



Quality Traits of Some New Sweet Corn (*Zea mays saccharata* Sturt.) Types in Tokat/Kazova Conditions*

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Abstract: This research was conducted to determine certain quality traits of new sweet corn varieties of sugary (su), sugar-enhanced (se) and shrunken (sh2) types in Tokat/Kazova conditions. A composite variety together with thirteen F1 sweet corn varieties with various sugar contents and grain colors were included in the research. The field trials were conducted in 2009 and 2010 growing seasons by the randomized complete block design with three replications, and water-soluble solids (WSS), sucrose contents, moisture contents and color traits (L*, hue and chromo) were investigated. Significant differences were obtained in the investigated characteristics, except for WSS contents by year and moisture contents by genotype. WSS contents of genotypes varied from 10.7 to 21.2 in °Brix. Average WSS contents as °Brix were 17.8 in the varieties of su-types, 18.9 in the se-types and 12.4 in the sh2-types varieties. Sucrose contents of the genotypes, on a dry-matter basis, ranged from 14.6 to 40.9%, while mean sucrose contents of su-, se- and sh2-types were 17.0%, 30.4% and 35.0%, respectively. Mean moisture contents of the varieties at harvest were quite similar (75.4-75.9%). It is important that the genotypes with better performance in grain yield and quality by locations be cultivated accordingly.

Keywords: Sweet corn, Quality, Environment, Sucrose content, su, se, sh2

Bazı Yeni Şeker Mısırları (*Zea mays saccharata* Sturt.) Tiplerinin Tokat Kazova Koşullarında Bazı Kalite Özelliklerinin Belirlenmesi

Öz: Bu araştırma, su, se ve sh₂ tipindeki farklı şeker mısırları genotiplerinin Tokat Kazova koşullarında bazı kalite özelliklerinin belirlenmesi amacıyla yürütülmüştür. Çalışmada, farklı şeker oranları ve tane renklerine sahip 13 adet F1 şeker mısırları çeşidi ile bir adet kompozit çeşit kullanılmıştır. Denemeler tesadüf blokları deneme desenine göre 3 tekrarlamalı olarak 2009 ve 2010 yıllarında Tokat-Kazova koşullarında yürütülmüştür. Denemede suda çözünür kuru madde (SÇKM), şeker (sakkaroz) içeriği, nem oranı, parlaklık ve renk değerleri (L, Hue, Kroma) özellikleri incelenmiştir. Çalışmada, SÇKM hariç yıllar arasında nem oranı hariç genotipler arasında ele alınan özellikler bakımından önemli farklılıklar elde edilmiştir. İki yıllık ortalama sonuçlara göre; Genotiplerin SÇKM oranları 10.7 ile 21.1 °Brix arasında değişmiş, ortalama °Brix değerleri su tipli çeşitlerde 17.8, se tipli çeşitlerde 18.9 ve sh₂ tipli çeşitlerde ise 12.4 olarak belirlenmiştir. Genotiplerin sakkaroz içerikleri % 14.6 ile % 40.9 arasında değişmiş, ortalama sakkaroz içeriği su, se ve sh₂ tipli genotiplerde sırasıyla % 17.0, % 30.4 ve % 35.0 olarak tespit edilmiştir. Araştırmada, genotiplerin hasatta ortalama nem değerleri (% 75.4- % 75.9) oldukça yakın olarak elde edilmiştir. Farklı yörelerde tüketicilerin isteklerini yerine getirecek kalitedeki genotipler belirlenerek üretime alınmalıdır.

Anahtar Kelimeler: Şeker mısırları, kalite, çevre, şeker, su se sh₂

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1. Introduction

Sweet corn has higher sugar content and thus better consumer acceptance than any other corn species when harvested at the end of milky stage.

Ears of sweet corn are consumed directly by boiling in water, grilling on the embers or roasting, whereas kernels are preserved by canning or freezing for extended shelf-life and consumption in various ways. Sugar contents of most corn species are rather low (1-3%, dry basis); however, sweet corn types contain much more sugar, ranging from 2-3% upto 30-40% (dry basis). Sucrose is the main sugar (60-70%), followed by glucose (10-15%), fructose (10-15%) and maltose (5%) in sweet corn (Hale et al. 2005a). In addition, sweet corn has the largest embryo, resulting in the highest oil and protein accumulation among all corn species (Orzolek et al. 2000; Tracy 2001).

Consumers take into consideration such quality characteristics as kernel color, texture and flavor (taste and aroma) in the preference of sweet corn (Wann et al. 1971). Varieties with homogeneous maturity, larger ear, yellow color and high sugar content are preferred by both producers and consumers. Kernel texture and sweetness are related to pericarp toughness, water-soluble solids (sugars and phytyglycogens) and moisture content (Azanza et al. 1996; Kleinhenz 2001). Sugar content, softness, flavor and other related characteristics of sweet corn are of low heritability (Azanza et al. 1994; Yousef and Juvik 2001). Asghar and Mehdi (1999) and Saleh et al. (2002) reported that heritabilities of most quality traits of sweet corns are generally low ($h^2 < 0.50$).

Different sugars are synthesized and stored in the endosperm of sweet corn, which are polymerized to phytyglycogens and starch during maturation and storage. The genes sugary (su), sugar-enhanced (se) and shrunken (sh2) dictate the rate and extent of sugar-to-starch conversion and in turn the degree of sweetness (Kleinhenz 2001; Tracy 2001). Moisture contents and water-soluble solids (WSS) of the su-type varieties vary, respectively, in the range of 71-73% and 11-12 in °Brix (Beckingham

2007). Hale et al. (2005a) reported that WSS concentrations were higher in su- and se-type varieties than those in sh2-type varieties. As su-type varieties convert sugars rapidly to starch after harvest maturity, their harvest period is rather narrow. In contrast, se- and sh2-types contain respectively 25-50% and 50-100% more sugars than su-types, resulting in more sweet taste and tender texture with prolonged harvest and market periods (Orzolek et al. 2000; Kleinhenz 2001; Lertrat and Pulam 2007). Hale et al. (2005b) determined that sucrose accounted for 55% of total sugars in su-types, 64% in se-types and 77% in sh2-types. Sweet corn products with tender/crispy texture and appetizing flavor are processed from genotypes with higher sugar and lower starch contents (Azanza et al. 1996).

Composite varieties of sweet corn have long been cultivated in Turkey; however, new varieties with higher sugar contents have started quickly displacing the old composite varieties. Composite and su-type varieties grown in Turkey had reportedly lower qualities as compared to se- and sh2-types (Sencar et al. 1992; Cesurer and Ülger 1997; Sencar et al. 1999; Turgut and Balcı 2001; Öktem and Öktem 2006).

Although WSS and total sugar contents are negatively correlated, WSS do not provide enough information on the contents and types of sugars (Hale et al. 2005a; Hale et al. 2005b). Therefore, determination of sugar profile is more meaningful than that of WSS. Michaels and Andrew (1986) ascertained that sugar content is an important quality trait. It is reported that sucrose concentration reached the highest level 20-25 days after pollination in sweet corn (Pajic et al. 1992; Lertrat and Pulam 2007). Zhu et al. (1992) reported that a sh2-type variety had the lowest WSS and the highest sucrose, whereas a su-type variety had the highest WSS and the lowest sucrose. Hale et al. (2005b) determined in su-, se- and sh2-types respectively that WSS varied between 22.0-25.7%, 21.8-23.6% and 14.7-15.4%, total sugars between 5.8-8.2%, 7.5-8.6% and 11.2-14.1%, sucrose contents between 3.7-4.0%, 4.7-5.6%

and 8.2-11.2%. WSS and sugar contents together with kernel characteristics related to eating quality in su- and sh2-type varieties were affected by environmental conditions. Azanza et al. (1996) reported that WSS was measured as 20.8% in su-type and 8.0% in sh2-type varieties, while sucrose was measured (on dry-matter basis) as 9.1% and 29.7%, respectively. Kleinhenz (2003) found that WSS contents ranged from 19.1 to 22.0% in se-type varieties, 15.9 to 17.6% in sh2-type varieties. Schultz and Juvik (2004) confirmed that sucrose levels were 8.3-9.1% in su-type, 16.4-31.2% in se-type and 24.8-34.4 in sh2-type genotypes. Eşiyok et al. (2004) reported that WSS contents significantly varied by varieties in three locations, where WSS ranged from 14.5 to 17.8 in °Brix. In that study, WSS were found to be the highest (21.2 °Brix) in Bornova location and the lowest (11.4 °Brix) in Cine location. Bozokalfa et al. (2004) and Tuncay et al. (2005) reported that WSS significantly changed in varieties as well as growth type, i.e, main or second crop. Sucrose levels were also affected by environment in another study (Ledencan et al. 2008). Ordas et al. (2008) obtained that the differences between the endosperm types were significant for WSS in two environments, though no difference was detected in another environment.

There were negative relationships between kernel moisture and starch contents (Kleinhenz 2001), and kernel moisture content varied with endosperm types and varieties (Beckingham 2007). Average kernel moisture contents at 22 days after pollination (DAP) were 70.8% in su-type, 71.3% in se-type and 74.4% in sh2-type varieties (Azanza et al. 1996). For optimum processing quality, su- and se-type varieties should have kernel moisture of about 73%, as opposed to 76% for sh2-type varieties. In fact, kernel moisture contents of sh2-type varieties change rather slowly (Anonymous 2010).

The varieties with various endosperm color (yellow, white and bicolor) were produced in the world; however, yellow color is habitually

preferred by consumers (Tracy 2001; Lerner and Dana 2007). Eşiyok et al. (2004) reported that L values (varied between 72.5 and 75.2), hue values (varied between 91.2 and 93.0) and chromo values (varied between 41.4 and 50.8), which are important color attributes, significantly changed among varieties. In addition, they reported that L, hue and chromo values of the sweet corns varied significantly by growth locations.

Since sweet corn consumption has been increasing in Turkey, this growing demand has to be satisfied through domestic production. The sweet corn varieties grown in Turkey were mostly composite and su-types. Additionally, almost all ready-to-eat cup-style sweet corn that has been widely consumed in Turkey is mostly imported. The purpose of this research was therefore to study quality characteristics of sweet corn varieties with different endosperm types and colors grown in Tokat/Kazova, Turkey.

2. Methodology

2.1. Description of growth location

The research was conducted in Tokat/Kazova in 2009 and 2010 growth years. Tokat/Kazova location has an altitude of 608 m, latitude of 40°13'N, longitude of 36°1'E. The average monthly temperatures in the first and second trial years were respectively 18.3 °C and 20.7 °C (Table 1), total rainfalls 200.0 mm and 179.5 mm and the average relative humidity 56.5% and 60.1%

Certain physical and chemical properties of the soil (0-20 cm) are given in Table 2. The soil was clay-loamy, slightly alkaline, medium in calcium carbonate (9.4-13.6%) and poor in organic matter (1.84-0.16%) in both years.

The available phosphorus was satisfactory in the first year but inadequate in the second year, whereas the soil was poor in potassium in the first year but rich in the second year (Karaman and Brohi 2004).

Table 1. Monthly mean temperature, rainfall and relative humidity parameters of Tokat/Kazova experimental location*Çizelge 1. Tokat/Kazova lokasyonunda aylık ortalama sıcaklık, yağış ve nispi nem parametreleri*

Month	Mean temperature (°C)		Total rainfall (mm)		Mean relative humidity (%)	
	2009	2010	2009	2010	2009	2010
April	11.2	12.0	45.5	64.6	60.1	63.2
May	15.6	17.9	60.1	45.3	62.3	59.0
June	21.4	22.3	20.0	59.8	52.2	62.4
July	22.5	25.0	73.9	6.4	55.5	60.8
August	20.6	26.3	0.5	3.4	52.5	54.9
Mean	18.3	20.7	200.0	179.5	56.5	60.1

Table 2. Soil physical and chemical properties in Tokat/Kazova experimental location (0-20 cm layer)*Çizelge 2. Tokat/Kazova lokasyonunda toprağın fiziksel ve kimyasal özellikleri (0-20 cm derinlik)*

Year	Texture	Total salt (%)	pH	CaCO ₃ (%)	Available P ₂ O ₅ (kg/da)	Available K ₂ O (kg/da)	Organic C (%)
2009	Clay-loam	0.023	7.88	13.6	7.56	4.64	1.84
2010	Clay-loam	0.034	7.82	9,4	2.06	99.31	0.16

2.2. Plant growth and harvest

A composite variety and thirteen F1 sweet corn varieties with varying sugar contents and grain colors were included in the research (Table 3).

The experiment was designed in a randomized complete block design with three replications. Each plot consisted of eight rows, 5.0 m long with 70 cm row spacing. The seeds were planted 20 cm in distance on the rows. Two rows of sorghum were planted at the edge of each plot to avoid cross-pollination of varieties. The seeds were sown on May 11 in 2009 and April 28 in 2010. The dates of field

emergences were recorded as May 19 in the first year and May 10-15 in the second year. In both years of the trials, hoeing was done twice with the help of a hand-hoe. Tillers were removed in knee-high stage and hilling was applied. Three and four irrigations were carried out at the stages of knee-high, tasseling and grain-filling in both years through a drop-irrigation system (Kırtok 1998). A full dose of phosphate (3 kg in the first year and 5 kg in the second year as P₂O₅ / da) along with a half dose of nitrogen (14 kg / da) were applied at sowing. The remaining half of the nitrogen was applied when

Table 3. Sweet corn genotypes included in the study and their certain properties*Çizelge 3. Çalışmada kullanılan şeker mısırı genotipleri ve bazı özellikleri.*

Genotype	Hybrid level	Endosperm type	Maturity period (day)	Kernel color	Seed source
IOChief	F ₁	<i>su</i> ¹	88	Yellow	Levan Seed Inc., USA
Bodacious	F ₁	<i>se</i> ²	75	Yellow	"
Envy	F ₁	<i>sh2</i> ³	81	Yellow	"
Silver Queen	F ₁	<i>su</i>	92	White	"
Cellestial	F ₁	<i>se</i>	87	White	"
Extra Tender	F ₁	<i>sh2</i>	82	White	"
Peaches&Cream	F ₁	<i>su</i>	85	Bicolor	"
Ambrosia	F ₁	<i>se</i>	75	Bicolor	"
Fantastic	F ₁	<i>sh2</i>	74	Bicolor	"
Lumina	F ₁	<i>su</i>	83	Yellow	Anadolu Seed, Turkey
Merit	F ₁	<i>su</i>	80	Yellow	May Seed, Turkey
Vega	F ₁	super sweet	Early	Yellow	May Seed, Turkey
Sunshine	F ₁	sweet	Early	Yellow	May Seed, Turkey
Sakarya	Composite				Sakarya Agr. Res. Inst., Turkey

¹Sugary, ²Sugar-enhanced, ³Shrunken (supersweet)

the plants were 40-50 cm in height. In each experiment, weeds were controlled with harrowing. Harvesting of the were performed between July 29 and August 14 in the first year and between July 20 and August 2 in the second year. Harvest was carried out around 21 days after the appearance of the silks, i.e., at the end of milky stage (Dartt et al. 2002).

2.3. Water-soluble solids (WSS) content

Milky endosperms at the optimum maturation stage from the middle of 10 different ears were separately squeezed by hand onto refractometer and WSS contents were measured in °Brix (Eşiyok et al. 2004).

2.4. Sugar (sucrose) content

The sucrose contents of samples at harvest time were determined through enzymatic-spectroscopic assay kit (Biyozim, Ankara) based on the method of Outlaw and Mitchell (1988) and Kunst et al. (1988). For this purpose, 2-3 kernels each from the middle of 10 ears (total 20-30 kernels, about 10 g) were taken and homogenized with ten-fold water followed by clarification through centrifugation and 22-µm syringe filter. Sucrose contents of samples were expressed on dry-matter basis.

2.5. Color properties

Brightness (L), hue and chroma values of corn ears were measured by Minolta Colormeter (Osaka, Japan) as described by Eşiyok et al. (2004).

2.6. Statistical analysis

The collected data were subjected to the analysis of variance (MSTAT-C software) employing the growing year as the random factor and the genotypes as the fixed factor. The means were compared using the Duncan multiple comparison test (Duzgunes et al. 1987).

3. Results and Discussion

3.1. Water-soluble solids (WSS) contents of sweet corns

The mean WSS contents of sweet corn varieties are presented in Table 5. The WSS of

the genotypes were not significantly different by the mean of the years, but varied significantly by both years and combined years (Table 4). Kleinhenz (2003) reported that se- and sh2-types varieties had significant differences by years. The WSS contents were reported to vary by the growing location and year (Eşiyok et al. 2004). In another study, it was determined that sugar corn varieties grown as the second crop had significantly higher WSS than those grown as the main crop, which was explained by the fact that vegetative season in the second crop was warmer and ear maturing period was cooler (Tuncay et al. 2005).

Two-year results show that WSS contents of genotypes ranged from 10.7 to 21.1 in °Brix (Table 5). Eşiyok et al. (2004) reported that WSS varied between 14.5 and 17.8 in °Brix. Other researchers (Gençtan and Uçkesen 2001; Bozkalfa et al. 2004; Tuncay et al. 2005) also determined that WSS varied by the genotype. In this study, °Brix values were 15.0-21.1 in su-type varieties, 18.5-19.4 in se-type varieties and 10.7-13.6 in sh2-type varieties, while average °Brix values were respectively 17.8, 18.9 and 12.4. WSS contents of se-type varieties was also determined higher than in sh2-type varieties in another study (Kleinhenz 2003). Zhu et al. (1992) determined that the lowest °Brix in a sh2- type variety whereas the highest °Brix in a su- type variety. Similarly, it was determined that °Brix value was 20.8 in su-type and 8.0 in sh2-type sweet corns (Azanza et al. 1996). Hale et al. (2005a) reported that WSS contents were higher in su- and se-type varieties than in sh2-type varieties. In addition, Kleinhenz (2003) reported that se- and sh2-type varieties with high yield had lower °Brix values.

3.2. Sucrose contents of sweet corns

Average sucrose contents of sweetcorn varieties are given in Table 5. Sucrose contents of genotypes varied from 11.6 to 39.6% (dry basis) in the first year and from 8.4 to 42.1% in the second year. The differences among genotypes were significant in both years (Table 4). Genotypic effects for sucrose contents were mainly observed (Table 4). Among the varieties,

Fantastic had the highest sucrose content in both years, whereas the composite variety (Sakarya) had the lowest sucrose content in the first year and Peaches&Cream in the second year. Other

researchers also reported genotypic variations in sucrose contents of sweet corns (Michaels and Andrew 1986; Pajic et al. 1992).

Table 4. Variance analysis table for quality characteristics of 14 sweet corn genotypes grown in Tokat/Kazova location for two years with three replications

Çizelge 4. Tokat/Kazova lokasyonunda iki yılda üç tekerrürlü olarak yetiştirilen 14 şeker mısır genotipinin kalite özelliklerini içeren varyans analiz tablosu

Variation source	df	Water-soluble solids (WSS) (°Brix)			Sucrose content (%)		
		Mean square	F value	Explained (%)†	Mean square	F value	Explained (%)
Year (Y)	1	0.05	0.04 ns	0.0	73.07	11.1*	0.8
Error	4	1.2		0.5	6.6		0.3
Genotype (G)	13	59.3	27.1**	78.4	484.3	22.8**	72.3
G x Y	13	7.3	3.3**	9.6	93.3	4.4**	13.9
Error	52	2.2		11.6	21.2		12.7
Variation source	df	Moisture content (%)			L*		
		Mean square	F value	Explained (%)	Mean square	F value	Explained (%)
Year (Y)	1	44.0	20.0*	6.6	596.9	346.7**	51.2
Error	4	2.2		1.3	1.7		0.6
Genotype (G)	13	5.9	0.9 ns	11.5	32.5	31.5**	36.3
G x Y	13	14.6	2.2*	28.7	6.6	6.4**	7.3
Error	52	6.6		51.9	1.0		4.6
Variation source	df	Hue			Chromo		
		Mean square	F value	Explained (%)	Mean square	F value	Explained (%)
Year (Y)	1	133.2	1643.0**	17.5	3912.9	432.7**	28.9
Error	4	0.1		0.0	9.0		0.3
Genotype (G)	13	30.1	62.4**	51.3	621.4	76.5**	59.7
G x Y	13	16.4	34.0**	27.9	82.6	10.2**	7.9
Error	52	0.5		3.3	8.1		3.1

**P<0.01, *P<0.05

Based on two-year results, sucrose content varied from 14.6 to 21.3% in su-type, 28.3 to 33.3% in se-type and 32.6 to 40.9% in sh2-type varieties. The mean sucrose contents were respectively 17.0, 30.4 and 35.0% for su-, se- and sh2-type varieties. The composite variety (Sakarya) is categorized in the same statistical group as su-type varieties. Similarly, Schultz and Juvik (2004) determined that sucrose contents were 8.3-9.1% in su-type, 16.4-31.2% in se-type and 24.0- 34.4% in sh2-type of sweet

corns. It was determined in previous studies that sh2-types had higher sucrose content than su-types (Michaels and Andrew 1986; Zhu et al. 1992; Azanza et al. 1996). It was also determined that sh2-types with low WSS contents had higher sucrose contents. A negative relationship between WSS and sucrose contents was established by Hale et al. (2005a). Mean sucrose contents of the genotypes were significantly affected by year, i.e., average sucrose content was found 25.9% in the first

Table 5. Water soluble solids (WSS), sucrose contents, moisture contents and color properties of sweet corn genotypes with their Duncan groups
Çizelge 5. Şeker mısır genotiplerinin suda çözünür kuru madde (WSS), sakkaroz içerikleri, nem içerikleri ve renk içerikleri ait ortalamalar ve Duncan gruplandırması

Genotype	WSS (°Brix)			Sucrose content (dry basis) (%)			Moisture content (%)			
	2009	2010	2009-2010	2009	2010	2009-2010	2009	2010	2009-2010	
IOChief (<i>su</i>)	19.5 <i>a**</i>	19.4 <i>b**</i>	19.5 <i>ab**</i>	17.9 <i>def**</i>	14.1 <i>def**</i>	16.0 <i>d**</i>	79.1	72.3 <i>e**</i>	75.7	
Lumina (<i>su</i>)	14.5 <i>bcd</i>	16.1 <i>bc</i>	15.3 <i>cde</i>	20.4 <i>b-f</i>	22.2 <i>cd</i>	21.3 <i>cd</i>	75.3	74.2 <i>b-e</i>	74.7	
Peaches&Cream (<i>su</i>)	19.3 <i>a</i>	22.8 <i>a</i>	21.1 <i>a</i>	21.7 <i>b-f</i>	8.4 <i>f</i>	15.1 <i>d</i>	76.8	69.2 <i>f</i>	73.0	
Merit (<i>su</i>)	12.8 <i>d</i>	17.2 <i>b</i>	15.0 <i>de</i>	16.6 <i>ef</i>	12.7 <i>def</i>	14.6 <i>d</i>	78.6	75.1 <i>a-e</i>	76.8	
Silver Queen (<i>su</i>)	17.5 <i>ab</i>	17.7 <i>b</i>	17.6 <i>bc</i>	19.2 <i>c-f</i>	20.0 <i>cd</i>	19.6 <i>d</i>	75.9	77.5 <i>a</i>	76.7	
Sunshine (<i>su</i>)	17.5 <i>ab</i>	18.0 <i>b</i>	17.8 <i>b</i>	20.3 <i>b-f</i>	10.1 <i>ef</i>	15.2 <i>d</i>	76.3	74.0 <i>cde</i>	75.2	
Sakarya (Composite)	17.1 <i>abc</i>	17.6 <i>b</i>	17.3 <i>bcd</i>	11.6 <i>f</i>	20.8 <i>cd</i>	16.2 <i>d</i>	76.4	72.4 <i>de</i>	74.4	
Bodacious (<i>se</i>)	19.9 <i>a</i>	17.0 <i>b</i>	18.5 <i>b</i>	37.5 <i>a</i>	19.1 <i>cde</i>	28.3 <i>bc</i>	75.7	75.5 <i>abc</i>	75.6	
Cellestial (<i>se</i>)	20.3 <i>a</i>	17.2 <i>b</i>	18.7 <i>ab</i>	31.5 <i>abc</i>	27.4 <i>bc</i>	29.5 <i>b</i>	74.8	77.1 <i>ab</i>	76.0	
Ambrosia (<i>se</i>)	20.2 <i>a</i>	18.6 <i>b</i>	19.4 <i>ab</i>	33.4 <i>ab</i>	33.2 <i>ab</i>	33.3 <i>b</i>	75.0	75.3 <i>a-d</i>	75.2	
Envy (<i>sh2</i>)	11.9 <i>d</i>	9.4 <i>e</i>	10.7 <i>g</i>	29.0 <i>a-e</i>	38.4 <i>a</i>	33.7 <i>b</i>	77.2	75.2 <i>a-e</i>	76.2	
Vega (<i>sh2</i>)	12.5 <i>d</i>	11.0 <i>de</i>	11.8 <i>fg</i>	31.2 <i>a-d</i>	34.6 <i>ab</i>	32.9 <i>b</i>	75.2	75.8 <i>abc</i>	75.5	
Extra Tender (<i>sh2</i>)	13.5 <i>cd</i>	13.6 <i>cd</i>	13.6 <i>ef</i>	32.3 <i>abc</i>	32.9 <i>ab</i>	32.6 <i>b</i>	75.6	75.6 <i>abc</i>	75.6	
Fantastic (<i>sh2</i>)	13.4 <i>cd</i>	13.4 <i>cd</i>	13.4 <i>ef</i>	39.6 <i>a</i>	42.1 <i>a</i>	40.9 <i>a</i>	74.9	77.3 <i>a</i>	76.1	
Mean	16.4	16.4	16.4	25.9 <i>a*</i>	24.0 <i>b</i>	24.9	76.2 <i>a*</i>	74.8 <i>b</i>	75.5	
C.V. (%)	9.4	8.6	9.0	20.2	16.2	18.5	4.5	1.5	3.4	
Genotype	L*			Hue			Chromo			
	2009	2010	2009-2010	2009	2010	2009-2010	2009	2010	2009-2010	
Yellow	IOChief	68.02 <i>g**</i>	74.54 <i>de**</i>	71.28 <i>fg**</i>	89.16 <i>a**</i>	89.05 <i>ab**</i>	89.10 <i>a**</i>	32.18 <i>abc**</i>	52.38 <i>ab**</i>	42.28 <i>ab**</i>
	Lumina	70.71 <i>ef</i>	76.05 <i>cde</i>	73.38 <i>b-e</i>	87.50 <i>ab</i>	89.72 <i>a</i>	88.61 <i>ab</i>	33.98 <i>a</i>	56.56 <i>a</i>	45.27 <i>a</i>
	Merit	66.47 <i>g</i>	74.49 <i>de</i>	70.48 <i>g</i>	83.23 <i>d</i>	87.89 <i>bc</i>	85.56 <i>ef</i>	30.18 <i>a-d</i>	49.25 <i>ab</i>	39.72 <i>bcd</i>
	Sunshine	67.36 <i>g</i>	73.43 <i>e</i>	70.39 <i>g</i>	88.55 <i>a</i>	85.73 <i>d</i>	87.14 <i>cd</i>	28.75 <i>cde</i>	46.22 <i>bc</i>	37.49 <i>cde</i>
	Sakarya	70.63 <i>ef</i>	75.02 <i>cde</i>	72.82 <i>def</i>	88.36 <i>ab</i>	88.93 <i>ab</i>	88.64 <i>ab</i>	33.45 <i>ab</i>	49.56 <i>ab</i>	41.51 <i>abc</i>
	Bodacious	71.21 <i>def</i>	74.90 <i>de</i>	73.06 <i>cde</i>	81.41 <i>ef</i>	88.39 <i>abc</i>	84.90 <i>fg</i>	29.78 <i>b-e</i>	43.28 <i>bc</i>	36.53 <i>def</i>
	Envy	73.01 <i>bcd</i>	80.30 <i>a</i>	76.65 <i>a</i>	86.71 <i>bc</i>	89.14 <i>ab</i>	87.93 <i>bc</i>	32.83 <i>ab</i>	55.51 <i>a</i>	44.17 <i>ab</i>
	Vega	70.89 <i>ef</i>	76.04 <i>cde</i>	73.46 <i>b-e</i>	88.27 <i>ab</i>	86.02 <i>d</i>	87.14 <i>cd</i>	33.89 <i>a</i>	52.39 <i>ab</i>	43.14 <i>ab</i>
Bicolor	Peaches&Cream	72.58 <i>cde</i>	76.87 <i>cd</i>	74.73 <i>bc</i>	83.59 <i>d</i>	88.81 <i>ab</i>	86.20 <i>de</i>	26.30 <i>ef</i>	39.86 <i>cd</i>	33.08 <i>ef</i>
	Ambrosia	67.68 <i>g</i>	75.93 <i>cde</i>	71.81 <i>efg</i>	79.98 <i>f</i>	88.66 <i>ab</i>	84.32 <i>gh</i>	24.54 <i>f</i>	31.86 <i>de</i>	28.20 <i>gh</i>
	Fantastic	70.16 <i>f</i>	77.15 <i>bcd</i>	73.65 <i>bcd</i>	85.33 <i>c</i>	86.22 <i>d</i>	85.78 <i>ef</i>	27.39 <i>def</i>	37.36 <i>cde</i>	32.38 <i>fg</i>
White	Silver Queen	77.19 <i>a</i>	77.94 <i>abc</i>	77.57 <i>a</i>	81.92 <i>de</i>	85.45 <i>d</i>	83.68 <i>h</i>	15.20 <i>h</i>	20.00 <i>f</i>	17.60 <i>i</i>
	Cellestial	73.47 <i>bc</i>	76.16 <i>cde</i>	74.81 <i>b</i>	80.72 <i>ef</i>	81.52 <i>e</i>	81.12 <i>i</i>	14.09 <i>h</i>	11.04 <i>g</i>	12.57 <i>j</i>
	Extra Tender	74.64 <i>b</i>	79.83 <i>ab</i>	77.23 <i>a</i>	82.43 <i>de</i>	86.86 <i>cd</i>	84.64 <i>fgh</i>	20.26 <i>g</i>	28.67 <i>e</i>	24.46 <i>h</i>
Mean	71.00 <i>b**</i>	76.33 <i>a</i>	73.67	84.80 <i>b**</i>	87.31 <i>a</i>	86.06	27.35 <i>b**</i>	41.00 <i>a</i>	34.17	
C.V. (%)	1.2	1.5	1.4	0.8	0.8	0.8	5.5	9.1	8.3	

Different letters in the same column indicate significant difference (**P<0.01, *P<0.05).

3.3. Moisture contents of sweet corns

Moisture contents of sweet corn genotypes at harvest did not differ significantly in the first year, whereas the differences were significant in the second year ($P < 0.01$) (Tablo 4). In this study, mean moisture contents were 75.4% in su-type, 75.6% in se-type and 75.9% in sh2-type varieties (Tablo 5). Azanza et al. (1996) reported that mean moisture contents at harvest were respectively 75.7 and 77.6% in su- and sh2- type varieties. It was reported that moisture content in sweet corn varied by genotype and endosperm type (Beckingham 2007).

3.4. Color properties (L^* , hue and chromo) of sweet corns

Color related values (L^* , hue and chromo) of sweet corn genotypes are presented in Table 5.

The lightness (L^*) values, significantly affected by year (Table 4), were 71.00 in the first year and 76.33 in the second year (Table 5). The L value is to a large extent environmentally controlled (Tablo 4). L value was changed by environment (Eşiyok et al. 2004). Tuncay ve ark. (2005) reported that L values of sweet corn cultivars were higher in main crops compared to second crops.

Two-year results show that L^* values of the genotypes changed from 70.39 to 77.57 (Table 5) and that differences between the genotypes were significant (Table 4). Eşiyok et al. (2004) and Tuncay et al. (2005) determined that L^* values varied from 72.52 to 77.55 in yellow varieties. As shown in Table 5, L^* values changed between 70.39-76.65 in the yellow varieties, 71.81-74.73 in the bicolor varieties and 74.81-77.57 in the white varieties. The average L^* values were 72.69 in the yellow varieties, 73.40 in the bicolor varieties and 76.54 in the white varieties.

It has been well established that hue values of sweet corn varieties differ by both genotype and environment, yet genetic factors are more dominant in hue values (Table 4). Eşiyok et al. (2004) determined significant differences in hue values of genotypes. As seen in Table 5, the highest hue values were observed on IOChief

yellow variety with 89.10, Peaches&Cream bicolor variety with 86.20 and Extra Tender white variety with 84.64. The hue values were decreased as the ear colors turned from yellow to white. In a study with yellow varieties, hue values varied from 91.24 to 93.00, which significantly differed by variety, location and growing season (Eşiyok et al. 2004; Tuncay et al. 2005).

Chromo values are to a large extent genetically controlled (Table 4). As listed in Table 5, chromo values of the genotypes ranged from 12.57 to 45.27 and the differences were statistically significant. Additionally, chromo values obtained in the second growth year were higher (Table 5). Tuncay et al. (2005) found differences in chroma values of main and second crops. In this research, chromo values were determined to be 36.53-45.27 in the yellow varieties, 28.20-33.08 in the bicolor varieties and 12.57-24.46 in the white color varieties. Eşiyok et al. (2004) determined that chromo values changed significantly from 41.35 to 50.77 in the yellow varieties. As the chromo values express the brightness of grains (Eşiyok et al. 2004), it can be deduced from the results that Lumina, Peaches&Cream and Extra Tender were the brightest varieties respectively among the yellow, bicolor and white varieties.

4. Conclusions

Quality traits, such as texture, color and taste, are key factors in consumer acceptance and preference of sweet corn products. In this study, significant differences by year were obtained in the moisture and sucrose contents of sweet corn varieties. Climatic factors were determined to be influential on the quality characteristics. WSS contents of the varieties varied from 10.7 to 21.1 in °Brix with mean values of 17.8 in su-type, 18.9 in se-type and 12.4 in sh2-type varieties. Sucrose contents of the genotypes changed from 14.6 to 40.9% (dry basis) with average values of 17.0%, 30.4% and 35.0% respectively for su-, se- and sh2-types varieties. Lightness (L^*), hue and chroma values of the sweet corns ranged respectively from 70.39-76.65, 84.90-89.10 and 36.53-45.27 in the

yellow varieties, 71.81-74.73, 84.32-86.20 and 28.20-33.08 in the bicolor varieties and 74.81-77.57, 81.12-84.64 and 12.57-24.46 in the white varieties. The results indicate that chief quality characteristics of sweet corn genotypes should be evaluated in different ecological regions so that suitable varieties with better consumer acceptance are adapted and cultivated.

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