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ORIGINAL PAPER

The effect of microwave and conventional drying on antioxidant activity, phenolic compounds and mineral profile of date fruit (*Phoenix dactylifera* L.) flesh

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Abstract In this study, the effect of microwave and conventional drying on antioxidant activity, phenolic compounds, mineral and total phenolic contents of date fruit meat (Silifke and Anamur) were determined. Both microwave (360, 540 and 720 W) and conventional (70, 90 and 110 °C) drying caused the reduction of phenolic compounds although there can not considerably variation in antioxidant activity of date flesh. Total phenolic contents of date flesh changed between 114.640 mgGAE/100 g (Silifke 540 W) and 133.484 mg GAE/100 g (Silifke 720 W) compared with control sample (156.128 mg GAE/100 g). While P contents of date fruit change between 86.00 mg/Kg (control) and 704.420 mg/Kg (360 W), P contents of Anamur samples ranged from 79.430 mg/Kg (Control) to 1288.780 mg/Kg (360 W). Mineral contents of date fruits dried in microwave oven were found higher than those of observed in conventional dried fruits (especially Ca and Mg contents of date fruits).

Keywords Date fruit · Microvawe · Drying · Antioxidant · Total phenolic compounds · Minerals

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Introduction

The date palm (*Phoenix dactylifera* L.) is cultivated in dry and semi-arid regions in the world and is an important member of the family Palmaceae [1–3]. It is one of mankind's oldest cultivated plants. It has been used as food for centuries [4, 5]. The date has been an important crop in the desert regions of Arabian countries and has formed the basis of survival for many ancient nomads, this continues to be true today [6]. On the other hand fruits exploitation of date palm tress represents an important economical support for indigenous populations [7]. Dates are rich in certain nutrients and provide a good source of rapid energy due to their high carbohydrate content (70–80 %). Most of the carbohydrates in dates are in the form of fructose and glucose, which are easily absorbed by the human body [8–10]. Increase in date fruit production will, therefore, play an extremely significant role in world wide improvement of the nutritional status of people, with special reference to calories and important minerals [9, 11]. In most cases, date seeds end up as waste products of many date fruit-processing plants. Date seeds are also ground and added to the feed of some animals. In addition, date pits are used in making a caffeine-free drink that can substitute for non-caffeinated coffee when coffee-related flavor is desired. Such a drink has been used in the Arab world for centuries [12, 13]. Habib and Ibrahim [13] reported that Khulas and Barhe date seeds contained 8.64 and 10.64 % moisture, 5.84 and 5.68 % crude protein, 7.92 and 7.52 % crude oil, 0.96 and 1.06 % ash and 3.94 and 2.43 % carbohydrate, respectively. Saafi et al. [1] reported that the most abundant fatty acids of the date seed oil were mainly oleic acid and lauric acid, followed by linoleic acid, palmitic acid and myrictic acid. Date pits could potentially be used as ingredients in the production of some functional foods for human consumption. Date pits could potentially be used as ingredients in the production of some functional foods for human consumption through enhancing the nutritional value of several food products [13]. The objective of current study was to determine the effect of microwave and conventional drying on antioxidant activity, phenolic compounds, mineral and total phenolic contents of date fruit flesh harvested from two different locations (Silifke and Anamur).

Material and method

Material

Fresh date fruits were collected from two locations (Anamur and Silifke) in Mersin in Turkey. They were transferred to laboratuary in cool bag for analyses. The seeds were removed from flesh samples. The flesh part was crushed until obtaining a homogeneous phase by a blender and the moisture content was established.

Methods

Drying process

The date fruits were manually cleaned, pitted and sliced into 3–4 mm slices with a knife. Approximately 30 g sliced fruits were spread on stainless stelel trays and transferred to the hot-air oven, and were placed on the turntable in a microwave oven. Samples were dried in an oven at 70, 90 and 110 °C or in a microwave oven at 360, 540 and 720 W until the moisture content was below 20 %. Additionally, fresh and dried samples were analysed. The initial moisture contents of the samples were measured by drying in an oven at 105 °C until a constant weight was obtained.

Extraction procedure

Dried date fruits were for determination of phenolic compound and antioxidant activity according to Kara et al. [14] 60 ml of methanol was added on ground samples (2 g each). Sample was centrifuged at 5000 rpm for 5 min and the supernatant was collected. The extract was concentrated at 50 °C in a rotary evaporator under vacuum. After these steps, liquid–liquid extraction was performed using 5 ml diethyl ether and 5 ml ethyl acetate in shaker, successively. This extraction was carried out three times. Organic phases were collected in each step and then evaporated at 50 °C. The dried extracts were dissolved in 2 ml of methanol. Prior to injection, the extract was filtered through a 0.45 µm nylon filter. All analyses were performed in triplicate.

Total phenolic content

Total phenol contents of obtained extracts were determined by using Folin-Ciacueltau (FC) reagent as described by Yoo et al. [15] with some modifications. FC (1 ml) was added and mixed for 5 min. Following the addition of 10 ml of Na_2CO_3, the solution in the tubes was mixed again and the final volume was adjusted to 25 ml with deionised water. At the end of 1 h, total phenolic content was determined at a wave lengt of 750 nm in a spectrophotometer. A calibration curve was made using gallic acid (0–200 mg/ml) as the standard. All determinations were performed in triplicate. The results are given as mg gallic acid equivalent (GAE)/100 g of fresh weight.

Antioxidant activity

The free radical scavenging activity of sdate fruits was determined using DPPH (1,1-diphenyl-2-picrylhydrazyl) according to Lee et al. [16]. The extract was mixed with 2 ml of a methanolic solution of DPPH. The mixture was shaken vigorously and allowed to stand at room temperature for 30 min, after which absorbance was recorded at 517 nm using a spectrophotometer. All determinations were performed in triplicate.

Determination of phenolic compounds

HPLC analyses of phenolic compounds were performed using a Shimadzu-HPLC equipped with a PDA detector and an Inertsil ODS-3 (5 µm; 4.6 × 250 mm) column. The mobile phase was a mixture of 0.05 % acetic acid in water (A) and acetonitrile (B). The flow rate of the mobile phase was1 ml/min at 30 °C and the injection volume was 20 µl. The peaks were recorded at 280 and 330 nm using a PDA detector. The gradient programme was as follows: 0–0.10 min 8 % B; 0.10–2 min 10 % B; 2–27 min 30 % B; 27–37 min 56 % B; 37–37.10 min 8 % B; 37.10–45 min 8 % B. The total running time per sample was 60 min.

Determination of mineral content

About 0.2 g of dried date fruit was put into burning cup with 15 ml of pure NHO_3 and 2 ml H_2O_2 (% 30 w/v) The sample was incinerated in a MARS 5 microwave oven at 210 °C. After digestion treatment, samples were filtrated through whatman No 42. The filtrates were collected in 50 ml flasks and analysed by ICP-AES. The mineral contents of the samples were quantified against standard solutions of known concentrations which were analysed concurrently [17].

Instrument: ICP-AES (Varian-Vista)
RF Power: 0.7–1.5 kw (1.2–1.3 kw for Axial)
Plasma gas flow rate (Ar): 10.5–15 L/min. (radial) 15"(axial)
Auxilary gas flow rate (Ar): 1.5"
Viewing height: 5–12 mm
Copy and reading time: 1–5 s (max. 60 s)
Copy time: 3 s (max. 100 s)

Statistical analyses

All analyses were carried out three times and the results are mean ± standard deviation (MSTAT C) of 25 independent date fruit flesh [18].

Results and discussion

Total phenolic contents and antioxidant activity values of fresh and dried date samples are presented in Table 1. The results of antioxidant activity of heat-processed samples were close to fresh date fruits. Microwave or conventional drying did not change dramatically the antioxidant activity of Silifke sample while a slight reduction was observed in Anamur sample after drying process. Maximum antioxidant activity value (83.823 %) were found in fresh date for Silifke sample ($p < 0.05$). Total phenolic contents of date varieties showed a reduction when drying process was applied. In Silifke date sample, total phenolic contents of date flesh heated in microvawe changed between 114.640 mgGAE/100 g (Silifke 540 W) and 133.484 mgGAE/100 g (Silifke 720 W) compared with control sample (156.128 mgGAE/100 g). In Anamur sample, total phenol contents ranged from 84.504 mgGAE/100 g (540 W) to 101.325 mgGAE/100 g (720 W) compared with control sample (158.853 mgGAE/100 g). Also total phenol contents of sun dried date fruits for Silifke sample was found higher (112.620 mgGAE/100 g) than that of Anamur sun dried (57.955 mgGAE/100 g). In Silifke date sample, while total phenol contents of date fruit flesh heated in oven change between 94.752 mg/100 g (Silifke, 70 °C) and 140.261 mg/100 g (Silifke, 90 °C), total phenol contents of date fruit ranged from 37.05 mg/100 g (Anamur, 70 °C) to 130.838 (Anamur, 90 °C). After the drying process, the best results were observed in samples dried at 90 °C, while the maximum decrease was determined in date fruits dried at 70 °C for both Silifke and Anamur date samples. In view of these results, it was determined that the optimum temperature was 90 °C for conventional drying; the best power was 720 W for microwave drying.

The phenolic compounds of fresh and dried date fruits are summarised in Table 2. The most dominant phenolic compounds of Silifke sample are (+)-catechin (9.718 mg/100 g), 1,2-dihydroxybenzene (11.964 mg/100 g), quercetin (6.481 mg/100 g) ($p < 0.05$). In Anamur sample, gallic acid (9.812 mg/100 g), 3,4-dihydroxybenzoic acid (6.282 mg/100 g), (+)-catechin (16.498 mg/100 g), 1,2-dihydroxybenzene (11.926 mg/100 g), quercetin (7.306 mg/100 g) and isorhamnetin (9.223 mg/100 g) were the major phenolic compounds ($p < 0.05$). Generally, phenolic compounds of Silifke sun dried fruit were found

Table 1 Total phenolic contents and antioxidant activities of fresh and dried date fruit flesh

Process	Moisture (%)	Antioxidant activity (%)	Total phenolic content (mg/100 g)
Silifke-control	63.785 ± 0.393*a	83.269 ± 0.001a	156.128 ± 0.021a
Silifke-360 W	8.990 ± 0.484d**	82.715 ± 0.002b	132.632 ± 0.004b
Silifke-540 W	8.845 ± 0.544d	83.324 ± 0.002a	114.640 ± 0.022c
Silifke-720 W	16.485 ± 0.954b	83.047 ± 0.001a	133.484 ± 0.044b
Silifke-70 °C	10.380 ± 0.262c	82.493 ± 0.001b	94.752 ± 0.123d
Silifke-90 °C	11.965 ± 0.595c	83.767 ± 0.001a	140.261 ± 0.017b
Silifke-110 °C	4.870 ± 0.125e	83.823 ± 0.001a	98.462 ± 0.021d
Silifke-Sun dried	3.455 ± 0.873e	83.324 ± 0.001a	112.620 ± 0.011c
Anamur- Control	64.055 ± 0.310a	65.097 ± 0.015c	158.853 ± 0.010a
Anamur-360 W	12.035 ± 0.579b	83.657 ± 0.001a	96.282 ± 0.020d
Anamur-540 W	14.045 ± 0.521b	82.881 ± 0.001b	84.504 ± 0.014d
Anamur-720 W	9.655 ± 0.318b	83.324 ± 0.001a	101.325 ± 0.012c
Anamur-70 °C	5.255 ± 0.774c	83.213 ± 0.002a	37.051 ± 0.013f
Anamur-90 °C	5.315 ± 0.199c	83.380 ± 0.001a	130.838 ± 0.023b
Anamur-110 °C	4.430 ± 0.749c	83.657 ± 0.001a	71.663 ± 0.027d
Anamur-Sun dried	3.625 ± 0.261c	83.158 ± 0.001a	57.955 ± 0.015e

* Mean ± standard deviation; ** values in each column with different letters are significantly different ($p < 0.05$)

Table 2 Phenolic compounds of fresh and dried date fruit flesh (mg/100 g)

Phenolic compounds	Silifke-control		Silifke-360 W		Silifke-540 W		Silifke-720 W		Silifke-70 °C		Silifke-90 °C		Silifke-110 °C		Silifke-sun dried	
Gallic acid	3.550	±0.469*a	3.063	±0.381a	0.856	±0.285d	3.306	±0.825a	0.819	±0.508d	2.215	±0.086b	1.817	±0.470c	2.436	±0.466b
3,4-dihydroxybenzoic acid	2.955	±0.541a**	2.272	±0.520a	1.014	±0.072b	2.664	±0.796a	0.544	±0.216c	2.695	±0.540a	1.927	±0.043b	1.169	±1.455b
(+)-catechin	9.718	±1.082a	7.981	±0.142b	3.802	±0.148c	9.310	±0.688a	3.110	±0.376c	10.451	±1.537a	6.346	±1.192b	8.919	±1.052a
1,2-dihydroxybenzene	11.964	±1.137a	7.373	±0.950b	4.693	±0.939c	6.205	±0.186b	4.363	±0.214c	6.935	±0.659b	5.553	±0.324b	2.915	±0.645d
Syringic acid	4.291	±0.022a	3.386	±0.457a	0.814	±0.300c	1.424	±0.379c	1.083	±0.063c	0.922	±0.804c	0.475	±0.492c	2.366	±0.048b
Caffeic acid	1.992	±0.867a	1.051	±0.381a	0.675	±0.149b	1.539	±0.819a	1.600	±0.831a	1.442	±0.551a	0.980	±0.513b	1.874	±0.290a
Rutin trihydrate	3.651	±0.435b	4.297	±0.086a	2.176	±0.752c	1.899	±0.781c	2.481	±0.015c	2.033	±0.062c	1.442	±0.543d	2.014	±0.847c
p-coumaric acid	0.462	±0.478a	0.279	±0.398b	0.101	±0.056c	0.370	±0.312b	0.371	±0.272b	0.483	±0.156a	0.170	±0.245c	0.331	±0.075b
trans-ferulic acid	1.245	±0.348	1.986	±0.139a	0.130	±0.297d	1.905	±0.448a	0.555	±0.570d	1.661	±0.041b	1.045	±0.276c	1.779	±0.329b
Apigenin 7 glucoside	1.557	±0.195a	1.835	±0.423a	0.210	±0.252c	1.497	±0.535a	0.420	±0.296c	1.377	±0.011a	1.304	±0.517a	1.221	±0.367b
Resveratrol	0.808	±0.070c	1.085	±0.513b	0.516	±0.695c	0.651	±0.447c	0.756	±0.806c	1.196	±0.454b	0.958	±0.212c	1.578	±0.032a
Quercetin	6.481	±0.197a	6.636	±0.886a	4.250	±1.006b	4.028	±0.940b	4.844	±1.070b	3.973	±0.995c	4.079	±0.408b	2.989	±0.767c
trans-cinnamic acid	0.649	±0.178a	0.640	±0.349a	0.248	±0.311b	0.667	±0.206a	0.212	±0.704b	0.694	±0.003a	0.635	±0.195a	0.339	±0.20b6
Naringenin	1.912	±0.256b	1.992	±0.854b	0.685	±0.811d	0.789	±0.267d	1.559	±0.059c	0.831	±0.300d	0.402	±0.197d	2.344	±0.807a
Kaempferol	2.570	±0.403a	1.839	±0.783b	2.120	±0.865a	1.208	±0.912b	1.771	±0.592b	0.786	±0.175c	0.962	±0.479c	1.119	±0.289b
Isorhamnetin	3.233	±0.761a	3.327	±0.172a	1.766	±0.663b	1.312	±0.527b	1.256	±0.938b	1.197	±0.462b	0.830	±0.610c	1.781	±0.211b
	Anamur-control		Anamur-360 W		Anamur-540 W		Anamur-720 W		Anamur-70 °C		Anamur-90 °C		Anamur-110 °C		Anamur-sun dried	
Gallic acid	9.812	±1.292a	6.134	±0.606b	3.835	±0.837d	7.489	±1.030b	2.957	±0.253d	7.880	±0.164b	5.331	±0.249c	3.890	±0.275d
3,4-dihydroxybenzoic acid	6.282	±0.726a	5.763	±0.906a	3.058	±0.706b	5.819	±0.621a	1.659	±0.185b	5.830	±0.796a	2.834	±0.925b	2.668	±0.631b
(+)-catechin	16.498	±1.507a	6.900	±0.428b	7.239	±0.525b	6.663	±0.462b	6.752	±0.616b	8.674	±0.309b	6.859	±0.727b	7.027	±0.434b
1,2-dihydroxybenzene	11.926	±1.897a	9.667	±1.155b	9.464	±0.889b	9.019	±0.679b	7.715	±0.593c	9.395	±0.217b	7.685	±0.799c	7.773	±0.630c
Syringic acid	2.583	±0.077b	1.988	±0.304b	1.933	±0.365b	2.766	±0.648b	1.361	±0.094b	2.651	±0.055b	8.589	±1.141a	1.815	±0.119b
Caffeic acid	4.281	±0.849a	1.173	±0.161c	4.418	±0.446b	3.798	±0.765b	4.104	±0.889b	4.297	±0.292b	4.126	±0.444b	4.056	±0.490b
Rutin trihydrate	3.442	±0.148b	1.443	±0.396c	1.442	±0.691c	2.657	±0.410b	1.184	±0.213c	3.157	±0.012b	9.762	±0.278a	2.857	±0.362b
p-coumaric acid	0.471	±0.364a	0.122	±0.208c	0.202	±0.288b	0.165	±0.261b	0.012	±0.355b	0.449	±0.020a	0.403	±0.417a	0.291	±0.186b
trans-ferulic acid	2.089	±0.021a	1.425	±0.297b	1.212	±0.331b	2.078	±0.781a	1.128	±0.580b	2.347	±0.027a	1.492	±0.296b	1.629	±0.632b
Apigenin 7 glucoside	2.684	±0.264a	1.481	±0.094b	1.296	±0.432b	1.892	±0.217a	1.065	±0.207b	1.907	±0.210a	1.412	±0.028b	1.225	±0.095b
Resveratrol	1.429	±0.908a	1.784	±0.179a	0.309	±0.271c	1.434	±0.171a	0.247	±0.859b	1.554	±0.589a	0.640	±0.225b	0.294	±0.059c
Quercetin	7.306	±0.282a	3.369	±0.375c	2.886	±0.726c	5.607	±0.676b	1.810	±0.024	5.711	±0.312b	2.222	±0.091c	2.856	±1.005c
trans-cinnamic acid	0.431	±0.537b	0.203	±0.172c	0.190	±0.195c	0.844	±0.027a	0.093	±0.103c	0.582	±0.168b	0.328	±0.037c	0.197	±0.043c
Naringenin	0.761	±0.954b	0.464	±0.551c	0.508	±0.459c	0.909	±0.332a	0.216	±0.789d	0.574	±0.842c	1.047	±0.608a	0.573	±0.614b
Kaempferol	5.369	±0.090a	2.568	±0.031c	1.590	±0.064	3.915	±0.288b	0.631	±0.650d	3.709	±0.179b	2.393	±0.215c	3.244	±0.084b
Isorhamnetin	9.223	±0.497a	1.418	±0.112d	1.261	±0.801d	4.893	±0.137c	0.646	±0.650e	6.982	±0.512b	1.497	±0.279d	1.081	±0.414d

* Mean ± standard deviation, ** values in each column with different letters are significantly different ($p < 0.05$)

partly low when compared with Anamur sun dried fruit. In general, It can be seen that drying process caused a reduction in the phenolic compounds of date fruits. These results were in accordance with the results of total phenolic content.

Table 3 shows the mineral contents of fresh and dried date flesh. According to results of mineral content, the date fruit was a significant source of potassiım (K), calcium (Ca), sulfur (S), magnesium (Mg) and phosphorus (P) minerals. Other minerals, e.g. Fe, Zn, Mn, B, Cu and Mo were presented at a lower levels. While P contents of date fruit change between 86.00 mg/Kg (control) and 704.420 mg/Kg (360 W), P contents of Anamur sample ranged from 79.430 mg/Kg (Control) to 1288.780 mg/Kg (360 W). Fe contents of Anamur date fruit heated in microvawe were found low than those of results of Silifke

Table 3 Mineral contents of fresh and dried date fruit flesh

Micro nutritional elements (mg kg^{-1})						
Process	Fe	Zn	Mn	B	Cu	Mo
Silifke-control	27.420 ± 1.00*b	5.220 ± 1.00c	0.000 ± 0.00	4.140 ± 1.00c	56.020 ± 0.99b	0.100 ± 0.01c
Silifke-360 W	39.420 ± 1.00a**	16.530 ± 1.02a	1.440 ± 0.30b	10.940 ± 1.02a	63.200 ± 1.02a	0.280 ± 0.21c
Silifke-540 W	31.800 ± 2.00b	11.310 ± 2.01b	0.790 ± 0.20c	8.980 ± 1.00b	5.450 ± 1.00c	0.140 ± 0.17c
Silifke-720 W	29.800 ± 1.65b	5.660 ± 2.20c	2.060 ± 0.30a	11.460 ± 2.01a	5.850 ± 1.00c	0.030 ± 0.13d
Silifke-70 °C	0.950 ± 0.65c	0.190 ± 0.11d	0.000 ± 0.00***	0.520 ± 0.32d	0.000 ± 0.00	0.730 ± 0.20a
Silifke-90 °C	0.920 ± 0.24c	0.140 ± 0.21d	0.000 ± 0.00	0.460 ± 01.21d	0.000 ± 0.00	0.640 ± 0.32b
Silifke-110 °C	1.120 ± 0.25c	0.130 ± 0.09d	0.000 ± 0.00	0.560 ± 0.09d	0.000 ± 0.00	0.800 ± 0.33a
Silifke-sun dried	1.010 ± 0.09c	0.110 ± 0.07d	0.000 ± 0.00	0.000 ± 0.00	0.000 ± 0.00	0.590 ± 0.30b
Anamur-control	15.160 ± 1.00c	1.350 ± 1.00d	0.000 ± 0.00	1.790 ± 0.02c	2.720 ± 0.98c	0.000 ± 0.00
Anamur-360 W	62.260 ± 1.30a	17.520 ± 1.00a	0.000 ± 0.00	2.290 ± 0.21c	8.930 ± 1.00b	1.680 ± 0.27a
Anamur-540 W	22.250 ± 1.50b	5.860 ± 1.00c	0.000 ± 0.00	6.840 ± 1.00b	55.120 ± 1.00a	0.000 ± 0.00
Anamur-720 W	22.960 ± 1.02b	10.280 ± 1.00b	0.120 ± 0.11	11.160 ± 1.00a	7.170 ± 1.00b	0.150 ± 0.26c
Anamur-70 °C	0.940 ± 0.99d	0.160 ± 0.11e	0.000 ± 0.00	0.620 ± 0.27d	0.000 ± 0.00	0.780 ± 0.11b
Anamur-90 °C	0.810 ± 0.54d	0.150 ± 0.10e	0.000 ± 0.00	0.020 ± 0.03e	0.000 ± 0.00	0.970 ± 0.21b
Anamur-110 °C	0.920 ± 0.20d	0.030 ± 0.09e	0.000 ± 0.00	0.090 ± 0.09e	0.000 ± 0.00	0.850 ± 0.17b
Anamur- Sun dried	1.080 ± 0.02d	0.210 ± 0.20e	0.000 ± 0.00	0.310 ± 0.09d	0.000 ± 0.00	0.960 ± 0.21b

Macro nutritional elements (mg kg^{-1})					
Process	P	K	Ca	Mg	S
Silifke- control	86.000 ± 1.00*d	1221.800 ± 2.00c	439.660 ± 0.12c	155.230 ± 0.36c	218.720 ± 1.64d
Silifke -360 W	704.420 ± 0.90a**	9086.750 ± 38.61a	1121.800 ± 67.44a	866.390 ± 1.13b	688.870 ± 0.36b
Silifke-540 W	508.440 ± 2.00b	8135.490 ± 100.00a	841.270 ± 1.00b	918.390 ± 2.00a	668.390 ± 0.10b
Silifke-720 W	456.370 ± 1.00b	5991.870 ± 0.37b	582.380 ± 0.02c	733.210 ± 0.90b	530.380 ± 1.02c
Silifke-70 °C	292.980 ± 0.05c	1120.930 ± 0.01c	0.000 ± 0.00	0.000 ± 0.00	723.470 ± 0.07a
Silifke-90 °C	384.190 ± 0.23c	1027.080 ± 0.20c	0.000 ± 0.00	0.000 ± 0.00	766.170 ± 2.00a
Silifke-110 °C	316.910 ± 0.30c	1206.330 ± 1.25c	0.000 ± 0.00	0.000 ± 0.00	774.540 ± 1.02a
Silifke-sun dried	354.440 ± 1.00c	1363.030 ± 0.23c	0.000 ± 0.00	0.000 ± 0.00	598.940 ± 1.00c
Anamur-control	79.430 ± 1.60d	686.140 ± 2.00c	145.720 ± 0.36c	43.240 ± 0.98c	193.100 ± 2.01d
Anamur-360 W	1288.780 ± 10.00a	968.780 ± 0.06b	57.990 ± 0.09d	0.000 ± 0.00	1182.450 ± 0.05a
Anamur-540 W	406.640 ± 0.05c	3960.420 ± 0.01a	716.740 ± 0.04b	594.550 ± 0.01b	564.060 ± 0.01c
Anamur-720 W	699.490 ± 0.01b	3656.860 ± 0.01a	965.830 ± 0.99a	727.910 ± 5.00a	682.590 ± 1.01c
Anamur-70 °C	477.930 ± 0.21c	919.940 ± 0.14b	0.000 ± 0.00	0.000 ± 0.00	1012.350 ± 2.14a
Anamur-90 °C	417.370 ± 1.00c	738.270 ± 0.11b	0.000 ± 0.00	0.000 ± 0.00	785.470 ± 1.20b
Anamur-110 °C	429.350 ± 1.00c	672.980 ± 0.11c	0.000 ± 0.00	0.000 ± 0.00	746.960 ± 1.52b
Anamur- sun dried	460.000 ± 1.00c	746.970 ± 0.66b	0.000 ± 0.00	0.000 ± 0.00	832.210 ± 0.32b

* Mean ± standard deviation, **,*** values in each column with different letters are significantly different ($p < 0.05$)

date fruit. In addition, mineral content of Silifke sample was higher than Anamur sample ($p < 0.05$). Moreover, microwave heating increased the content of micro elements (Fe, Zn, Mn, B, Cu and Mo) of both date flesh ($p < 0.05$). However, micro elements were negatively affected by the conventional drying process. On the other hand, a significant increase was observed in macro elements (P, K and S). Conventional drying caused destruction of Ca and Mg contents while the increase is determined in Ca and Mg minerals dried in microwave oven. K contents of both date samples heated in microwave were found higher than those of both oven and sun dried ($p < 0.05$). In addition, Ma, Cu, Ca and Mg contents of date fruit could not established in sun and oven dried date fruits for Silifke location.

Generally, antioxidant activities of samples were found similar. No significant difference was found between date fruits. The highest total antioxidant activity was found at biser (unripe) stage, with a mean ferric reducing antioxidant power (FRAP) value of 5.71 ± 4.31 mmol/100 g fresh weight (FW), followed by rutab (soft and ripped) with FRAP values of 1.2 mmol per 100 g FW and tamer (dried fruit) 0.94 ± 0.21 mmol per 100 g FW [19]. The overall average total phenolics of biser, rutab and data were 196.8, 116.7 and 159.9 mg GAE 100 g fresh weight, respectirely [19]. Date fruits undergo many physical and chemical changes during maturation. Some of these changes such as the decrease in the concentration of tannins, ascorbic acid and β-carotene directly affect their antioxidant capacity [19].

The total phenolics content reported by Al-Farsi et al., [20] for several Omani tamer varieties ranged between 217 and 343 mg per 100 g. Phenolic compounds which have been identified in date fruits and that may contribute to the antioxidant activities include proto chatechuic, *p*-hydroxbenzoic, syringic, vanillic, caffeic, *p*-coumaric and ferulic [21, 22]. Al-Shahib and Marshall [5] reported that lulu date cultivar contained 38.7 mg/100 g Ca, 0.4 mg/100 g Cu, 4.2 mg/100 g Fe, 132.7 mg/100 g Mg, 152.2 mg/100 g P, 633,2 mg/100 g K, 9.7 mg/100 g Na and 1.6 Zn mg/100 g. According to Booij et al., [23], the mineral composition of the different dates varieties vary according with their geographical origin. The current results seems to confirm those mentioned by Youssef et al., [24] which showed that the mineral variations in fruits can in general show considerable variations not only between the species and the varieties but also within the same varieties cultivated under different agroclimatic conditions. As a result, obtained values provide an important data to explane the proximate changes at seven different date varieties. More study should be carried out on effect of processing conditions on date composition and technological properties.

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