Sweetness in Diploid and Triploid Watermelon Fruit

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Internal watermelon fruit quality is a composite of flesh color and texture, freedom from defects (such as hollowheart), optimum maturity, sweetness, seed size and frequency in diploids, and freedom from seeds in triploids (Maynard, 2001).

According to Maynard (2001), "sweetness, one of the prime quality factors in watermelon fruit is related to total soluble solids (TSS), as measured by °Brix with a refractometer." The U.S. Standards for Grades of Watermelons (USDA, 1978) indicates watermelons may be labeled as having good internal quality with 8% TSS as determined in a random sample by an approved refractometer. Likewise, fruit may be labeled as having very good internal quality with TSS of 10% or greater. Having personally sampled thousands of watermelon fruit, it is my contention that fruit with 8% TSS are in fact not very good and those with 10% TSS are barely enjoyable. Most people would thoroughly enjoy fruit with 11%-12% TSS".

TSS is a measure of the concentration of the reducing sugars fructose and glucose and the nonreducing sugar sucrose. The relative concentration of these sugars is influenced by cultivar and stage of maturity. Glucose and fructose concentrations generally increase up to 24 days after pollination (DAP) and decline thereafter. Sucrose is first detectable at 20 DAP and increases thereafter. The relative concentration of these sugars is important since they vary in perceived sweetness with sucrose having a value at 1.0, glucose 0.60-0.75, and fructose 1.40-1.75. Accordingly, cultivars or maturity that result in high fructose concentrations is a desirable feature (Elmstrom and Davis, 1981).

TSS are determined routinely by watermelon breeders and cultivar evaluators as one estimator of fruit quality along with a myriad of other characteristics.

Methods. Diploid and triploid watermelon cultivars and advanced experimental hybrids were evaluated each spring season from 1991 through 2001 at the University of Florida's Gulf Coast Research and Education Center at Bradenton. The number of entries in each class was determined by commercial seed producer submissions. TSS were determined on two fruit in each plot at each harvest. Accordingly, determinations were made on 12 fruit with three replications and two harvests or on 16 fruit with four replications and two harvests for each entry. A hand-held refractometer (Atago ATC-1, 32-10 Honcho, Itabashi-ku, Tokyo 173-001, Japan) was used from 1991 to 1998 and a digital refractometer (Atago PR-101) was used from 1999 to 2001 for TSS determinations. Fruit were sampled by cutting from stem to blossom end, removing a section of tissue from the center (heart) of the fruit, and squeezing a few drops of juice on the refractometer prism surface. TSS data were subjected to analysis of variance and Duncan's multiple range test was used for mean separation (SAS, 2001).

Results. TSS for diploid and triploid watermelon cultivars that were evaluated at least four seasons are shown in Table 1. The range in diploid TSS was from 11.4% for 'Festival' to 12.6% for 'Sultan'. For triploid cultivars, TSS varied from 11.7% for 'Jack of Hearts' to 13.4% for 'Tri-X-Carousel'. TSS of 11 triploid cultivars exceeded the highest diploid fruit TSS. Only two triploid cultivars ('Summer Sweet 5032' and 'Jack of Hearts') had TSS that were lower than the second highest TSS that was found in diploid 'Royal Majesty' fruit.

The average TSS of diploid and triploid watermelon fruit by year from 1991 through 2001 averaged over all cultivars and determinations in that year is shown in Table 2. Average TSS in triploid fruit was higher than that in diploid fruit in 9 of 11 years and there was no difference in the other 2 years. TSS in diploid fruit varied from 11.1% in 1991

(Maynard, 1991) to 12.9% in 2000 (Maynard and Dunlap, 2000) while triploid fruit TSS ranged from 12.0 in 1991 and 1997 (Maynard, 1997) to 13.8% in 2000. The 1991 (486 mm) and 1997 (423 mm) spring seasons were characterized by much higher than normal rainfall during the growing season, whereas rainfall was sparse during the spring 2000 (114 mm) season. Accordingly, the highest TSS in watermelon fruit occur in seasons of low rainfall, usually accompanied by high light and low disease incidence; conditions that also favor high TSS. The 11-year average TSS was higher in triploid fruit, 12.7%, than in diploid fruit, 11.8%.

What factors may account for or contribute to higher TSS in triploid watermelon fruit than in diploid fruit? Some possibilities are: 1) energy used to produce seeds in diploid fruit is diverted to sugar production in triploid fruit, 2) triploid plants are generally larger than diploid plants and therefore have greater photosynthetic potential, 3) triploid fruit are generally smaller than diploid fruit so that equivalent sugar content is concentrated in triploid fruit. There may be other explanations as well.

Literature Cited

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Table 1. Total soluble solids of diploid and triploid watermelon cultivars included in at least four trials. Gulf Coast Research and Education Center, University of Florida.

Diploid				Triploid		
	Years	Soluble			Years	Soluble
Cultivar	(no.)	Solids (%)		Cultivar	(no.)	Solids (%)
Sultan	6	12.6 a[z]		Tri-X-Carousel	4	13.4 a
Royal Majesty	5	12.1 ab		Tri-X-Palomar	4	13.3 ab
Sangria	11	12.0 bc		Revolution	4	13.2 ab
Royal Sweet	9	12.0 bc		Millennium	8	13.2 a-c
Regency	7	11.9 b-d		Constitution	4	13.1 a-c
Royal Star	9	11.8 b-d		Freedom	5	13.1 a-c
Piñata	4	11.7 b-d		Gem Dandy	4	13.0 a-d
Legacy	4	11.7 b-d		Summer Sweet 5544	4	12.9 c-d
Fiesta	11	11.6 b-d		Tri-X-Shadow	5	12.9 b-d
Starbrite	8	11.6 b-d		Millionaire	11	12.7 c-e
Mardi Gras	6	11.6 b-d		Tiffany	5	12.7 c-e
Barron	4	11.5 cd		Genesis	9	12.6 d-f
Festival	4	11.4 d		Tri-X-313	14	12.6 d-f
				Summer Sweet 5244	9	12.6 d-f
				Revelation	4	12.5 d-f
				Scarlet Trio	7	12.5 d-f
				Sunrise	5	12.5 ef
				Summer Sweet 2532	4	12.4 ef
				Nova	6	12.3 fg
				King of Hearts	8	12.3 fg
				Queen of Hearts	8	12.3 fg
				Crimson Trio	10	12.2 fg
				Summer Sweet 5032	4	11.9 h
				Jack of Hearts	4	11.7 h

[z]Mean separation in columns by Duncan's multiple range test, 5% level.

Table 2. Total soluble solids of diploid and triploid watermelons by year. Gulf Coast Research and Education Center, University of Florida.

	Diploid			**Triploid**	
		Average			**Average**
	Entries	**Soluble Solids**		**Entries**	**Soluble Solids**
Year	**(no.)**	**(%)**		**(no.)**	**(%)**
1991	16	11.1 b[z]		27	12.0 a
1992	20	11.9 b		20	13.3 a
1993	25	11.9 b		39	12.8 a
1994	17	12.1 a		25	12.3 a
1995	20	12.2 a		28	12.4 a
1996	29	11.3 b		38	12.7 a
1997	36	11.3 b		32	12.0 a
1998	36	11.3 b		21	12.6 a
1999	32	11.7 b		28	13.1 a
2000	34	12.9 b		50	13.8 a
2001	27	12.0 b		37	13.0 a
11-year average		11.8 b		11-year average	12.7 a

[z]Mean separation in rows by Duncan's multiple range test, 5% level.