cultivars in the Northwest (Yang, 2005). 'Duke' and 'Bluecrop' generally have good firmness and shelf-life, while 'Elliott' is considered a 'soft' berry due to poor fruit firmness by the Northwest blueberry industry (Yang, 2003). For newly released highbush blueberry cultivars, fruit firmness is a very important trait for blueberry marketability and shelf-life, especially during cold storage. Since fruit firmness has shown improvement through

traditional breeding methods for highbush blueberries (Ehlenfeldt and Martin, 2002), it is expected these newly released cultivars should have better shelf-life as measured by fruit firmness. Blueberry firmness can be reliably determined by using the FirmTech II firmness tester, which has been currently used in several university and USDA labs for berry or other fruit research (Ehlenfeldt and Martin, 2002; Hanson, et al., 1993).

In this experiment, we used the FirmTech II to compare fruit firmness between three popular commercial highbush blueberry cultivars and three newly released highbush cultivars to determine their shelf-life during and after cold storage.

MATERIALS AND METHODS

In the 2005 growing season, 'Duke', 'Bluecrop', 'Elliott', 'Draper', 'Liberty', and 'Aurora' were harvested by hand from the USDA-OSU cultivar evaluation block at the NWREC. Almost all fruits were from the first pick and they were placed in commercial 125 g clamshells (Naturipe Farms LLC; Naples, FL). Treatments included three storage periods at 1, 2, and 3 weeks with six highbush blueberry cultivars as stated above. Each clamshell was treated as a replicate and there were three replicates per treatment. Cold storage temperatures ranges from 1 to 4°C and clamshells were placed on metal shelves in the cold room. At weeks 1, 2, and 3 after cold storage, clamshells were allowed to acclimate to room temperature, 7-10 berries were randomly selected and fruit firmness were determined by the FirmTech II firmness tester (BioWorks, Inc., Wamego, KS). Then 3-5 berries were frozen under -20°C with total soluble solids (TSS) determined later. Clamshells were continually kept at room temperature with firmness determined and TSS samples collected at days 3, 6, 9, and 12 respectively. After 12-days, the berries generally became unmarketable. TSS was determined by thawing frozen berry samples at room temperature for 4 hours; then berries were crushed in a disposable plastic cup. TSS was determined using a refractometer (Atago PAL-1, USA).

Firmness and TSS data were analyzed using the PROC GLM procedure of SAS software (SAS Institute, Inc., Gary, NC) and means were ranked by Duncan's multiple range test when appropriate.

RESULTS AND DISCUSSION

Overall, berry firmness and TSS were affected by storage periods of 1 week, 2 weeks, and 3 weeks under cold storage (Table 1), which was expected giving changes in fruit moisture content, with as much as 10% moisture loss in 'Duke' variety (data not shown). As a result, changes in fruit moisture content affected fruit firmness and TSS during cold storage. The overall ranking of firmness for all six cultivars were 'Duke', 'Draper', 'Bluecrop', 'Aurora', 'Elliott', and 'Liberty' (from highest firmness value to the least; Table 1). It appears early ripening cultivars ('Duke' and 'Draper') tended to have higher firmness than late season cultivars ('Elliott' and 'Aurora'). 'Liberty' had the highest TSS of 19.7 °Brix, while 'Bluecrop' had the lowest at 12.3 °Brix.

Firmness during room temperature storage decreased for all cultivars. Fruits tended to last a week or so at room temperature after cold storage, regardless of cultivar. After one week of cold storage, 'Draper' and 'Duke' had the highest firmness and 'Elliott' and 'Liberty' the lowest firmness after 3 days at room temperature. At week 2, 'Duke' had the highest firmness while 'Elliott' had the lowest firmness during the 12-day period. At week 3 during the 12-day test period, the cultivars with the highest and lowest firmness were 'Duke' and 'Elliott', respectively. 'Draper' had the quickest decrease in firmness from day 0 to 3 in all three storage periods evaluated, indicating 'Draper' as a fresh berry may become soft faster when placed on shelf without cooling. Although the firmness of blueberries is largely determined by genetics or cultivar, cultural practices such as fertilization and irrigation can affect berry firmness. For example, the firmness of blueberries could be improved by cultural management practices such as calcium application (Stückrath et al., 2008; Hanson et al., 1993). It has also been demonstrated that firmness of blueberries can be improved by using plant hormones or growth regulators (NeSmith, 1999). Because 'Liberty' tended to have the lowest fruit firmness, altered

cultural practices may increase its firmness because its sweetness would make for excellent fresh market fruits.

From week 1 to 3, 'Liberty' had the highest TSS level among all cultivars at the beginning of the three day sampling, while 'Bluecrop' and 'Aurora' tended to have the lowest TSS level for almost all sampling dates. TSS levels increased at days 9 and 12 for 'Draper' at week 1 and week 3 cold storage periods, indicating accelerated ripening at room temperatures. TSS level in 'Bluecrop' was the least variable from day to day over the three separate cold storage periods, suggesting low TSS levels in the berry may contribute to stable TSS levels during room temperature storage.

CONCLUSIONS

If shelf-life is determined by berry firmness, the shelf-life of 'Duke' and 'Draper' are very similar. 'Aurora' had a better shelf-life than 'Elliott's, however 'Liberty' had a shelf-life no better than 'Bluecrop'.

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Table

Table 1. Total soluble solids (TSS) and firmness of six highbush blueberry cultivars during storage.

Cultivar	Main effects means TSS (º Brix)	 Firmness (g/mm of deflection)
Duke	14.2	169.4
Draper	15.6	163.7
Bluecrop	12.3	149.4
Liberty	19.7	133.3
Elliott	14.9	138.9
Aurora	13.1	148.7
Factorial Analysis	*P*(F)	*P*(F)
Week	<0.0001	<0.0001
Day	0.0871	<0.0001
Cultivar	<0.0001	<0.0001
Day×cultivar	0.6198	0.0136

Figure

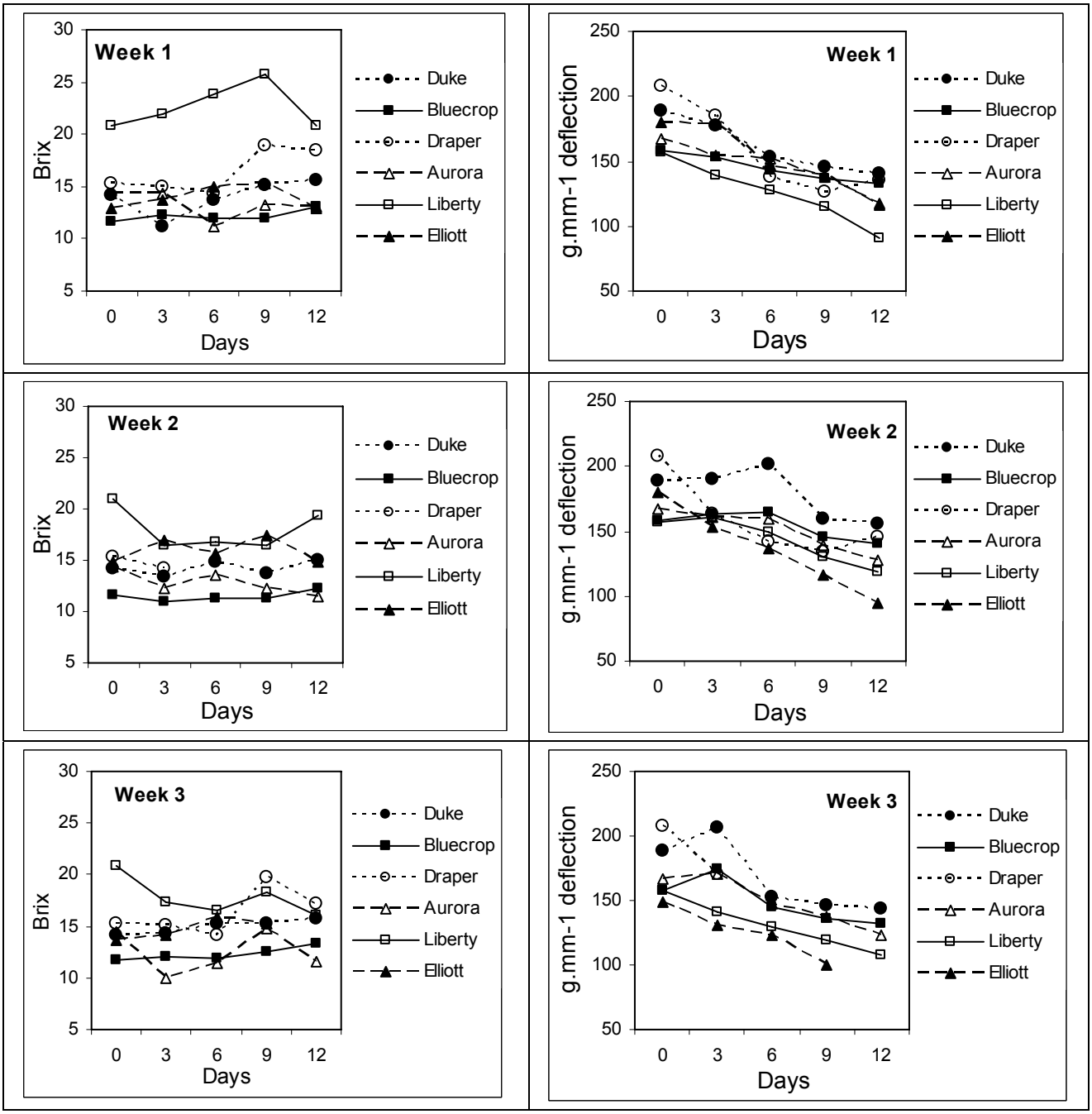

Fig. 1. Changes in fruit TSS (ºBrix) and firmness (g/mm of deflection) after one to three weeks of cold storage. After each cold storage period, samples were left at room temperature and measurements were taken every three days.