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## Effect of drying on antioxidant activity, total phenol and mineral contents of pear fruits

*Wirkung der Trocknung auf die antioxidative Aktivität, Gesamtphenol und den Mineralgehalt von Birnenfrüchten*

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### Summary

In this study, the effect of drying on total phenolic content, antioxidant activity and mineral content of pear varieties (Ankara, Deveci and Santa maria) was investigated. While the phenolic contents of Ankara variety are found between 18.125 and 165.625 mg GAE/100 g, total phenolic contents of Deveci pear ranged from 86.146 to 171.458 mg GAE/100 g. With regard to the DPPH assay, antioxidant activities of fresh pear varieties were determined as 4.840 % for Ankara, 20.731 % for Deveci and 42.283 % for Santa maria, respectively. The increase of the drying time raised the antioxidant activities of pears. The antioxidant activity of Deveci was found higher (71.689 %; 25 h of drying). than others. K contents of fresh pears were 1196.860 ppm for Ankara; 1255.393 ppm for Deveci; 744.540 ppm for Santa maria. The application of heat treatment led to increase in phenolic contents and antioxidant activities. In addition, the amounts of minerals, especially K, Mg and P, were also raised during drying when compared to the fresh pears.

**Keywords:** pear, varieties, drying, antioxidant, total phenol, minerals

### Zusammenfassung

In dieser Studie wurde die Wirkung des Trocknens auf den Gesamtphenolgehalt, die Antioxidationsaktivität und den Mineralgehalt von Birnensorten (Ankara, Deveci und Santa maria) untersucht. Während der Phenolgehalt der Ankara-Sorte zwischen 18,125 und 165,625 mg GAE / 100 g liegt, liegen die gesamten phenolischen Gehalte der Deveci-Birne zwischen 86,146 und 171,458 mg GAE / 100 g. Im Hinblick auf den DPPH-Test wurden antioxidative Aktivitäten von frischen Birnensorten als 4,840 % für Ankara, 20,731 % für Deveci und 42,283 % für Santa maria bestimmt. Die Erhöhung der Trockenzeit erhöhte die antioxidativen Aktivitäten von Birnen. Die antioxidative Aktivität von Deveci wurde höher gefunden (71,689 %, 25 h Trocknung). als andere. Der K-Gehalt an frischen Birnen betrug 1196,860 ppm für Ankara; 1255,393 ppm für Deveci; 744,540 ppm für Santa Maria. Die Anwendung der Wärmebehandlung führte zu einer Erhöhung der phenolischen Gehalte und der antioxidativen Aktivitäten. Zusätzlich wurden die Mengen an Mineralien, insbesondere K, Mg und P, während des Trocknens im Vergleich zu den frischen Birnen erhöht.

**Schlüsselwörter:** Birne, Sorten, Trocknen, Antioxidans, Gesamtphenol, Mineralgehalt

## Introduction

Pear belongs to the *Rosaceae* family, *Pyrus* genus (da Silva et al. 2013) and grows in temperate zones, originated in the Asiatic region (Doymaz and Ismail, 2012). Fresh fruit contains phenolics, vitamins, minerals, sugars, amino acids, volatile compounds, organic acids, fatty acids, large amount of water and concentration of these components responsible for organoleptic properties (Chen et al. 2007; Salta et al. 2010; Santos et al. 2014; Guine et al. 2015). One of the most important preservation process to prolong the self life of fruits is drying (Fumagalli and Silveria, 2005). Drying process is also most commonly used conservation technique thanks to the following advantages: (1) minimizing biochemical, chemical and microbiological deterioration, (2) extend the self life, (3) process simplicity, (4) mass reduction, (5) minimizing costs of packaging, storage and transportation, (6) forming the aroma compounds (da Silva et al. 2013). Physical appearance is an important parameter for consumer preference (Lopez et al. 1997). Unappropriate drying such as continuous hot air, long drying time or high temperature causes wrinkled, hard, bitter and burnt fruit (Chong et al. 2013). Additionally, heat treatment effects the phenolic compounds and causes reduction of their content or antioxidant capacity (Guine et al. 2014). For this reason, applied temperature and time have critical importance in drying process. The objective of present work was to determine the phenolic compounds, antioxidant activities and mineral contents of pear varieties during drying process.

## Materials and Methods

### Materials

Samples from three varieties of pear, Santa maria, Deveci and Ankara, were used and obtained from a local market in Konya, Turkey. Samples were peeled, and cut into thin slices (5 mm thickness) prior to drying process.

### Methods

#### Drying process

Pear slices were laid together to a rod and dried in an at 70 °C. Pear slices were taken 15, 20 and 25 hours later. Fresh and dried pear samples were analysed. The initial moisture content of slices was measured at 105 °C for 24 h.

#### Extraction of polyphenol compounds

For extraction, 1 g of ground sample was used, and stirred with 10 ml of 80 % aqueous methanol with 1 % of HCl. After samples were sonicated for 15 min, the tubes were kept for 24 h at 4 °C. Then, the extract was centrifuged 15,000 rpm for 10 min and the supernatant was taken for analyses (Chong et al. 2013).

#### Determination of total phenol

Total phenol contents were determined by Folin-Ciocalteu (FC) reagent according to Yoo et al. (2004). 10 mL of Na<sub>2</sub>CO<sub>3</sub> solution tubes and 1 ml of Folin-Ciocalteu were mixed, and was completed with 25 ml deionised water. After 1 hours, total phenol content was measured 750 nm in a spectrophotometer.

#### Determination of antioxidant activity

The antioxidant activity was determined with DPPH (1,1-diphenyl-2-picrylhydrazyl) (Lee et al. 1998). After the

extract was mixed with 2 mL DPPH methanolic solution, it was shaken strongly. After keeping at room temperature for 30 min, the absorbance was measured at 517 nm in a spectrophotometer.

#### Determination of Minerals

15 ml of pure NHO<sub>3</sub> and 2 ml H<sub>2</sub>O<sub>2</sub> (% 30 w/v) were added into 0.2 g sample in burning cup, and incinerated in a microwave oven at 210 °C. After filtrating, it was analysed by ICP-AES (Skujins,1998).

#### Statistical analyses

The results were given as mean±standard deviation of independent pear fruits (Püskülcü and İköz, 1989).

## Results and Discussion

Total phenolic and antioxidant activities of fresh and dried fruits at 70 °C in different times (15h, 20h, 25h and exact dry) are given in Table 1. The initial moisture contents of Ankara, Deveci and Santa maria varieties were found as 86.018 %, 84.578 % and 85.350 %, respectively. While the phenolic contents of Ankara variety change between 18.125 and 165.625 mg GAE/100 g, the amount of phenolic contents of Deveci variety ranged from 86.146 to 171.458 mg GAE/100 g. In variety Santa maria, the content of phenolics were between 48.646 and 93.229 mg GAE/100 g. Generally, greatest amount of phenolic contents was determined in pears dried during 25 h. In addition, the minimum content of phenolics was observed in fresh pears for all varieties. Total phenol values of pear fruits showed increase when the drying time increased. On the other hand, the phenolic compounds of exact dry samples were slightly reduced. According to the study of Mrad et al. (2012), the highest reduction of total phenolic content was found in pear dried during 10h at 30 °C while only 3 % reduction was measured at 70 °C (2h of drying). Total phenolic con-

**TABLE 1:** Total phenolic contents and antioxidant activities of pear varieties (n:3).

| Variety     | Drying time and temperature (70 °C) | Total Phenolic Content (mg GAE/100 g) | Antioxidant Activity (%) |
|-------------|-------------------------------------|---------------------------------------|--------------------------|
| Ankara      | Fresh                               | 18.125 ± 0.001*                       | 4.840 ± 0.001            |
| Ankara      | 15h                                 | 48.125 ± 0.008                        | 3.470 ± 0.045            |
| Ankara      | 20h                                 | 100.000 ± 0.002                       | 15.068 ± 0.045           |
| Ankara      | 25h                                 | 165.625 ± 0.029                       | 39.361 ± 0.008           |
| Ankara      | Exact dry                           | 103.125 ± 0.019                       | 38.447 ± 0.007           |
| Deveci      | Fresh                               | 86.146 ± 0.059                        | 42.283 ± 0.005           |
| Deveci      | 15h                                 | 101.667 ± 0.059                       | 40.365 ± 0.001           |
| Deveci      | 20h                                 | 158.958 ± 0.001                       | 70.320 ± 0.004           |
| Deveci      | 25h                                 | 171.458 ± 0.001                       | 71.689 ± 0.001           |
| Deveci      | Exact dry                           | 123.646 ± 0.037                       | 70.320 ± 0.004           |
| Santa maria | Fresh                               | 48.646 ± 0.001                        | 20.731 ± 0.014           |
| Santa maria | 15h                                 | 66.875 ± 0.037                        | 21.461 ± 0.008           |
| Santa maria | 20h                                 | 74.688 ± 0.013                        | 15.890 ± 0.014           |
| Santa maria | 25h                                 | 93.229 ± 0.027                        | 34.795 ± 0.002           |
| Santa maria | Exact dry                           | 79.375 ± 0.005                        | 18.721 ± 0.007           |

\*: mean ± standard deviation

tent of the fresh pear (cv. D. Joaquina) was 8.5 and 238 mg GAE/100g of mg dry mass and wet samples, respectively (Guine et al. 2015). At the end of drying, the amount of phenolic compounds dried at 60 °C and 70 °C were 3.36 and 3.48 mg GAE/g, respectively. Chong et al. (2013) determined that total phenolic contents in the dried fruits ranged from 79.99 to 201.94 mg GAE/100g for pear and loos about 13-64% to fresh sample. Santos et al. (2014) informed that total phenolic compounds of pulp of pears ranged between 228.1 and 291.0 mg GAE/100g in fresh state; 246.3 and 324.2 mg GAE/100g in dried at 40°C; 230.6 and 343.2 mg GAE/100g in dried at 60°C. This situation originated in less susceptible to degradation of phenolic compounds in pulp by temperature (Santos et al. 2014). With regard to the DPPH assay, antioxidant activities of fresh pear varieties were determined as 4.840 % for Ankara, 20.731 % for Deveci and 42.283 % for Santa maria. The highest antioxidant activity was found at Deveci with 71.689 % (25h of drying). The increase of the drying time raised the antioxidant activities of pears. In general, the results of antioxidant activity

behaved in parallel to the results of total phenolic content. The antioxidant activity of the fresh pears was 23.9 µmol Trolox/g dry mass and decreased to about 40% of the initial value during drying (Guine et al. 2015). Drying conditions played an important role on antioxidant activity of plant materials (Chong et al. 2013). Concerning the mineral contents of pear varieties as was displayed in Table 2, pears were a significant source of K, Mg, Na ad P minerals. Particularly, K contents of fresh pears were 1196.860 ppm for Ankara; 1255.393 ppm for Deveci; 744.540 ppm for Santa maria. After drying process, mineral contents of Ankara, Deveci and Santa maria reached to 6723.730 ppm, 7528.715 ppm and 7227.386 ppm, respectively. It was observed the increase in mineral contents of all pear varieties associated with applied drying process.

**TABLE 2:** Total phenolic contents and antioxidant activities of pear varieties (n:3).

| Variety     | Drying time | Mo             | Ca              | B              | Cu             | Fe             | K                |
|-------------|-------------|----------------|-----------------|----------------|----------------|----------------|------------------|
| Ankara      | Fresh       | 0.068 ± 0.041* | 65.013 ± 1.386  | 8.356 ± 0.118  | 4.403 ± 0.080  | 25.577 ± 0.890 | 1196.860 ± 6.127 |
| Ankara      | 15h         | 0.002 ± 0.316  | 126.408 ± 0.020 | 10.183 ± 0.014 | 6.485 ± 0.008  | 25.273 ± 0.130 | 4729.300 ± 0.045 |
| Ankara      | 20h         | 0.024 ± 0.006  | 239.274 ± 0.488 | 10.649 ± 0.046 | 7.520 ± 0.013  | 35.413 ± 0.008 | 6803.432 ± 0.191 |
| Ankara      | 25h         | 0.046 ± 0.010  | 207.330 ± 0.152 | 13.194 ± 0.241 | 6.542 ± 0.003  | 21.480 ± 0.039 | 6826.031 ± 0.026 |
| Ankara      | Exact dry   | 0.149 ± 0.002  | 141.551 ± 0.018 | 14.577 ± 0.016 | 6.307 ± 0.005  | 22.955 ± 0.006 | 6723.730 ± 0.021 |
| Deveci      | Fresh       | 0.054 ± 0.008  | 42.017 ± 1.363  | 6.290 ± 0.095  | 2.990 ± 0.082  | 19.710 ± 1.873 | 1255.393 ± 1.523 |
| Deveci      | 15h         | 0.338 ± 0.004  | 24.070 ± 0.549  | 10.883 ± 0.409 | 5.228 ± 0.571  | 27.750 ± 0.420 | 5298.045 ± 0.463 |
| Deveci      | 20h         | 0.002 ± 0.012  | 91.516 ± 0.509  | 10.240 ± 0.075 | 7.188 ± 0.152  | 25.731 ± 0.081 | 7245.619 ± 0.258 |
| Deveci      | 25h         | 0.343 ± 0.230  | 46.002 ± 0.390  | 8.477 ± 0.031  | 8.402 ± 0.253  | 23.551 ± 0.651 | 7649.115 ± 0.361 |
| Deveci      | Exact dry   | 0.109 ± 0.032  | 157.284 ± 0.018 | 11.429 ± 0.252 | 11.119 ± 0.512 | 19.417 ± 0.261 | 7528.715 ± 0.233 |
| Santa maria | Fresh       | 0.004 ± 0.001  | 68.727 ± 0.629  | 6.843 ± 0.376  | 2.923 ± 0.032  | 18.363 ± 1.522 | 744.540 ± 3.596  |
| Santa maria | 15h         | 0.056 ± 0.005  | 239.179 ± 0.001 | 13.266 ± 0.005 | 4.563 ± 0.003  | 25.794 ± 0.010 | 4502.231 ± 0.027 |
| Santa maria | 20h         | 0.111 ± 0.004  | 179.365 ± 0.003 | 12.759 ± 0.011 | 8.008 ± 0.026  | 21.457 ± 0.357 | 6380.180 ± 0.003 |
| Santa maria | 25h         | 0.007 ± 0.004  | 171.501 ± 0.002 | 17.503 ± 0.006 | 6.675 ± 0.003  | 16.057 ± 0.006 | 7954.723 ± 0.005 |
| Santa maria | Exact dry   | 0.068 ± 0.041  | 148.555 ± 0.478 | 14.757 ± 0.024 | 7.775 ± 0.002  | 29.706 ± 0.005 | 7227.386 ± 2.872 |

| Variety     | Drying time | Mg              | Mn            | Na              | P               | S               | Zn            |
|-------------|-------------|-----------------|---------------|-----------------|-----------------|-----------------|---------------|
| Ankara      | Fresh       | 91.767 ± 2.044* | 1.680 ± 0.184 | 304.207 ± 5.560 | 153.780 ± 1.402 | 130.090 ± 2.248 | 3.495 ± 0.219 |
| Ankara      | 15h         | 298.597 ± 0.010 | 2.039 ± 0.019 | 154.100 ± 0.376 | 340.820 ± 0.502 | 245.782 ± 0.383 | 3.906 ± 0.100 |
| Ankara      | 20h         | 370.470 ± 0.092 | 0.977 ± 0.021 | 182.710 ± 0.204 | 645.776 ± 0.041 | 379.160 ± 1.459 | 5.152 ± 0.100 |
| Ankara      | 25h         | 413.786 ± 0.062 | 0.940 ± 0.011 | 157.669 ± 0.005 | 653.478 ± 0.005 | 381.002 ± 0.005 | 3.806 ± 0.048 |
| Ankara      | Exact dry   | 345.473 ± 0.043 | 0.880 ± 0.006 | 168.045 ± 0.009 | 608.387 ± 0.008 | 296.715 ± 0.025 | 4.307 ± 0.007 |
| Deveci      | Fresh       | 101.533 ± 7.057 | 1.490 ± 0.168 | 273.010 ± 1.826 | 164.320 ± 7.714 | 101.780 ± 6.408 | 2.753 ± 0.050 |
| Deveci      | 15h         | 249.720 ± 0.351 | 1.072 ± 0.042 | 186.516 ± 0.332 | 613.526 ± 0.321 | 293.647 ± 0.354 | 7.203 ± 0.082 |
| Deveci      | 20h         | 393.412 ± 0.222 | 1.846 ± 0.200 | 160.532 ± 0.275 | 898.055 ± 0.037 | 228.040 ± 0.476 | 6.202 ± 0.007 |
| Deveci      | 25h         | 281.545 ± 0.268 | 1.686 ± 0.001 | 200.276 ± 0.001 | 735.346 ± 0.278 | 292.223 ± 0.175 | 6.659 ± 0.101 |
| Deveci      | Exact dry   | 421.067 ± 0.303 | 2.113 ± 0.228 | 175.517 ± 0.094 | 884.863 ± 0.017 | 389.680 ± 0.766 | 7.206 ± 0.152 |
| Santa maria | Fresh       | 75.677 ± 7.034  | 1.280 ± 0.149 | 312.287 ± 6.915 | 110.543 ± 3.363 | 99.157 ± 0.436  | 2.177 ± 0.145 |
| Santa maria | 15h         | 323.325 ± 0.031 | 1.137 ± 0.020 | 160.687 ± 0.244 | 482.281 ± 0.008 | 267.431 ± 0.002 | 3.758 ± 0.004 |
| Santa maria | 20h         | 385.532 ± 0.010 | 1.783 ± 0.006 | 159.705 ± 0.026 | 531.426 ± 0.005 | 305.794 ± 0.001 | 3.435 ± 0.001 |
| Santa maria | 25h         | 357.945 ± 0.040 | 1.577 ± 0.005 | 130.290 ± 0.005 | 591.959 ± 0.005 | 307.826 ± 0.006 | 3.348 ± 0.010 |
| Santa maria | Exact dry   | 465.855 ± 0.452 | 2.704 ± 0.035 | 145.752 ± 0.018 | 610.059 ± 0.005 | 298.731 ± 0.162 | 4.023 ± 0.040 |

\*: mean ± standard deviation

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## Conflict of interest

The authors declare that no conflict of interest among authors.

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