Characteristics of Soluble Sugar Accumulation in Commercially Grown *Fragaria chiloensis*

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Sugar concentration is one of the most important factors for the quality of strawberry fruit. Glucose, fructose, and sucrose are the major soluble sugars that are found in the fruit. Many cultivars predominantly accumulate glucose and fructose at almost equal level but sucrose level is generally much lower (Hancock, 1999). The levels of three major sugars in some Japanese cultivars, however, are almost equal or sucrose is often the highest (Uematsu, 1998). Ripe *Fragaria chiloensis* fruit show high (7.3 to 10.6) soluble solid content (SSC) but the sugar

composition is not yet clear (Lavin and Maureira, 2000). In the present study, we analyzed soluble sugar concentration of promising land races in *F. chiloensis* and the results were compared with those in *F. ×ananassa*.

Materials and Methods

Experiment I. *Fragaria ×ananassa* from California ('Chandler' and 'Seascape'), Spain ('Tudla'), and Japan ('Hokowase' and 'Reiko') and two land races of *F. chiloensis* (accessions

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97PUR-1A and 94BAU-1A) were used for the sugar analysis. All fruit were grown in central Chile (Lat. 35° 56'S) and ripe fruit were collected on 25 Nov. and 7 Dec. 1999, respectively. Glucose, fructose, and sucrose levels were enzymatically analyzed as described previously (Nishizawa and Shishido, 1998).

Experiment II. Fruit of *F. chiloensis* (accession 94BAU-1A) and *F. ×ananassa* ('Camarosa') were collected on 21 Nov. 2001

Table 1. Soluble sugar concentration of ripe strawberry fruit grown in central Chile.

Species, variety, or land race	SSC		Sugar concn (mg·g ⁻¹ fresh wt)							
	(%)		Glucose		Fructose		Sucrose		Hexose/sucrose	
			Harvest date ^a							
	25 Nov.	7 Dec.	25 Nov.	7 Dec.	25 Nov.	7 Dec.	25 Nov.	7 Dec.	25 Nov.	7 Dec.
<i>F.×ananassa</i>										
Chandler	8.9 ± 0.4	9.7 ± 0.3	27.1 ± 1.2	33.6 ± 1.3	23.7 ± 0.9	35.3 ± 1.6	14.2 ± 2.5	18.7 ± 2.7	3.58	3.68
Seascape	7.1 ± 0.2	6.7 ± 0.4	24.1 ± 1.1	22.0 ± 1.1	22.4 ± 1.3	24.5 ± 1.4	15.3 ± 1.1	11.8 ± 1.6	3.04	3.94
Tudla	5.4 ± 0.2	6.0 ± 0.1	18.0 ± 0.9	20.8 ± 0.6	17.0 ± 0.4	22.7 ± 0.6	8.2 ± 0.8	10.0 ± 0.9	4.27	4.35
Hokowase	9.9 ± 0.2	9.5 ± 0.8	32.9 ± 1.0	34.1 ± 3.0	29.4 ± 3.0	38.4 ± 3.0	12.0 ± 1.9	13.3 ± 1.8	5.19	5.45
Reiko	8.5 ± 0.2	8.0 ± 0.3	23.3 ± 0.8	26.8 ± 1.2	21.9 ± 2.5	30.4 ± 1.2	18.7 ± 2.4	16.3 ± 1.0	2.42	3.51
<i>F. chiloensis</i>										
94BAU-1A	9.7 ± 0.2	9.7 ± 0.2	31.8 ± 1.0	33.2 ± 1.0	30.4 ± 1.7	34.8 ± 1.0	14.0 ± 2.2	16.9 ± 2.2	4.44	4.02
97PUR-1A	8.4 ± 0.3	8.8 ± 0.3	28.8 ± 1.2	33.9 ± 1.3	24.4 ± 2.4	36.7 ± 1.2	6.5 ± 1.4	7.8 ± 0.8	8.18	9.05

^aRipe fruit were harvested in 1999. Data show mean ± standard error (n = 20 and 4 for SSC and sugar compositions, respectively).

Fig. 1. Changes in soluble sugar concentration during fruit development. Vertical bars indicate standard errors (n = 4). Development stages are classified as immature green (stage I), white (stage II), partially pigmented (stage III), and fully pigmented (stage IV), respectively.

from central Chile and those of *F. ×ananassa* ('Akihime') from Yamagata, Japan (Lat. 36°33' N) on 26 Mar. 2002. Fruit were classified into four growth stages (I = immature to IV = fully ripe). Glucose, fructose, and sucrose levels in each growth stage were determined.

Results and Discussion

Experiment I. Both 'Seascape' and 'Tudla' showed lower SSC than other cultivars/land races (Table 1). SSC of *F. chiloensis* was similar to that of Japanese cultivars and showed high values (8.4 to 9.7) as reported previously (Lavin and Maureira, 2000). The levels of three major soluble sugars in '94BAU-1A' were similar to those in 'Hokowase' that was known as very sweet variety. Although hexose levels were similar between '97PUR-1A' and '94BAU-1A', sucrose level of '97PUR-1A' was almost half

of '94BAU-1A', resulting in highest hexose/sucrose ratio in the seven cultivars/land races. This high hexose/sucrose ratio may contribute to the taste of ripe fruit since '97PUR-1A' has a special sweetness.

Experiment II. Both glucose and fructose in '94BAU-1A' increased rapidly from stage I to III, reaching 24 and 35 mg·g⁻¹ fresh wt at stage III, respectively (Fig. 1). Hexoses in 'Akihime' were almost lowest from stage I to III among the cultivars/land races. However the values did not differ apparently among the cultivars/land races at stage IV. Sucrose concentration of '94BAU-1A' increased linearly from stage I to IV, reaching 22 mg·g⁻¹ fresh wt at stage IV. A rapid increase of sucrose accumulation in 'Akihime' was observed until stage III and remained a constant value thereafter. Sucrose level of 'Tudla' did not increase apparently after stage II, reaching only 12 mg·g⁻¹ fresh wt at stage IV. Our results

revealed that commercially grown *F. chiloensis* fruit could accumulate similar or often higher soluble sugars compared with *F. ×ananassa*. This shows that *F. chiloensis* will have enough vendibility in terms of sweetness.

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