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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 Na₂CO₃ 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 NHO₃ and 2 ml H₂O₂ (% 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 İkiz, 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 μ mol 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 and 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 \pm 0.041*	65.013 \pm 1.386	8.356 \pm 0.118	4.403 \pm 0.080	25.577 \pm 0.890	1196.860 \pm 6.127
Ankara	15h	0.002 \pm 0.316	126.408 \pm 0.020	10.183 \pm 0.014	6.485 \pm 0.008	25.273 \pm 0.130	4729.300 \pm 0.045
Ankara	20h	0.024 \pm 0.006	239.274 \pm 0.488	10.649 \pm 0.046	7.520 \pm 0.013	35.413 \pm 0.008	6803.432 \pm 0.191
Ankara	25h	0.046 \pm 0.010	207.330 \pm 0.152	13.194 \pm 0.241	6.542 \pm 0.003	21.480 \pm 0.039	6826.031 \pm 0.026
Ankara	Exact dry	0.149 \pm 0.002	141.551 \pm 0.018	14.577 \pm 0.016	6.307 \pm 0.005	22.955 \pm 0.006	6723.730 \pm 0.021
Deveci	Fresh	0.054 \pm 0.008	42.017 \pm 1.363	6.290 \pm 0.095	2.990 \pm 0.082	19.710 \pm 1.873	1255.393 \pm 1.523
Deveci	15h	0.338 \pm 0.004	24.070 \pm 0.549	10.883 \pm 0.409	5.228 \pm 0.571	27.750 \pm 0.420	5298.045 \pm 0.463
Deveci	20h	0.002 \pm 0.012	91.516 \pm 0.509	10.240 \pm 0.075	7.188 \pm 0.152	25.731 \pm 0.081	7245.619 \pm 0.258
Deveci	25h	0.343 \pm 0.230	46.002 \pm 0.390	8.477 \pm 0.031	8.402 \pm 0.253	23.551 \pm 0.651	7649.115 \pm 0.361
Deveci	Exact dry	0.109 \pm 0.032	157.284 \pm 0.018	11.429 \pm 0.252	11.119 \pm 0.512	19.417 \pm 0.261	7528.715 \pm 0.233
Santa maria	Fresh	0.004 \pm 0.001	68.727 \pm 0.629	6.843 \pm 0.376	2.923 \pm 0.032	18.363 \pm 1.522	744.540 \pm 3.596
Santa maria	15h	0.056 \pm 0.005	239.179 \pm 0.001	13.266 \pm 0.005	4.563 \pm 0.003	25.794 \pm 0.010	4502.231 \pm 0.027
Santa maria	20h	0.111 \pm 0.004	179.365 \pm 0.003	12.759 \pm 0.011	8.008 \pm 0.026	21.457 \pm 0.357	6380.180 \pm 0.003
Santa maria	25h	0.007 \pm 0.004	171.501 \pm 0.002	17.503 \pm 0.006	6.675 \pm 0.003	16.057 \pm 0.006	7954.723 \pm 0.005
Santa maria	Exact dry	0.068 \pm 0.041	148.555 \pm 0.478	14.757 \pm 0.024	7.775 \pm 0.002	29.706 \pm 0.005	7227.386 \pm 2.872

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

*: mean \pm standard deviation

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Conflict of interest

The authors declare that no conflict of interest among authors.

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