

## Clonal Selection of a Winter-Type European Pear Cultivar 'Ankara' (*Pyrus communis* L.)

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**Abstract:** Clones of the 'Ankara' pear (*Pyrus communis* L.) cultivar, which is a winter-type of European pear, were investigated in terms of morphological and chemical characteristics, and sensory analyses, in the Ankara (Turkey) region in 2001, 2002, and 2003. Fruit weight, length, and diameter; core diameter; skin and flesh color; flesh firmness; soluble solids content; titratable acidity; pH; grittiness; melting degree in the mouth (buttery flesh); flavor; texture; and appearance were determined in 40, 17, and 26 clones in 2001, 2002, and 2003, respectively. Two clones #5 and #6, were selected as superior clones of 'Ankara' pear in 16 clones, which were not alternate bearing during 3 years. The average fruit weight, fruit length, and diameter of clone #5 were 225.5 ± 32.8 g, 69.6 ± 1.3 mm, and 73.7 ± 3.4 mm, respectively. The same measurements of clone #6 were 202.1 ± 2.0 g, 65.9 ± 0.1 mm, and 72.0 ± 0.2 mm, respectively. Grittiness was low, and texture and appearance were fine in these clones over the course of 3 years.

**Key Words:** Pear, *Pyrus communis* L., 'Ankara' pear, clonal selection

### Kışlık Tip Avrupa Armut Çeşidi Ankara (*Pyrus communis* L.)'nin Klonal Seleksiyonu

**Özet:** Avrupa armutlarının kışlık bir tipi olan Ankara armut çeşidinin klonları, morfolojik ve kimyasal özellikler ve duyu analizi esas alınarak, 2001, 2002 ve 2003'de Ankara civarında araştırılmıştır. Meyve ağırlığı, uzunluğu ve çapı, çekirdek evi çapı, kabuk ve meyve eti rengi, meyve eti sertliği, suda eriyebilir kuru madde kapsamı, titre edilebilir asitlik, pH, kumluluk, ağızda erime düzeyi (tereyağı gibi meyve eti), tat, tekstür ve görünümü yıllara göre sırasıyla 40, 17 ve 26 klonla belirlenmiştir. Üç yıl boyunca periyodisite göstermemiş olan değerlendirilmeye alınmış 16 klon içerisinde Ankara armudunun en iyi klonları olarak 5 ve 6 nolu iki klon seçilmiştir. Klon 5'de ortalama meyve ağırlığı, meyve uzunluğu ve çapı sırasıyla 225.5 ± 32.8 g, 69.6 ± 1.3 ve 65.9 ± 0.1 mm'dir. Klon 6'da bu değerler sırasıyla 202.1 ± 2.0 g, 65.9 ± 0.1 mm ve 72.0 ± 0.2 mm'dir. Bu klonlarda üç yıl boyunca kumluluk düşük, tekstür ve görünüm iyi olmuştur.

**Anahtar Sözcükler:** Armut, *Pyrus communis* L., Ankara armudu, klonal seleksiyon

### Introduction

The Caucasus Mountains and Asia Minor (Trans-Caucasia, Iran, and Turkmenistan) were reported to be the centers of diversity for cultivated pears (Vavilov, 1951). This area is of special importance because it is thought to be the origin of domesticated forms of the European pear, *Pyrus communis* L., which is the main commercial species in Europe, North America, South America, Africa, and Australia. *P. communis* L. is distributed west to southeastern Europe, Turkey and Eurasia (Bell et al., 1996). Turkey is an important pear producing country with 430,000 t of production (FAO,

2004). Many cultivars originated from Anatolia are grown throughout Turkey. The Ankara pear is one of them and it is the most popular winter pear cultivar in Turkey (Kiper, 1941; Oraman, 1947; Özbek, 1947; Dokuzoğuz, 1972). It has a several desirable attributes, including very rich flavor, good texture, and very long post-harvest storage life (Köksal et al., 2002). It is mainly grown in the middle of Anatolia around the city of Ankara. The fruit of Ankara pears is medium sized and globular. The skin is green and thin, and the flesh is juicy. There are a few distinct types of this cultivar grown in different regions that differ in quality and yield (Kiper,

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1941; Oraman, 1947; Dokuzoğuz, 1972). The purpose of this study was to identify superior 'Ankara' pear clones based on fruit characteristics.

## Materials and Methods

This study was performed in 11 locations in the vicinity of Ankara, Turkey. Fruits of more than 10,000 'Ankara' pear trees, which were planted in commercial orchards or mixed plantations, were subjected to initial investigation, and the number was decreased to 40 trees in 2001 based on their high yield and attractive appearance of fruits (size, shape, and color). In 2002 and 2003, only 17 and 26 of the 40 trees, respectively, were evaluated because of the biennial bearing nature of the pears. The trees were approximately 15-35 years old and grafted on seedling rootstocks. Cultural practices (irrigation, fertilizer application, weed control, pruning, and spraying) were used in the regular orchards. The following characteristics were determined for the harvested fruits:

Morphological characteristics: Fruit weight, length, and diameter, core diameter, and skin and flesh color.

Physical and chemical analyses: Flesh firmness, soluble solids content, titrable acidity, and pH.

Sensory analyses: Grittiness, melting degree in the mouth (buttery flesh), flavor, texture, and appearance.

The harvest was made on the commercial harvest date between mid September and October, depending on the location. Twenty fruit samples were analyzed from each tree. The fruits were individually weighed, and the length, diameter, and core diameter were measured. Skin color and flesh color were measured on opposite sides of the fruit using a Minolta chromameter (model CR-200; Minolta Camera Co., Osaka, Japan), which provided CIE  $L^*$   $a^*$   $b^*$  values. The values were used to calculate hue angle (hue  $^\circ = \arctangent [b^*/a^*]$ ), where  $0^\circ =$  red-purple;  $90^\circ =$  yellow;  $180^\circ =$  bluish-green, and  $270^\circ =$  blue (McGuire, 1992). Flesh firmness was tested on 3 sides of each fruit by an Effegi penetrometer with a 7.8 mm plunger after removal of the peel. It was read in kilograms and then converted to Newtons (N) (Blankenship et al., 1997). Soluble solids content was measured using a Carl-Zeiss Abbe refractometer. For

titrable acidity, a 10 ml sample of juice was diluted with 20 ml of distilled water and then titrated with 0.1 N NaOH to pH 8.1. Titrable acidity was expressed as percent (g malic acid/100 ml) (Patterson and Nichols, 1988). Juice pH was measured with a pH meter.

Samples of 10 fruits were used in sensory analyses, which were conducted by 6 to 10 panelists. Grittiness, buttery flesh, and flavor were scored as low, intermediate, and high, and texture and appearance were scored as extremely coarse, coarse, intermediate, fine, and extremely fine.

Statistical analyses were conducted on 16 clones, which were not alternate bearing during the 3 years of the study.

All data on fruit weight, length, diameter, core diameter, skin and flesh color, flesh firmness, soluble solids, titrable acidity, and pH were calculated as mean and standard error of mean for each year. Data were analyzed using analysis of variance (ANOVA) in accordance with the F-test ( $P = 0.05$ ) and means were compared by least significant difference (LSD) ( $P \leq 0.05$ ).

## Results and Discussion

Fruit characteristics of 16 'Ankara' pear trees (clones), which gave fruit over 3 years were evaluated (Tables 1-6). There were significant differences among the clones based on morphological, physical, and chemical characteristics in each year (Tables 1-5). Average data of the 3 years were used for the evaluation of the 16 clones, which were not alternate bearing during the study. As shown in Tables 1 and 2, the heaviest, the longest, and the largest fruits were clones #5 and #6. Average fruit weight was  $225.5 \pm 32.8$  g for clone #5 and  $202.1 \pm 2.0$  g for clone #6. These values are heavier than the reported average fruit weight (150 g) of 'Ankara' pears (Köksal et al., 2002). Average fruit length was  $69.6 \pm 1.3$  mm and average fruit diameter was  $73.7 \pm 3.4$  mm for clone #5. The same dimensions for clone #6 were  $65.9 \pm 0.1$  mm and  $72.0 \pm 0.2$  mm, respectively. Fruit length ( $69.6 \pm 1.3$  mm and  $65.9 \pm 0.1$  mm) (Table 1) and diameter ( $73.7 \pm 3.4$  mm and  $72.0 \pm 0.2$  mm) (Table 2) of these clones were higher than the others analyzed in this study. According to Oraman (1947), average fruit length and diameter of 'Ankara' pear were  $65.88 \pm 0.45$  mm and

Table 1. Fruit weight and length of 'Ankara' pear clones.

| Clone No.           | 2001              | 2002         | 2003         | Average      |
|---------------------|-------------------|--------------|--------------|--------------|
|                     | Fruit weight (g)  |              |              |              |
| 1                   | 173.0 ± 4.9*      | 207.4 ± 10.2 | 181.3 ± 6.1  | 187.2 ± 10.4 |
| 4                   | 183.0 ± 7.2       | 191.0 ± 9.9  | 124.2 ± 5.8  | 166.1 ± 21.1 |
| 5                   | 190.0 ± 6.2       | 195.6 ± 6.1  | 291.2 ± 13.4 | 225.5 ± 32.8 |
| 6                   | 203.7 ± 7.9       | 198.2 ± 10.5 | 204.4 ± 11.3 | 202.1 ± 2.0  |
| 7                   | 233.5 ± 8.6       | 168.3 ± 5.3  | 146.7 ± 6.0  | 182.9 ± 26.1 |
| 8                   | 192.3 ± 10.4      | 172.9 ± 9.0  | 171.6 ± 8.1  | 178.9 ± 6.7  |
| 9                   | 189.0 ± 4.7       | 190.0 ± 13.7 | 140.6 ± 4.4  | 173.2 ± 16.3 |
| 12                  | 200.1 ± 9.1       | 105.0 ± 5.7  | 67.7 ± 2.8   | 124.2 ± 39.4 |
| 13                  | 207.3 ± 12.5      | 138.0 ± 10.2 | 140.0 ± 7.4  | 161.8 ± 22.8 |
| 16                  | 145.6 ± 4.0       | 120.8 ± 4.1  | 117.7 ± 5.8  | 128.0 ± 8.8  |
| 17                  | 150.2 ± 4.5       | 147.2 ± 4.9  | 194.1 ± 9.5  | 163.8 ± 15.2 |
| 18                  | 182.2 ± 4.3       | 189.4 ± 7.3  | 167.8 ± 7.9  | 179.8 ± 6.4  |
| 19                  | 179.7 ± 5.8       | 194.2 ± 5.3  | 148.4 ± 10.4 | 174.1 ± 13.5 |
| 20                  | 183.4 ± 2.9       | 177.4 ± 6.9  | 122.0 ± 3.9  | 160.9 ± 19.5 |
| 21                  | 222.2 ± 10.2      | 160.1 ± 7.5  | 129.4 ± 4.7  | 170.6 ± 27.3 |
| 32                  | 161.7 ± 6.4       | 143.7 ± 7.5  | 120.2 ± 4.1  | 141.9 ± 12.0 |
| LSD <sub>0.05</sub> | 21.3              | 22.7         | 21.0         |              |
| Clone No.           | Fruit length (mm) |              |              |              |
|                     | 2001              | 2002         | 2003         | Average      |
| 1                   | 62.8 ± 0.8        | 66.7 ± 1.0   | 63.4 ± 0.8   | 64.3 ± 1.2   |
| 4                   | 66.9 ± 1.0        | 64.1 ± 1.0   | 60.5 ± 0.8   | 63.8 ± 1.9   |
| 5                   | 68.8 ± 0.7        | 67.9 ± 1.0   | 72.2 ± 1.6   | 69.6 ± 1.3   |
| 6                   | 65.9 ± 1.0        | 65.7 ± 1.0   | 66.1 ± 1.1   | 65.9 ± 0.1   |
| 7                   | 67.1 ± 1.0        | 61.9 ± 0.9   | 60.0 ± 1.1   | 63.0 ± 2.1   |
| 8                   | 65.1 ± 1.3        | 62.1 ± 1.2   | 62.0 ± 0.6   | 63.1 ± 1.0   |
| 9                   | 66.4 ± 1.0        | 61.8 ± 1.4   | 59.0 ± 0.8   | 62.4 ± 2.1   |
| 12                  | 65.6 ± 1.0        | 53.9 ± 1.0   | 49.8 ± 0.9   | 56.4 ± 4.7   |
| 13                  | 66.1 ± 1.1        | 58.6 ± 1.6   | 58.6 ± 1.3   | 61.11 ± 2.5  |
| 16                  | 63.1 ± 0.6        | 54.2 ± 0.5   | 58.0 ± 0.8   | 58.43 ± 2.6  |
| 17                  | 64.1 ± 0.8        | 61.2 ± 0.8   | 66.1 ± 1.2   | 63.80 ± 1.4  |
| 18                  | 67.3 ± 0.6        | 62.2 ± 1.0   | 62.0 ± 1.1   | 63.84 ± 1.7  |
| 19                  | 68.6 ± 0.9        | 63.6 ± 0.8   | 60.4 ± 1.3   | 64.24 ± 2.4  |
| 20                  | 70.8 ± 0.8        | 65.6 ± 1.1   | 59.1 ± 0.9   | 65.20 ± 3.4  |
| 21                  | 70.3 ± 1.8        | 60.0 ± 1.2   | 61.1 ± 1.0   | 63.80 ± 3.2  |
| 32                  | 64.3 ± 0.9        | 59.5 ± 1.0   | 58.7 ± 0.8   | 60.85 ± 1.7  |
| LSD <sub>0.05</sub> | 2.9               | 3.0          | 2.9          |              |

\* ± Standard Error.

Table 2. Fruit diameter and core diameter of 'Ankara' pear clones.

| Clone No.           | 2001                | 2002       | 2003       | Average    |
|---------------------|---------------------|------------|------------|------------|
|                     | Fruit diameter (mm) |            |            |            |
| 1                   | 71.6 ± 0.9*         | 72.7 ± 1.3 | 69.0 ± 0.8 | 71.1 ± 1.1 |
| 4                   | 73.4 ± 0.9          | 71.7 ± 1.4 | 61.5 ± 1.2 | 68.8 ± 3.7 |
| 5                   | 69.2 ± 0.7          | 71.6 ± 0.8 | 80.5 ± 1.5 | 73.7 ± 3.4 |
| 6                   | 71.5 ± 1.0          | 72.1 ± 1.4 | 72.3 ± 1.4 | 72.0 ± 0.2 |
| 7                   | 78.1 ± 1.0          | 68.9 ± 0.8 | 64.3 ± 0.9 | 70.4 ± 4.1 |
| 8                   | 69.7 ± 1.3          | 69.6 ± 1.5 | 68.1 ± 1.1 | 69.1 ± 0.5 |
| 9                   | 75.2 ± 1.0          | 70.6 ± 1.8 | 63.7 ± 0.8 | 69.8 ± 3.3 |
| 12                  | 69.2 ± 3.4          | 56.9 ± 1.1 | 48.1 ± 0.8 | 58.1 ± 6.1 |
| 13                  | 73.0 ± 1.4          | 63.2 ± 1.5 | 63.8 ± 1.2 | 66.7 ± 3.2 |
| 16                  | 64.2 ± 0.8          | 60.3 ± 0.8 | 60.1 ± 1.1 | 61.5 ± 1.3 |
| 17                  | 65.2 ± 0.8          | 63.7 ± 0.8 | 73.2 ± 1.3 | 67.4 ± 2.9 |
| 18                  | 68.6 ± 0.7          | 69.3 ± 0.8 | 68.9 ± 1.2 | 69.0 ± 0.2 |
| 19                  | 68.8 ± 0.7          | 72.6 ± 0.8 | 66.1 ± 1.9 | 69.2 ± 1.9 |
| 20                  | 68.7 ± 0.6          | 68.1 ± 1.0 | 60.7 ± 1.0 | 65.8 ± 2.6 |
| 21                  | 72.5 ± 1.0          | 65.6 ± 1.2 | 61.7 ± 0.8 | 66.6 ± 3.1 |
| 32                  | 65.1 ± 0.9          | 64.1 ± 1.2 | 60.8 ± 0.8 | 63.3 ± 1.3 |
| LSD <sub>0.05</sub> | 3.7                 | 3.3        | 3.2        |            |
|                     | Core diameter (mm)  |            |            |            |
| 1                   | 17.8 ± 0.6          | 14.9 ± 0.6 | 14.3 ± 0.3 | 15.3 ± 0.4 |
| 4                   | 17.9 ± 0.5          | 15.8 ± 0.5 | 15.1 ± 0.4 | 16.3 ± 0.3 |
| 5                   | 14.5 ± 0.3          | 13.9 ± 0.3 | 12.0 ± 0.3 | 13.5 ± 0.3 |
| 6                   | 16.1 ± 0.6          | 13.8 ± 0.4 | 12.5 ± 0.5 | 13.7 ± 0.3 |
| 7                   | 14.8 ± 0.3          | 16.1 ± 0.3 | 13.1 ± 0.4 | 14.6 ± 0.2 |
| 8                   | 15.7 ± 0.4          | 12.5 ± 0.4 | 12.6 ± 0.3 | 13.6 ± 0.3 |
| 9                   | 15.7 ± 0.4          | 14.4 ± 0.5 | 12.9 ± 0.4 | 14.3 ± 0.3 |
| 12                  | 16.9 ± 0.4          | 13.5 ± 0.5 | 13.1 ± 0.3 | 14.5 ± 0.3 |
| 13                  | 16.0 ± 0.5          | 14.5 ± 0.4 | 13.6 ± 0.2 | 14.7 ± 0.2 |
| 16                  | 15.4 ± 0.2          | 13.5 ± 0.2 | 13.7 ± 0.3 | 14.2 ± 0.2 |
| 17                  | 15.9 ± 0.4          | 16.5 ± 0.3 | 15.2 ± 0.3 | 15.9 ± 0.2 |
| 18                  | 14.0 ± 0.4          | 14.2 ± 0.4 | 14.1 ± 0.3 | 14.1 ± 0.2 |
| 19                  | 17.5 ± 0.3          | 14.2 ± 0.3 | 12.9 ± 0.3 | 14.9 ± 0.3 |
| 20                  | 17.8 ± 0.4          | 14.7 ± 0.2 | 14.9 ± 0.4 | 15.8 ± 0.3 |
| 21                  | 13.2 ± 0.5          | 14.1 ± 0.3 | 16.4 ± 0.4 | 14.6 ± 0.3 |
| 32                  | 14.3 ± 0.3          | 14.0 ± 0.3 | 16.5 ± 0.3 | 14.9 ± 0.2 |
| LSD <sub>0.05</sub> | 1.1                 | 1.1        | 1.0        |            |

\* ± Standard Error.

Table 3. Fruit color hue levels of skin and flesh of 'Ankara' pear clones.

| Clone No.           | 2001          | 2002        | 2003        | Average     |
|---------------------|---------------|-------------|-------------|-------------|
|                     | Flesh hue (°) |             |             |             |
| 1                   | 110.5 ± 0.6*  | 113.3 ± 0.3 | 110.2 ± 1.2 | 111.3 ± 1.0 |
| 4                   | 112.1 ± 0.4   | 113.9 ± 0.3 | 110.9 ± 0.8 | 112.3 ± 0.9 |
| 5                   | 113.5 ± 0.2   | 114.5 ± 0.2 | 111.8 ± 1.0 | 113.3 ± 0.8 |
| 6                   | 112.6 ± 0.8   | 113.4 ± 0.2 | 113.2 ± 0.3 | 113.1 ± 0.2 |
| 7                   | 114.2 ± 0.2   | 115.4 ± 0.2 | 111.5 ± 0.3 | 113.7 ± 1.1 |
| 8                   | 112.7 ± 0.6   | 113.3 ± 0.5 | 112.5 ± 0.4 | 112.8 ± 0.2 |
| 9                   | 113.0 ± 0.3   | 115.2 ± 0.3 | 112.9 ± 0.3 | 113.7 ± 0.7 |
| 12                  | 110.2 ± 2.2   | 113.2 ± 0.6 | 111.9 ± 0.5 | 111.8 ± 0.8 |
| 13                  | 110.1 ± 2.4   | 114.2 ± 0.5 | 112.0 ± 0.7 | 112.1 ± 1.2 |
| 16                  | 112.3 ± 0.3   | 113.8 ± 0.4 | 112.0 ± 0.6 | 112.7 ± 0.6 |
| 17                  | 114.4 ± 0.3   | 115.2 ± 0.1 | 114.4 ± 0.3 | 114.7 ± 0.3 |
| 18                  | 109.7 ± 0.4   | 112.8 ± 0.3 | 112.1 ± 0.4 | 111.5 ± 0.9 |
| 19                  | 111.9 ± 0.3   | 114.6 ± 0.3 | 112.8 ± 0.2 | 113.1 ± 0.8 |
| 20                  | 114.4 ± 0.2   | 115.2 ± 0.2 | 114.2 ± 0.3 | 114.6 ± 0.3 |
| 21                  | 113.9 ± 0.4   | 112.9 ± 0.3 | 112.8 ± 0.2 | 113.2 ± 0.4 |
| 32                  | 110.8 ± 0.4   | 113.4 ± 0.4 | 113.4 ± 0.2 | 112.5 ± 0.9 |
| LSD <sub>0.05</sub> | 2.6           | 1.0         | 2.0         |             |
| Clone No.           | Flesh hue (°) |             |             |             |
|                     | 2001          | 2002        | 2003        | Average     |
| 1                   | 99.5 ± 0.3    | 99.1 ± 0.5  | 101.7 ± 0.2 | 100.1 ± 0.8 |
| 4                   | 103.7 ± 0.4   | 102.8 ± 0.4 | 104.7 ± 0.4 | 103.7 ± 0.5 |
| 5                   | 100.1 ± 0.3   | 100.2 ± 0.5 | 100.8 ± 0.4 | 100.4 ± 0.2 |
| 6                   | 102.1 ± 0.2   | 99.2 ± 0.5  | 102.0 ± 0.3 | 101.1 ± 1.0 |
| 7                   | 101.5 ± 0.3   | 100.8 ± 0.5 | 104.4 ± 0.4 | 102.2 ± 1.1 |
| 8                   | 102.9 ± 0.3   | 102.0 ± 0.6 | 103.4 ± 0.4 | 102.8 ± 0.4 |
| 9                   | 103.6 ± 0.4   | 99.9 ± 0.4  | 104.0 ± 0.3 | 102.5 ± 1.3 |
| 12                  | 99.5 ± 0.4    | 104.0 ± 0.4 | 105.7 ± 0.2 | 103.1 ± 1.8 |
| 13                  | 100.0 ± 0.4   | 103.7 ± 0.4 | 102.0 ± 1.4 | 101.9 ± 1.1 |
| 16                  | 98.6 ± 0.4    | 100.8 ± 0.3 | 100.2 ± 0.3 | 99.9 ± 0.7  |
| 17                  | 101.2 ± 0.4   | 99.9 ± 0.4  | 100.2 ± 0.4 | 100.4 ± 0.4 |
| 18                  | 97.4 ± 0.3    | 98.2 ± 0.4  | 98.7 ± 0.3  | 98.1 ± 0.4  |
| 19                  | 96.3 ± 0.3    | 98.5 ± 0.4  | 100.0 ± 0.3 | 98.3 ± 1.1  |
| 20                  | 100.9 ± 0.4   | 100.1 ± 1.2 | 102.7 ± 0.3 | 101.3 ± 0.8 |
| 21                  | 99.8 ± 0.3    | 100.7 ± 0.2 | 103.3 ± 0.3 | 101.3 ± 1.1 |
| 32                  | 99.6 ± 0.5    | 100.5 ± 0.4 | 100.4 ± 1.2 | 100.2 ± 0.3 |
| LSD <sub>0.05</sub> | 1.1           | 1.5         | 1.5         |             |

\* ± Standard Error.

Table 4. Fruit flesh firmness and soluble solids of 'Ankara' pear clones.

| Clone No.           | 2001               | 2002       | 2003       | Average    |
|---------------------|--------------------|------------|------------|------------|
|                     | Flesh firmness (N) |            |            |            |
| 1                   | 67.1 ± 0.7*        | 70.5 ± 1.4 | 66.1 ± 0.9 | 67.9 ± 0.7 |
| 4                   | 60.7 ± 0.9         | 62.2 ± 1.2 | 59.4 ± 1.1 | 60.8 ± 0.6 |
| 5                   | 64.1 ± 1.1         | 67.6 ± 0.7 | 71.0 ± 1.2 | 67.6 ± 0.7 |
| 6                   | 73.8 ± 1.3         | 73.2 ± 1.8 | 66.9 ± 1.2 | 70.8 ± 1.0 |
| 7                   | 76.4 ± 1.4         | 72.6 ± 1.1 | 66.6 ± 1.6 | 71.9 ± 0.9 |
| 8                   | 63.2 ± 1.1         | 80.8 ± 1.2 | 69.6 ± 1.5 | 71.4 ± 1.3 |
| 9                   | 57.2 ± 0.9         | 82.6 ± 2.5 | 65.3 ± 0.8 | 68.3 ± 1.6 |
| 12                  | 67.4 ± 2.6         | 80.8 ± 1.0 | 50.2 ± 0.8 | 66.1 ± 1.9 |
| 13                  | 48.0 ± 1.8         | 75.3 ± 0.9 | 66.4 ± 1.9 | 63.3 ± 1.7 |
| 16                  | 58.5 ± 1.2         | 73.8 ± 1.4 | 80.2 ± 1.4 | 71.9 ± 1.4 |
| 17                  | 54.1 ± 1.0         | 75.4 ± 1.3 | 66.5 ± 1.1 | 65.3 ± 1.3 |
| 18                  | 60.8 ± 0.9         | 80.2 ± 0.8 | 70.9 ± 1.3 | 70.6 ± 1.2 |
| 19                  | 62.1 ± 0.6         | 69.8 ± 1.5 | 65.0 ± 0.9 | 65.6 ± 0.7 |
| 20                  | 50.4 ± 0.7         | 68.5 ± 1.0 | 61.1 ± 0.5 | 60.0 ± 1.1 |
| 21                  | 55.8 ± 1.0         | 73.4 ± 0.7 | 60.0 ± 0.7 | 63.1 ± 1.1 |
| 32                  | 49.1 ± 0.8         | 72.9 ± 1.3 | 57.7 ± 0.8 | 59.9 ± 1.4 |
| LSD <sub>0.05</sub> | 3.5                | 3.7        | 3.2        |            |
|                     | Soluble solids (%) |            |            |            |
| 1                   | 13.5 ± 0.1         | 14.4 ± 0.1 | 15.1 ± 0.1 | 14.4 ± 0.5 |
| 4                   | 13.0 ± 0.1         | 13.4 ± 0.1 | 12.9 ± 0.4 | 13.1 ± 0.1 |
| 5                   | 13.1 ± 0.1         | 13.5 ± 0.1 | 14.2 ± 0.1 | 13.6 ± 0.3 |
| 6                   | 13.2 ± 0.0         | 14.3 ± 0.1 | 13.3 ± 0.1 | 13.6 ± 0.4 |
| 7                   | 14.7 ± 0.1         | 14.1 ± 0.1 | 15.6 ± 0.2 | 14.8 ± 0.4 |
| 8                   | 13.8 ± 0.2         | 14.5 ± 0.2 | 14.7 ± 0.3 | 14.3 ± 0.2 |
| 9                   | 13.3 ± 0.1         | 14.5 ± 0.4 | 14.5 ± 0.2 | 14.1 ± 0.4 |
| 12                  | 16.1 ± 0.1         | 13.2 ± 0.2 | 12.6 ± 0.4 | 14.0 ± 1.1 |
| 13                  | 14.7 ± 0.2         | 11.4 ± 0.3 | 10.9 ± 0.6 | 12.4 ± 1.2 |
| 16                  | 16.6 ± 0.0         | 15.1 ± 0.3 | 14.3 ± 0.5 | 15.3 ± 0.7 |
| 17                  | 12.0 ± 0.1         | 13.4 ± 0.2 | 12.1 ± 0.2 | 12.5 ± 0.4 |
| 18                  | 15.0 ± 0.1         | 13.2 ± 0.0 | 13.6 ± 0.4 | 13.9 ± 0.6 |
| 19                  | 16.9 ± 0.1         | 15.2 ± 0.4 | 15.1 ± 0.1 | 15.7 ± 0.6 |
| 20                  | 12.8 ± 0.3         | 13.8 ± 0.1 | 13.7 ± 0.2 | 13.4 ± 0.3 |
| 21                  | 15.2 ± 0.2         | 15.0 ± 0.3 | 14.1 ± 0.1 | 14.8 ± 0.3 |
| 32                  | 17.3 ± 0.3         | 14.1 ± 0.0 | 15.0 ± 0.1 | 15.5 ± 0.9 |
| LSD <sub>0.05</sub> | 0.4                | 0.6        | 0.8        |            |

\* ± Standard Error.

Table 5. Titratable acidity and juice pH levels of 'Ankara' pear clones.

| Clone No.           | 2001                   | 2002        | 2003        | Average     |
|---------------------|------------------------|-------------|-------------|-------------|
|                     | Titratable acidity (%) |             |             |             |
| 1                   | 0.36 ± 0.01*           | 0.20 ± 0.01 | 0.40 ± 0.01 | 0.32 ± 0.06 |
| 4                   | 0.26 ± 0.01            | 0.17 ± 0.0  | 0.33 ± 0.01 | 0.26 ± 0.04 |
| 5                   | 0.26 ± 0.01            | 0.16 ± 0.0  | 0.38 ± 0.01 | 0.27 ± 0.06 |
| 6                   | 0.28 ± 0.01            | 0.20 ± 0.0  | 0.32 ± 0.02 | 0.27 ± 0.04 |
| 7                   | 0.27 ± 0.01            | 0.25 ± 0.01 | 0.32 ± 0.01 | 0.28 ± 0.02 |
| 8                   | 0.26 ± 0.01            | 0.22 ± 0.01 | 0.34 ± 0.01 | 0.27 ± 0.04 |
| 9                   | 0.21 ± 0.01            | 0.22 ± 0.01 | 0.28 ± 0.01 | 0.24 ± 0.02 |
| 12                  | 0.28 ± 0.01            | 0.19 ± 0.0  | 0.41 ± 0.01 | 0.29 ± 0.06 |
| 13                  | 0.2 ± 0.01             | 0.19 ± 0.01 | 0.36 ± 0.01 | 0.25 ± 0.06 |
| 16                  | 0.16 ± 0.01            | 0.11 ± 0.01 | 0.30 ± 0.01 | 0.19 ± 0.06 |
| 17                  | 0.18 ± 0.01            | 0.16 ± 0.0  | 0.28 ± 0.0  | 0.21 ± 0.04 |
| 18                  | 0.28 ± 0.01            | 0.17 ± 0.0  | 0.42 ± 0.01 | 0.29 ± 0.07 |
| 19                  | 0.28 ± 0.01            | 0.17 ± 0.01 | 0.30 ± 0.01 | 0.25 ± 0.04 |
| 20                  | 0.16 ± 0.01            | 0.12 ± 0.0  | 0.15 ± 0.0  | 0.14 ± 0.01 |
| 21                  | 0.39 ± 0.01            | 0.2 ± 0.0   | 0.27 ± 0.01 | 0.29 ± 0.06 |
| 32                  | 0.27 ± 0.01            | 0.16 ± 0.0  | 0.21 ± 0.01 | 0.21 ± 0.03 |
| LSD <sub>0.05</sub> | 0.02                   | 0.01        | 0.03        |             |
|                     | pH                     |             |             |             |
| 1                   | 3.84 ± 0.01            | 4.45 ± 0.03 | 4.41 ± 0.02 | 4.23 ± 1.93 |
| 4                   | 4.13 ± 0.02            | 4.41 ± 0.01 | 4.28 ± 0.05 | 4.27 ± 0.08 |
| 5                   | 3.96 ± 0.03            | 4.33 ± 0.01 | 4.20 ± 0.00 | 4.16 ± 0.11 |
| 6                   | 4.02 ± 0.01            | 4.43 ± 0.02 | 4.35 ± 0.06 | 4.27 ± 0.13 |
| 7                   | 4.49 ± 0.03            | 4.43 ± 0.01 | 4.52 ± 0.02 | 4.48 ± 0.03 |
| 8                   | 4.25 ± 0.01            | 4.51 ± 0.03 | 4.43 ± 0.03 | 4.40 ± 0.08 |
| 9                   | 4.39 ± 0.03            | 4.45 ± 0.02 | 4.43 ± 0.05 | 4.42 ± 0.02 |
| 12                  | 4.32 ± 0.02            | 4.60 ± 0.00 | 4.43 ± 0.05 | 4.45 ± 0.08 |
| 13                  | 4.46 ± 0.02            | 4.55 ± 0.03 | 4.45 ± 0.06 | 4.49 ± 0.03 |
| 16                  | 4.23 ± 0.03            | 4.66 ± 0.02 | 4.60 ± 0.00 | 4.50 ± 0.13 |
| 17                  | 4.53 ± 0.02            | 4.80 ± 0.00 | 5.05 ± 0.03 | 4.79 ± 0.15 |
| 18                  | 4.09 ± 0.01            | 4.70 ± 0.00 | 4.65 ± 0.03 | 4.48 ± 0.20 |
| 19                  | 4.17 ± 0.01            | 4.65 ± 0.03 | 4.73 ± 0.02 | 4.52 ± 0.17 |
| 20                  | 4.41 ± 0.01            | 4.80 ± 0.00 | 5.00 ± 0.00 | 4.74 ± 0.17 |
| 21                  | 3.94 ± 0.02            | 4.48 ± 0.02 | 4.41 ± 0.04 | 4.28 ± 0.17 |
| 32                  | 4.14 ± 0.04            | 4.65 ± 0.03 | 4.80 ± 0.01 | 4.53 ± 0.20 |
| LSD <sub>0.05</sub> | 0.06                   | 0.06        | 0.08        |             |

\*± Standard Error.

Table 6. Visual and sensory fruit characteristics of ‘Ankara’ pear cultivars.

| Clone No. | Grittiness   | Buttery flesh | Flavor       | Texture      | Appearanc    |
|-----------|--------------|---------------|--------------|--------------|--------------|
| 1         | low          | intermediate  | intermediate | fine         | fine         |
| 4         | low          | intermediate  | intermediate | fine         | fine         |
| 5         | low          | intermediate  | intermediate | fine         | fine         |
| 6         | low          | intermediate  | intermediate | fine         | fine         |
| 7         | low          | intermediate  | intermediate | intermediate | intermediate |
| 8         | low          | intermediate  | intermediate | fine         | fine         |
| 9         | low          | intermediate  | intermediate | fine         | fine         |
| 12        | intermediate | low           | low          | coarse       | coarse       |
| 13        | intermediate | low           | low          | coarse       | coarse       |
| 16        | low          | intermediate  | intermediate | intermediate | fine         |
| 17        | low          | intermediate  | low          | intermediate | fine         |
| 18        | intermediate | intermediate  | intermediate | intermediate | fine         |
| 19        | low          | intermediate  | intermediate | intermediate | fine         |
| 20        | low          | intermediate  | low          | intermediate | fine         |
| 21        | low          | intermediate  | low          | intermediate | fine         |
| 32        | low          | intermediate  | low          | intermediate | fine         |

73.76 ± 0.19 mm, respectively. The fruit length and diameter can change significantly over time. Bell et al. (1996) reported that fruit size is a highly variable character because it is influenced by many environmental factors as well as by fruit set and yield, and, consequently, more than one season may be required to adequately assess this character. We found that clones #5 and #6 (Figure 1) were of large size in all years of the study. In addition, the sizes of the fruits were within the range of the fruit size accepted for the dessert cultivars, which is 60 to 80 mm in diameter, in general (Bell et al., 1996).

The average core diameter of ‘Ankara’ pear clones ranged between 13.5 ± 0.3 and 16.3 ± 0.3 mm (Table 2). Clone #5 had the smallest core diameter (13.5 ± 0.3 mm), which was also low in clone #6 (13.7 ± 0.3 mm). The average hue value of skin color ranged between 111.3 ± 1.0° (clone #1) and 114.7 ± 0.3° (clone #17). The average flesh color ranged 98.1 ± 0.4° (clone #18) and 103.1 ± 1.8° (clone #12) (Table 4). The decrease in the hue values indicates change in fruit skin color from green to yellow (McGuire, 1992) as a result of chlorophyll decomposition during maturation (Gorski and Creasy, 1977; Tuna-Güneş, 2003). The average skin color was 113.3 ± 0.8° and 113.1 ± 0.2°, and flesh

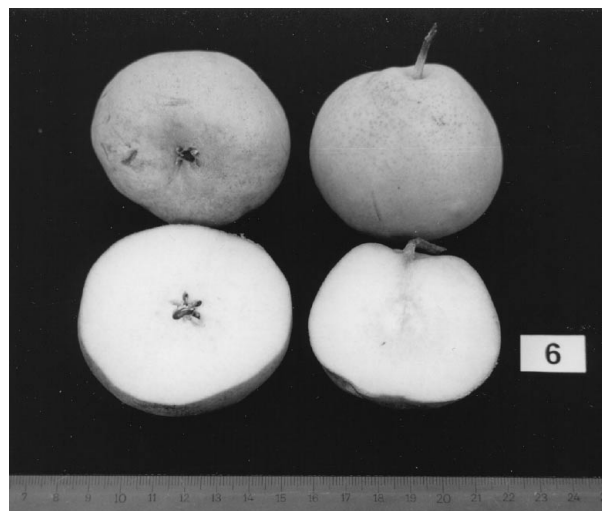


Figure 1. Fruit of Ankara pear cultivar clone #6.

color was 100.4 ± 0.2° and 101.1 ± 1.0° in clones #5 and #6. These 2 clones had hardy fruits at the harvest date (Table 4). Flesh firmness was 67.6 ± 0.7 N and 70.8 ± 1 N in clones #5 and #6, respectively. Soluble solids (13.6%) and titrable acidity (0.3%) levels were



similar for both clones (Tables 3 and 4). The average pH level of 'Ankara' pear clones ranged between  $4.23 \pm 1.93$  and  $4.79 \pm 0.15$  (Table 4). Clones #5 ( $4.16 \pm 0.11$ ) and #6 ( $4.27 \pm 0.13$ ) had lower pH level than most of the other clones.

Panelists were able to identify differences in grittiness, buttery flesh, flavor, texture, and appearance among the 'Ankara' pear clones. Fruits of all clones, except clones #7, #12, and #13, had good appearance. However, clones #1, #4, #5, #6, #8, #9, #16, and #19 had other desirable sensory characteristics, such as low grittiness, high degree of buttery flesh, intermediate flavor, good level of texture, and appearance (Table 6).

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## Conclusions

We selected clones #5 and #6 as superior among the evaluated 'Ankara' pear clones. These clones were grafted on Quince-A rootstock in 2005 and a replicated trial was established. Yield and fruit characteristics will be evaluated when trees reach maturity.

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