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The Revealing of Morphological Variability and Characterization of Some Confectionery Pumpkin

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ABSTRACT

In this study, it was aimed to examine some morphological features and determine the proximity between genotypes in 105 confectionary pumpkins lines (*Cucurbita pepo* L.), which were determined as promising at S4 level. In the study, some observations and measurements of plants including fruit and seed characteristics were taken. The appearance of plant genotypes are: 81.9% erect, 15.2% clutching, 0.9% semi-clutching; while the degree of branching of the genotypes was found to be 32.3% weak, 47.7% moderate, 22.8% high, and it was determined as 84.7% branched and 15.3% bush type. The body color of the genotypes has been found to be 49.5% green, 37.14% light green, 13.3% dark green. Leaf color was found as 64.7% green, 30.4% dark green, 4.7% light green, and leaf lobbing were determined as 1.9% low, 48.5% medium, 2.8% high, 4.7% excessive and 41.9% were defined as absent. The fruit spot density was determined as: 73.3% was low, 24.7% dense, 1.9% more spotted and 19.0% of the mature fruits was cream, 4.7% yellow, 0.9% green, 1.9% green-yellow, 4.7% dark-yellow, 28.6% light-yellow and 41.9% orange. The size of the mature fruits was 21.9% short, 38.0% medium and 40% long, while the diameter was determined as 62.8% long, 35.23% medium, and 3.8% narrow. The fruit size of genotypes respectively was: 14.2% of large, 36.1% medium, 50.4% small, and 0.9% small-medium. In order to determine the genetic diversity between genotypes, principal component analysis (PCA) and cluster analysis were performed and it was seen that genotypes were divided into 6 groups.

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Bazı Çerezlik Kabak Genotiplerinde Morfolojik Değişkenliğin Ortaya Konması

ÖZET

Bu çalışma, S4 kademesinde ümitvar olarak belirlenmiş 105 adet çerezlik kabak hattında (*Cucurbita pepo* L.), bazı morfolojik özelliklerin incelenmesi ve genotipler arası yakınlıkların belirlenmesi amacıyla yapılmıştır. Çalışmada bitki, meyve ve tohum özelliklerine ait bazı gözlem ve ölçümler yapılmıştır. Genotiplerin bitki görünümü %81.9 dik, %15.2 sarılıcı ve %0.9 yarı sarılıcı bulunurken kol atma derecesi %32.3'ünde zayıf, %47.7'sinde orta %22.8'inde fazla bulunmuş, genotiplerin %84.7'ü kollu %15.2'i kolsuz olarak saptanmıştır. Genotiplerin %49.5'i yeşil, %37.14'ü açık yeşil, %13.3'ü ise koyu yeşil gövdeli olarak bulunmuştur. Genotiplerde yaprak rengi, %64.7'sinde yeşil, %30.4'ünde koyu yeşil, %4.7'sinde açık yeşil; dilimlilik %1.9'unda az, %48.5'inde orta, %2.8'inde fazla, %4.7'sinde çok fazla, %41.9'unda yok, olarak tanımlanmıştır. Meyve benek renginde, % 31.4'ü yeşil, %7.6'sı turuncu, %0.9'u sarı, %60'ı krem; benek yoğunluğunda; %73,3'ü az, %24.7'si yoğun, %1.9'u fazla; meyve renginde, %19.0'u krem, %4.7'si sarı, %0.9'u yeşil, %1.9'u yeşil-sarı, %4.7'si koyu-sarı, %28.6'sı açık sarı, %41.9'u turuncu olarak bulunmuştur. Tohumluk meyve boyu; %21.9'unda kısa, %38.0'inde

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orta, %40'ında uzun; meyve çapı %62.8'inde uzun, %35.23'ünde orta, %3.8'inde dar olarak belirlenmiştir. Genotiplerin %14.2'si iri, %36.1'i orta, %50.4'ü küçük ve %0.9 küçük-orta meyve iriliğine sahip olmuştur. Genotipler arasındaki genetik çeşitliliğin belirlenmesi amacıyla, temel bileşenler analizi (PCA) ile cluster analizi yapılmış ve genotiplerin 6 gruba ayrıldığı görülmüştür.

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INTRODUCTION

The Cucurbitaceae family have contained, herbaceous and annual plant species such as *Cucurbita pepo*, *Cucurbita maxima* and *Cucurbita moschata* that have great economic importance in the world and Turkey (Robinson and Decker-Walters, 1997). These species are used in human nutrition as well as in different industries. The pumpkin seeds have been consumed as confectionary in Turkey for many years, and their consumption has increased daily. Thus, a significant increase have seen in its production because of its nutritional value and benefit to human health in recent years (Ermiş, 2010). Pumpkin seeds contain high amounts of fat (40-50%) and protein (30-40%). It is also rich in carbohydrates (20-25%) and vitamin E values (Abak et al., 1997; Türkmen et al., 2015). There are no registration in Turkey for confectionary pumpkin cultivars. For this reason, confectionary pumpkins cultivation is made using by local populations. Since local cultivars have been grown in the same region for many years, they were easily adapted to climate-changing and to other conditions. Productivity and quality are the main factors in cultivation and it is necessary to have a good practice of growing techniques and to have genetically ideal varieties. This is only possible with hybrid cultivars that are of a premium nature. Hybrid cultivars are combine the superior features and increase productivity. In the case of breeding of hybrid cultivars, it is first necessary to determine the characteristics of the genetic diversity of the core collection. Therefore, it is important to collect, preserve and include these varieties to the plant breeding programs without genetic loss. Conventional morphological markers are used in determining the genetic relationships among the plants. In vegetable breeding, it is always important to determine the variation of morphological characteristics among genetic resources. In Turkey, there are some studies conducted on the breeding of confectionary pumpkin by different researchers. Türkmen et al. (2016) examined the plant, leaf, flower, fruit and seed properties of 81 confectionary pumpkin lines at S5 level according to UPOV parameters. It has been reported that some promising genotypes can contribute economy by being used in hybrid seed production in Turkey. In a study that conducted in Portugal, 20 morphological characteristics identified for *Cucurbita* spp. were used

to evaluate the diversity of 54 *C. pepo*, 32 *C. maxima* and 21 *C. moschata* genotypes. The highest mean values were observed in *C. pepo* for fruit length, shell thickness and seed weight, *C. maxima* for fruit width and 1000 seed weight, and *C. moschata* genotypes for fruit weight and thickness (Martins et al., 2015). Multi-variable analysis are used to evaluate data obtained from qualified gen pools created within the reclamation programs (Alkan, 2011). In order to detect the variability of certain characteristics, morphological features must be thoroughly inspected. For this reason, "Multi-variable Statistical Analysis" have been developed (Çakır, 1994). Cluster Analysis is one of the many variable statistical methods that have particularly been popular in recent years. These features are used to determine the superior genotypes by utilizing the criteria prepared by UPOV. Usage of the data obtained after the characterization studies, the similarities and groupings among of genotypes can be easily displayed by using cluster analysis and principle component analysis (Karaağaç and Balkaya, 2010). Soltani et al. (2016) compared 11 *C. pepo*, *C. moschata* and *C. maxima* genotypes, 3 of which were open-pollinated, and it was observed that genotypes were divided into 6 basic groups in terms of fruit and seed characteristics in the cluster analysis.

The main goal of this study was to determine some morphological characteristics differences and similarities among the local and nonlocal confectionary pumpkin genotypes of Turkey and to find solutions to the seed problem for confectionary pumpkin producers for future breeding efforts.

MATERIAL and METHODS

In the study, 105 prominent confectionary pumpkin genotypes (*Cucurbita pepo* L.) were used as plant material, which was previously selfed at S4 level. Seed sowing was realized in plastic seedling trays filled with peat moss (one seed per cell) and 10 seeds were sown from each genotype. Within a week following the sowing, the plants emerged, when the seedlings were ready for planting five of each genotype were planted under greenhouse conditions and irrigated by drip irrigation method. Morphological observation criteria were prepared by using the modified UPOV variety feature document (UPOV, 2002). In this study, the plant appearance, branching, and its degree, stem and leaf color, lobbing on the leaf, presence and color of the

ring at the base of the petal and spot color and density in ripe fruits, fruit color, fruit height, fruit diameter, the height-diameter ratio in mature fruit (index), size, 1000 grain weight, seed color, and cracking ease of seed were determined (UPOV, 2002).

The pumpkin genotypes can be easily demonstrated by using the morphological data determined by the existing similarities-differences and groupings among genotypes by using cluster analysis and principal component analysis.

All data were evaluated with the WARD program, it was included in the JMP computer program for cluster analysis and promising genotypes were determined by factor analysis with Principle Component Analysis (PCA) (Ward, 1963).

RESULTS and DISCUSSION

The plant appearance of the genotypes was found to be 81.9% erect, 15.2% clutching, 0.9% semi-clutching. The branching degree of the genotypes was found to be 47.7% moderate, 32.3% weak, 22.8% high and it was determined as 84.7% branched and 15.3% bush type. The body color of the genotypes was found as 49.5% green, 37.14% light green, 13.3% dark green (Table 1). Seymen (2010) had determined that, 59 (47.5%) of the confectionary pumpkin genotypes as erect, 49 (39.5%) genotype as semi-clutching and 16 (12.5) genotype as clutching. While 58 (46.7%) genotypes did not show branching, 66 (53.2) genotypes were observed, and 40 (32.2%) of these genotypes were semi-branching. When the stem color was examined, 23 (18.5%) of the genotypes were determined as light green, 28 (22.5%) dark green, and 73 (58.8%) green. Besides, Türkmen et al. (2016) determined the plant appearance of *C. pepo* genotypes as 37% erect, 31% semi-erect and 32% clutching, and branching status was 93% present and 7% absent. Leaf color was found as 64.7% green, 30.4% dark green, 4.7% light green, and leaf lobbing were determined as 1.9% low, 48.5% medium, 2.8% excess, 4.7% too much and 41.9% absent. The presence of the ring at the base of the crown was 81.9% absent, 18.0% present and the color of the ring at the crown base was 81.9% absent, 2.6% green-yellow and 13.3% green (Table 1). The fruit spot color was found to be green in 31.4%, orange in 7.6%, yellow in 0.9% and cream in 60% of the genotypes. It was determined that 73.3% of the genotypes was low, 24.7% dense, and 1.9% more spotted. In terms of fruit colors, the 19.0% of mature fruits was cream, 4.7% yellow, 0.9% green, 1.9% green-yellow, 4.7% dark-yellow, 28.6% light-yellow and 41.9% orange. The size of the mature fruits was 21.9% short, 38.0% medium and 40% long, while the diameter was 62.8% long, 35.23% medium and 3.8% narrow. The length to diameter ratio was determined as 58.0% round, 22.8% elliptical and 20% tall, while the size of the mature fruit was 14.2% large, 36.1% medium and 50.4% small (Table 2). In the study by Seymen (2010),

leaf color was determined as light green in 26 genotypes, dark green in 34 genotypes and green in 64 genotypes. Leaf lobbing was low in 54 genotypes, very low in 36 genotypes, medium in 16 genotypes and more in 18 genotypes. When the presence of a ring at the base of the crown was examined, while there was no ring at the base of the crown in 28 genotypes, rings were observed in 96 genotypes, while the ring color was yellow in 30 genotypes, 35 genotypes were green and 31 genotypes had a green-yellow ring color. It has been observed that our findings and Seymen's results are similar to the leaf color. But the leaf lobbing, the presence of the ring at the base of the crown, and the color of the ring at the base of the crown have different values compared to our study. It is thought that some incompatibilities may be related to the material used, the region and ecological differences and even the cultivation conditions. Türkmen et al. (2016) found that there is no leaf lobe in 3 genotypes, less in 37, medium in 32 and excess in 9. In our study, the seed color was found as 32.3% cream, 2.8% cream-dark cream, 48.5% light cream, 1.9% light cream-dark cream, 5.7% light cream-cream. Cracking ease of genotypes was found to be 60% difficult, 2.9% easy, 10.47% easy-difficult. They were taken seeds from one fruit between 73.5 and 418.8 g and 1000 grain weight was varied between 12.57 ± 0.40 and $131.02 \pm 15.5g$ (Table 3). Principal component analysis (PCA) provided a simplified classification of confectionary pumpkin genotypes for genetic diversity and breeding studies. PCA is based on the visualization of type projections on an axis or a series of axes that can best represent the relationship among types in a multidimensional field (Karaağaç, 2006). The PCA plot shows geometric distances reflecting similarities among genotypes in the table in terms of the measured variables.

According to these analysis, it was seen that genotypes were divided into 6 groups (Figure1). Group A contained two genotypes with PCA 1 negative and PCA 2 positive. Group B contained two genotypes with PCA 1 negative and PCA 2 positive. Group C included 12 genotypes with low PCA 1 and medium PCA 2 values. Group D contained two genotypes with PCA 1 negative and PCA 2 positive. Group F contained 17 genotypes with positive PCA1 and PCA2 values. Group E contained 66 genotypes with PCA 1 positive and negative and PCA 2 positive. Small genetic distance has been detected between genotypes 21 and 69. It has been observed that high diversity in terms of morphological characterization occurs in confectionary pumpkin genotypes. Martins et al. (2015) used 20 morphological features for the diversity of 54 *C. pepo*, 32 *C. maxima* and 21 *C. moschata* populations collected from the northern and center of Portugal. As a result of statistical analysis, they revealed the

difference at $P < 0.005$ level for all characteristics except fruit thickness.

They revealed that these three species were separated in PCA and the total variation was 52.5%. Mladenovic et al. (2014), in their study to determine morphological characterization for 20 genotypes, showed that these genotypes were divided into 5 groups on the PCA axis as a result of principal component analysis. In a morphological characterization study conducted in 76 genotypes of *C. pepo* and *C. maxima* species; *C. pepo* included 10 genotypes classified as Cluster 1, while *C.*

maxima included 66 genotypes classified as Cluster 2. As a result of the PCA analysis, it was observed that 76 genotypes were divided into two groups and 66 *C. maxima* genotypes were separated from 10 *C. pepo* genotypes (Chao et al., 2013). The diversity of 64 *C. pepo* entries aimed at providing genetic improvement and application in Cucurbita breeding programs was analyzed using morphological markers. In principal component analysis (PCA), the 64 entries were clearly divided into two groups: a group of stemless seeds and a group of seeds covered with a shell (Yunli et al., 2020).

Table 1. Plant Appearance (A), Branching (B), Degree of The Branching (C), The Body Color (D), Leaf Color (E), Leaf Lobbing (F), The Presence of The Ring (G), The Collor of Thering (H)

Çizelge 1. Bitki Görünümü (A), Kol Atma (B), Kol Atma Derecesi (C), Gövde Rengi (D), Yaprak Rengi (E), Yaprak Lopluluğu (F), Halkanın Varlığı (G), Taç dibinde halkanın rengi (H)

Genotype Name	A		C	D	E	F	G	H
4	Erect	Present	Weak	Green	Green	Medium	Absent	-
5	Erect	Present	Medium	Light- Green	Light- Green	Medium	Present	Green- Yellow
11	Erect	Present	Weak	Light- Green	Yeşi	Absent	Present	Green- Yellow
17	Clutching	Absent	-	Dark- Green	Green	Absent	Absent	-
20	Erect	Present	Medium	Green	Green	Medium	Absent	-
21	Erect	Present	High	Light- Green	Green	Absent	Absent	-
22	Semi-Clutching	Absent	Weak	Green	Green	Absent	Absent	-
23	Erect	Present	Medium	Light- Green	Green	Absent	Absent	-
26	Erect	Present	High	Light- Green	Dark- Green	Absent	Present	Green
27	Erect	Present	Medium	Green	Green	Absent	Present	Green
28	Erect	Present	Medium	Light- Green	Dark- Green	Absent	Absent	-
33	Erect	Present	High	Green	Green	Absent	Absent	-
37	Erect	Present	High	Green	Green	Absent	Absent	-
38	Erect	Present	Weak	Green	Green	Absent	Absent	-
41	Erect	Present	Medium	Green	Dark- Green	Absent	Absent	-
42	Erect	Present	Medium	Green	Dark- Green	Absent	Absent	-
43	Erect	Present	High	Green	Green	Medium	Absent	-
46	Erect	Present	Medium	Green	Dark- Green	Absent	Present	Green
47	Erect	Present	High	Light- Green	Green	Absent	Absent	-
49	Erect	Present	Medium	Light- Green	Dark- Green	Absent	Present	Green
50	Erect	Present	High	Green	Green	Absent	Absent	-
56	Erect	Present	Medium	Light- Green	Dark- Green	Absent	Absent	-
58	Erect	Present	Medium	Green	Dark- Green	Medium	Absent	-
60	Erect	Present	Weak	Dark- Green	Green	Absent	Absent	-
64	Erect	Present	Medium	Green	Dark- Green	Medium	Present	Green

65	Erect	Present	Medium	Dark- Green	Green	Absent	Absent	-
66	Erect	Present	High	Green	Dark- Green	Medium	Absent	-
74	Erect	Present	High	Light- Green	Green	Absent	Absent	-
77	Erect	Present	Weak	Green	Green	Absent	Absent	-
78	Erect	Present	Medium	Light- Green	Green	Absent	Present	Green
83	Erect	Present	Weak	Light- Green	Green	Absent	Present	Green
85	Erect	Present	Weak	Green	Green	Absent	Absent	-
86	Erect	Present	Medium	Green	Dark- Green	Absent-Medium	Absent	-
87	Erect	Present	Weak	Light- Green	Dark- Green	Medium	Absent	-
88	Erect	Present	Medium	Green	Dark- Green	Absent	Absent	-
89	Erect	Present	Medium	Green	Dark- Green	Absent	Absent	-
90	Erect	Present	Medium	Green	Green	Absent	Absent	-
91	Erect	Present	Medium	Green	Dark- Green	Medium	Absent	-
92	Erect	Present	Weak	Light- Green	Dark- Green	Medium	Absent	-
93	Erect	Present	Medium	Light- Green	Green	Absent	Absent	-
94	Erect	Present	Medium	Dark- Green	Dark- Green	Medium	Absent	-
96	Erect	Present	High	Light- Green	Green	Absent	Absent	-
97	Erect	Present	High	Light- Green	Green	Absent	Absent	-
98	Erect	Present	High	Light- Green	Dark- Green	Absent	Absent	-
99	Erect	Present	High	Green	Green	Medium	Absent	-
100	Erect	Present	Medium	Light- Green	Light- Green	Medium	Present	Green- Yellow
102	Erect	Present	Medium	Light- Green	Green	Absent	Absent	-
103	Erect	Present	Weak	Green	Dark- Green	Medium	Absent	-
105	Erect	Present	Medium	Dark- Green	Dark- Green	Absent	Absent	-
109	Erect	Present	Medium	Dark- Green	Green	Absent	Absent	-
110	Erect	Present	Medium	Green	Dark- Green	Absent	Absent	-
111	Erect	Present	Weak	Dark- Green	Green	High	Absent	-
112	Erect	Present	High	Light- Green	Green	Medium	Absent	-
116	Erect	Present	High	Green	Green	Medium	Absent	-
118	Erect	Present	Medium	Light- Green	Green	Medium	Absent	-
120	Erect	Present	Medium	Dark- Green	Green	Absent	Absent	-
124	Erect	Present	Weak	Green	Green	Absent	Absent	-
125	Erect	Present	Weak	Light- Green	Dark- Green	Absent	Absent	-
127	Erect	Present	Medium	Light- Green	Light- Green	Medium	Present	Green- Yellow
128	Erect	Present	Weak	Light- Green	Green	Medium	Present	Green
129	Erect	Present	Medium	Green	Dark- Green	High	Absent	-
130	Semi-C	Present	-	Light- Green	Green	Medium	Absent	-
131	Erect	Present	Weak	Green	Light- Green	Medium	Absent	-

132	Erect	Present	Weak	Light- Green	Green	Medium	Absent	-
133	Erect	Present	Weak	Green	Green	High	Absent	-
134	Erect	Present	High	Light- Green	Green	Medium	Absent	-
137	Erect	Present	Medium	Light- Green	Green	Medium	Absent	-
138	Erect	Present	Medium	Light- Green	Green	Medium	Absent	-
144	Clutching	Absent	-	Green	Green	High	Absent	-
145	Erect	Present	High	Green	Green	High	Absent	-
146	Erect	Present	High	Dark- Green	Green	Absent	Absent	-
147	Erect	Present	Medium	Light- Green	Green	Medium	Absent	-
149	Clutching	Absent	Medium	Dark- Green	Light- Green	Medium	Absent	-
150	Erect	Present	Medium	Light- Green	Green	High	Absent	-
152	Clutching	Absent	-	Light- Green	Green	Medium	Absent	-
153	Erect	Present	Medium	Green	Green	Low	Absent	-
154	Erect	Present	Medium	Green	Green	Low	Absent	-
155	Erect	Present	High	Green	Green	Absent	Absent	-
156	Erect	Present	Medium	Green	Green	Absent	Absent	-
157	Erect	Present	High	Green	Green	Absent	Absent	-
158	Clutching	Absent	-	Light- Green	Green	Absent	Absent	-
159	Clutching	Absent	-	Green	Dark- Green	Medium	Present	Green
161	Erect	Present	Medium	Green	Green	Absent	Absent	-
162	Erect	Present	Medium	Light- Green	Green	Medium	Absent	-
164	Erect	Present	Medium	Green	Green	Absent	Absent	-
166	Erect	Present	Medium	Green	Green	Absent	Absent	-
169	Clutching	Absent	-	Green	Green	Absent	Present	Green
170	Clutching	Absent	-	Green	Dark- Green	Medium	Present	Green
174	Erect	Present	High	Green	Green	Medium	Absent	-
175	Erect	Present	High	Green	Dark- Green	Medium	Absent	-
176	Erect	Present	High	Dark- Green	Dark- Green	Absent	Absent	-
177	Erect	Present	Weak	Light- Green	Green	Medium	Absent	-
178	Clutching	Absent	-	Light- Green	Green	Medium	Present	Green- Yellow
179	Clutching	Absent	-	Green	Green	Medium	Absent	-
180	Clutching	Absent	-	Green	Green	Absent	Present	Green
183	Erect	Present	Medium	Light- Green	Dark- Green	Medium	Absent	-
184	Erect	Present	High	Green	Green	Absent	Absent	-
187	Erect	Present	Weak	Green	Green	Medium	Absent	-
188	Clutching	Absent	-	Light- Green	Green	Absent	Present	Green
189	Clutching	Absent	-	Dark- Green	Dark- Green	Absent	Present	Green
190	Clutching	Absent	-	Dark- Green	Dark- Green	Absent	Absent	-
191	Clutching	Absent	-	Dark- Green	Dark- Green	Absent	Absent	-
192	Erect	Present	Medium	Green	Green	Absent	Absent	-

196	Erect	Present	Medium	Green	Green	Medium	Absent	-
198	Clutching	Absent	-	Green	Dark-Green	Medium	Absent	-

Table 2. Fruit Spot Color (A), Spotted dense (B), Mature Fruits Color (C), Mature Fruits Length (D), Mature Fruits Diameter (E), The Length to Diameter Ratio (F), Size of The Mature Fruit (G)

Çizelge 2. Meyve Benek Rengi (A), benek yoğunluğu (B), olgun meyvelerde renk (C), tohumluk meyvenin boyu (D), tohumluk meyvenin çapı (E), tohumluk meyvenin boy çap oranı (F), tohumluk meyvenin iriliği (G)

Genotype Name	A	B	C	D	E	F	G
4	Cream	Low	Cream	Long	Long	Round	Medium
5	Cream	Low	Cream	Long	Long	Round	Medium
11	Green	Dense	Orange	Short	Long	Elliptical	Medium
17	Cream	Low	Orange	Short	Long	Round	Medium
20	Orange	Low	Orange	Long	Medium	Long	Medium
21	Green	Low	Orange	Short	Long	Round	Medium
22	Green	Dense	Orange	Long	Medium	Long	Small
23	Cream	Low	Light-Yellow	Long	Long	Long	Medium
26	Cream	Low	Cream	Long	Narrow	Long	Medium
27	Cream	Low	Light-Yellow	Short	Medium	Elliptical	Large
28	Cream	Low	Light-Yellow	Long	Long	Long	Small
33	Cream	Low	Light-Yellow	Long	Long	Elliptical	Small
37	Cream	Low	Light-Yellow	Long	Long	Elliptical	Small
38	Green	Low	Green-Yellow	Long	Long	Long	Small
41	Cream	Low	Dark-Yellow	Medium	Long	Elliptical	Medium
42	Cream	Low	Light-Yellow	Long	Medium	Long	Small
43	Cream	Dense	Light-Yellow	Long	Long	Round	Small
46	Cream	Low	Cream	Long	Long	Round	Small
47	Cream	Low	Orange	Medium	Medium	Round	Medium
49	Cream	Low	Cream	Medium	Long	Round	Small
50	Green	High	Orange	Short	Long	Round	Medium
56	Cream	Low	Light-Yellow	Medium	Medium	Elliptical	Medium
58	Cream	Low	Orange	Long	Long	Elliptical	Small
60	Green	Dense	Green-Yellow	Medium	Long	Round	Small
64	Cream	Low	Light-Yellow	Short	Long	Round	Large
65	Green	Dense	Orange	Short	Long	Round	Large
66	Orange	Dense	Light-Yellow	Short	Long	Round	Small
74	Green	Low	Orange	Medium	Long	Round	Small
77	Cream	Low	Cream	Long	Medium	Elliptical	Small
78	Cream	Low	Light-Yellow	Medium	Medium	Round	Medium
83	Cream	Low	Cream	Long	Long	Elliptical	Small
85	Cream	Dense	Cream	Medium	Long	Elliptical	Small
86	Cream	Low	Orange	Short	Long	Round	Medium
87	Cream	Low	Light-Yellow	Medium	Medium	Elliptical	Small
88	Cream	Low	Light-Yellow	Short	Dark	Long	Large
89	Cream	Low	Orange	Medium	Medium	Round	Small
90	Green	Dense	Orange	Long	Medium	Long	Small
91	Cream	Low	Cream	Long	Long	Long	Small
92	Cream	Dense	Light-Yellow	Long	Long	Round	Small
93	Green	Dense	Orange	Long	Medium	Long	Medium
94	Cream	Low	Orange	Long	Long	Elliptical	Medium
96	Cream	Dense	Light-Yellow	Long	Medium	Long	Large
97	Cream	Low	Yellow	Long	Medium	Long	Medium
98	Green	Dense	Orange	Short	Dark	Elliptical	Large
99	Cream	Low	Light-Yellow	Long	Medium	Elliptical	Small
100	Cream	Low	Light-Yellow	Long	Long	Round	Small
102	Cream	Low	Cream	Short	Long	Round	Medium

103	Cream	Low	Orange	Long	Long	Elliptical	Smal
105	Cream	Low	Orange	Long	Long	Elliptical	Smal
109	Cream	Low	Light- Yellow	Medium	Long	Round	Medium
110	Cream	Low	Yellow	Medium	Long	Round	Smal
111	Green	Dense	Orange	Medium	Long	Round	Smal
112	Cream	Low	Light- Yellow	Short	Long	Round	Large
116	Green	Dense	Orange	Short	Long	Round	Medium
118	Cream	Low	Light- Yellow	Long	Medium	Long	Medium
120	Green	Dense	Orange	Short	Long	Round	Medium
124	Cream	Low	Light- Yellow	Short	Long	Round	Large
125	Cream	Low	Light- Yellow	Medium	Medium	Round	Medium
127	Cream	Low	Cream	Long	Long	Round	Medium
128	Cream	Low	Light- Yellow	Medium	Medium	Round	Smal
129	Cream	Low	Cream	Short	Long	Round	Medium
130	Green	Low	Orange	Long	Medium	Long	Smal
131	Cream	Low	Light- Yellow	Short	Long	Round	Smal
132	Yellow	Low	Orange	Short	Medium	Round	Medium
133	Cream	Low	Cream	Medium	Medium	Round	Large
134	Green	Dense	Dark-Yellow	Medium	Long	Round	Smal
137	Orange	Low	Orange	Long	Medium	Elliptical	Smal
138	Cream	Low	Light- Yellow	Long	Long	Round	Smal
144	Green	High	Dark-Yellow	Medium	Medium	Round	Large
145	Green	Low	Orange	Medium	Medium	Round	Smal
146	Green	Dense	Orange	Medium	Medium	Elliptical	Medium
147	Green	Low	Yellow	Medium	Medium	Elliptical	Smal
149	Green	Dense	Orange	Short	Long	Round	Medium
150	Green	Dense	Orange	Medium	Long	Round	Smal
152	Cream	Low	Light- Yellow	Long	Long	Long	Large
153	Cream	Low	Yellow	Short	Long	Round	Medium
154	Green	Dense	Orange	Long	Long	Elliptical	Smal
155	Cream	Low	Cream	Medium	Medium	Elliptical	Medium
156	Green	Low	Dark-Yellow	Long	Long	Long	Large
157	Cream	Low	Light- Yellow	Medium	Medium	Elliptical	Medium
158	Cream	Low	Light- Yellow	Medium	Long	Round	Medium
159	Green	Dense	Orange	Medium	Medium	Round	Medium
161	Cream	Low	Cream	Medium	Long	Round	Medium
162	Green	Dense	Orange	Long	Medium	Long	Smal
164	Cream	Low	Dark-Yellow	Long	Long	Long	Large
166	Green	Low	Orange	Medium	Medium	Round	Smal
169	Cream	Low	Cream	Long	Long	Long	Smal
170	Green	Dense	Orange	Medium	Long	Round	Smal
174	Green	Dense	Green	Medium	Long	Round	Smal
175	Cream	Low	Cream	Medium	Long	Round	Medium
176	Cream	Low	Dark-Yellow	Short	Long	Round	Medium
177	Orange	Low	Orange	Medium	Long	Round	Medium
178	Green	Dense	Orange	Short	Medium	Round	Large
179	Green	Low	Orange	Long	Long	Round	Smal
180	Cream	Low	Cream	Medium	Long	Round	Smal
183	Green	Low	Orange	Medium	Medium	Round	Large
184	Orange	Low	Orange	Medium	Long	Round	Smal
187	Green	Dense	Orange	Medium	Medium	Elliptical	Medium
188	Cream	Low	Cream	Long	Medium	Long	Smal
189	Cream	Low	Orange	Long	Long	Round	Smal
190	Cream	Low	Yellow	Medium	Long	Round	Smal
191	Orange	Low	Orange	Medium	Long	Round	Smal

192	Orange	Low	Orange	Medium	Long	Round	Smal
196	Orange	Low	Orange	Medium	Medium	Elliptical	Smal
198	Cream	Low	Cream	Long	Long	Round	Smal

Table 3. Seed Weight (g), 1000 Seed Weight (g), Seed Color, Cracking Ease

Çizelge 3. Tohum Ağırlığı (g), 1000 Tohum Ağırlığı (g), tohum Rengi, Çıtlama Kolaylığı

Genotype Name	Seed Weight (gram)	1000 Grain Weight (gram)	Seed Color	Cracking Ease
4	281.84±22.47	78.10±1.34	Light Cream	Difficult
5	236.46±17.85	74.58±23.11	Light Cream	Difficult
11	193.88±34.78	47.79±5.50	Light Cream	Easy
17	187.08±39.59	16.08±2.77	Light Cream	Easy
20	213.33±40.940	95.27±23.45	Light Cream	Difficult
21	183.91±11.44	64.21±10.06	Cream	Difficult
22	281.53±58.68	72.41±18.66	Cream	Difficult
23	190.04±37.50	65.01±3.54	Cream	Difficult
26	126.64±21.22	34.34±4.48	Cream	Easy
27	300.43±19.61	38.54±3.89	Cream	Difficult
28	302.66±11.38	62.52±1.78	Light Cream	Easy
33	280.17±446.11	131.02±15.5	Light Cream-Cream	Easy
37	244.11±30.01	44.59±3.24	Dark Cream	Easy
38	163.34±5.19	70.23±6.91	Dark Cream	Easy
41	156.94±4.28	44.70±3.3	Cream	Easy
42	158.35±28.21	40.95±2.22	Light Cream	Easy-Difficult
43	181.64±41.41	37.15±21.52	Light Cream	Easy
46	301.14±76.19	79.25±2.86	Dark Cream	Easy-Difficult
47	102.35±22.30	38.27±0.06	Light Cream	Easy
49	236.26±25.63	82.12±1.50	Light Cream	Easy
50	186.40±27.18	61.78±18.92	Cream	Difficult
56	231.44±21.52	39.30±0.49	Light Cream	Easy
58	135.54±30.02	77.11±2.04	Cream	Difficult
60	200.68±14.28	36.98±7.54	Cream	Easy
64	190.78±33.30	37.40±0.79	Light Cream	Easy-Difficult
65	204.85±28.86	34.39±13.86	Light Cream	Difficult
66	189.75±18.07	72.19±8.62	Cream	Easy
74	180.56±86.40	23.28±0.20	Light Cream	Difficult
77	332.20±97.86	60.43±10.91	Light Cream-Dark Cream	Difficult
78	273.54±21.00	30.70±0.49	Light Cream	Easy
83	90.30±11.03	62.56±7.55	Light Cream	Easy-Difficult
85	251.46±65.12	46.25±22.67	Cream	Difficult
86	200.80±13.73	14.29±0.20	Light Cream	Easy
87	228.58±42.87	34.66±3.94	Light Cream	Difficult
88	252.52±17.32	72.26±8.66	Light Cream	Easy
89	272.50±15.59	54.58±3.83	Cream	Difficult
90	225.94±6.60	54.57±11.22	Light Cream	Difficult
91	205.97±27.11	35.29±1.04	Light Cream	Easy
92	266.34±37.97	37.16±0.49	Light Cream	Easy
93	166.30±32.22	83.54±5.72	Light Cream	Difficult
94	275.54±1.21	44.98±13.27	Light Cream	Easy-Difficult
96	227.54±1.78	22.59±22.34	Light Cream-Cream	Easy-Difficult
97	195.76±8.04	41.53±1.08	Light Cream	Difficult
98	118.62±9.54	82.12±1.50	Light Cream	Easy
99	334.42±26.24	59.17±0.58	Cream	Easy
100	228.32±18.28	12.57±0.40	Cream	Easy
102	93.38±17.71	16.08±18.56	Cream	Difficult
103	141.08±25.32	34.46±13.06	Light Cream-Cream	Difficult
105	234.11±9.54	47.44±5.25	Cream	Difficult
109	311.50±26.24	91.52±9.62	Light Cream-Cream	Easy-Difficult
110	252.70±21.15	129.84±6.59	Dark Cream	Difficult

111	229.92±13.97	43.90±2.75	Dark Cream	Difficult
112	180.24±15.30	29.67±6.83	Light Cream	Difficult
116	178.32±11.76	107.17±5.07	Light Cream	Easy
118	183.36±17.33	68.90±6.29	Cream	Difficult
120	254.52±12.01	40.18±11.40	Cream	Easy
124	239.81±28.92	50.16±0.11	Cream	Difficult
125	240.90±7.32	77.21±12.50	Cream	Easy
127	202.66±32.47	79.8±1.50	Light Cream	Difficult
128	203.30±27.45	91.52±3.82	Light Cream	Difficult
129	200.60±26.38	81.26±5.25	Cream	Difficult
130	418.84±32.47	75.83±14.73	Cream-Dark Cream	Easy-Difficult
131	283.28±30.26	29.75±0.50	Light Cream-Cream	Easy-Difficult
132	248.67±25.40	75.81±2.95	Light Cream	Difficult
133	249.12±30.60	72.04±4.90	Cream	Difficult
134	323.46±28.95	86.09±4.30	Light Cream	Difficult
137	246.97±18.46	83.49±2.46	Cream	Difficult
138	333.02±26.24	105.23±2.20	Light Cream	Easy
144	368.36±62.52	85.13±11.77	Cream-Dark Cream	Difficult
145	232.12±13.97	72.60±13.62	Cream	Difficult
146	239.96±87.30	55.44±11.85	Light Cream	Difficult
147	295.04±9.54	73.33±2.12	Light Cream	Difficult
149	284.56±49.58	92.53±2.91	Light Cream Dark Cream	Easy-Difficult
150	295.36±31.84	75.61±3.96	Light Cream	Difficult
152	184.62±1.83	106.68±6.25	Cream	Difficult
153	332.28±67.42	106.62±4.67	Light Cream	Difficult
154	275.52±10.87	26.45±4.55	Light Cream	Difficult
155	299.63±58.18	117.24±5.11	Light Cream	Difficult
156	142.18±39.25	78.66±2.91	Dark Cream	Difficult
157	221.83±31.84	91.18±7.90	Light Cream	Difficult
158	188.18±62.91	96.39±7.45	Light Cream	Difficult
159	73.50±29.82	32.14±2.10	Light Cream	Easy
161	183.76±32.01	16.33±0.49	Cream	Difficult
162	301.74±30.01	79.73±6.88	Cream	Difficult
164	246.74±73.5	50.43±6.03	Dark Cream	Difficult
166	240.28±26.81	78.32±11.33	Light Cream	Difficult
169	318.86±60.81	113.42±0.80	Light Cream-Cream	Difficult
170	286.88±33.05	76.14±1.04	Light Cream	Easy
174	203.62±28.48	81.47±1.10	Cream	Difficult
175	201.26±48.69	101.57±0.28	Cream	Difficult
176	255.31±26.81	57.89±0.58	Light Cream	Easy
177	288.43±2.55	50.41±0.28	Light Cream	Difficult
178	225.40±0.89	112.26±8.67	Cream	Difficult
179	217.52±46.08	93.87±17.66	Light Cream	Easy
180	296.24±29.14	109.65±6.11	Cream	Difficult
183	235.92±17.96	63.93±2.77	Cream	Easy
184	225.81±12.38	10.88±0.61	Cream	Difficult
187	280.91±3.50	98.70±16.25	Cream-Dark Cream	Difficult
188	140.06±25.39	128.62±0.270	Light Cream	Difficult
189	259.85±5.78	53.44±4.63	Light Cream	Difficult
190	181.72±53.01	60.02±25.04	LightCream-DarkCream	Difficult
191	205.24±12.13	31.66±1.02	Light Cream	Difficult
192	259.85±28.35	64.07±11.97	Light Cream	Easy-Difficult
196	181.72±11.97	99.96±11.97	Dark Cream	Difficult
198	205.24±22.58	85.42±4.44	Cream	Difficult
Average	229.65	63.77		

CONCLUSION

As a result, it has been determined that confectionary pumpkin genotypes are at a promising level and it is

possible to develop confectionary pumpkin varieties for different regions and ecological conditions. The data obtained will be an important resource and guide for

upcoming studies on genetic diversity in confectionary pumpkin.

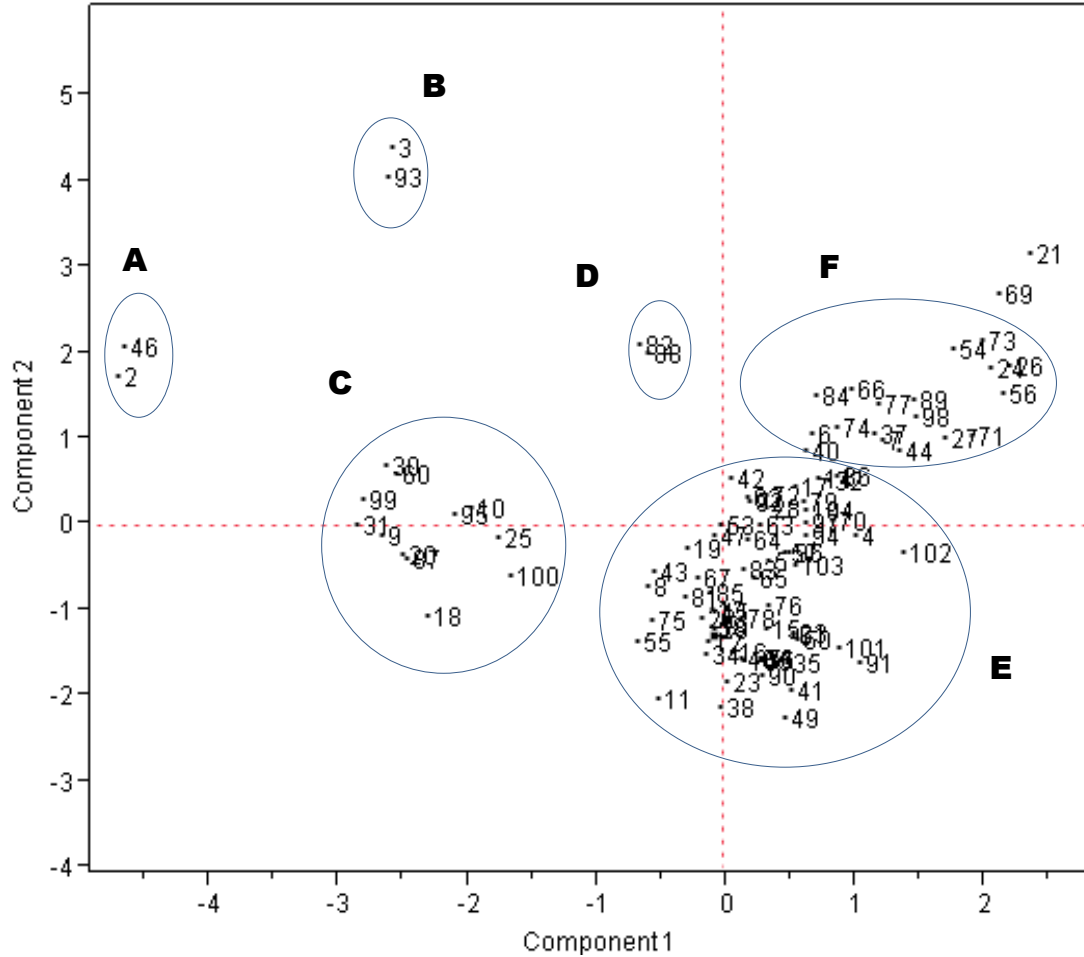


Figure1. Two dimensional graphic obtained from principal component analysis with morphological data
Şekil 1. Morfolojik verilerle yapılan temel bileşen analizi sonucu elde edilen iki boyutlu grafik

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Researchers' Contribution Rate Statement Summary

The authors declare that they have contributed equally to the article.

Conflict of Interest Statement

The article authors declare that they do not have any conflict of interest.

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