

CHEMICAL COMPOSITIONAL PROPERTIES AND MINERAL CONTENTS OF SOME APPLE CULTIVARS

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Abstract. *The total soluble solids, pH, total acids, total phenolic and ascorbic acid values of apple fruits grown in Konya, Turkey were determined. The amounts of total polyphenols of apple fruits were determined as chlorogenic acid equivalents and ranged from 95 mg/kg to 245 mg/kg. The total acids values of apples varied between 4.3g /kg to 20.3 g/kg. Ascorbic acid contents of apple pomace were found 4.8 mg/100g to 19.5 mg/100g. The mineral contents (B, Ca, Cu, Fe, K, Mg, Na, Ni, P, Se, and Zn) of samples were analysed by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES). According to results, Ca, K, Mg, Na, P and Zn contents were established very high in all the apple samples. The Ca levels of apple fruits ranged between 7215.2 mg/kg to 10116.2 mg/kg .These results show that apples may be useful for the evaluation of dietary information in important food crops.*

Key words: *apple, mineral, chemical, composition.*

INTRODUCTION

Fruits and vegetables are valuable sources of minerals (Smolin & Grosvenar 2000, Milton 2003, Cosmulescu et al. 2009). The increase in the consumption of refined foods and the lack of vitamins and minerals in the diet can cause health problems (Ivey & Elmen 1986). Minor elements have very important functions and are believed to be key components of proteins such as haemoprotein and haemoglobin, which have essential biochemical functions, and of other essential enzyme systems, even at low doses (Tolonen 1990, Kumari et al. 2004). Also, several fruits are a significant source of ascorbic acid for humans and their consumption in the last years increased at very quick rates. Fruits and vegetables contain many different dietary phytonutrients which contribute to the prevention of degenerative

diseases caused by oxidative stress (Kaur & Kapoor 2001). Polyphenols are one of the phytochemical groups with antioxidant, antimicrobial, anticancer and cardiovascular protective activities (Chu et al. 2000, Bendini et al. 2006, Cetkoviv et al. 2008).

The aim of this study was to determine some chemical properties and mineral contents of 43 apple samples in Konya, Turkey.

MATERIAL AND METHODS

Material

Fourty-three apple samples grown in Konya, Turkey were used for this work (Table 1). The apple samples were collected at their commercial maturity. Fruits were packed in polyethylene containers and kept at +4 °C during analyses. Before analyses, skin and seeds of samples were removed, and crushed using a commercial blender.

Table 1.
Apple varieties, locations and garden old used in experiment

Sample No	Locations	Varieties	Garden old
1	Eski Yeşildere Köyü	Golden	25
2	Alaçatı Köyü Yolu	Starking- Golden	3
3	Ereğli Yolu	Starking- Golden	35
4	Kızık Yolu	Starking- Golden	22
5	Yenişehir Mah. Göztepe yolu üzeri	Golden- Starking	22
6	Kılbasan Yolu	Granny Smith	8
7	Kılbasan Yolu	Golden	9
8	Çiğdemli Köyü	Gala	4
9	Bölükyazı	Red chif	2
10	Mesudiye Köyü	Starkrimson	10
11	Konya yolu Mesudiye köprüsü Üzeri	Golden	10
12	Bölük yazı Köy Girişi	Starkrimson	15
13	Konya Yolu Üzeri	Amasya	3
14	Konya Yolu üzerinBumas yanı	Golden- Starking	9
15	Kızılyaka yolu	Grany Smith	13
16	Kamısağıl (Akçaşehir Kasabası)	Starking- Golden	25
17	Kamısağıl (Akşehir Kasabası)	Starking- Golden	30
18	Zahran (Akçaşehir Kasabası)	Golden- Starking	20
19	Çayırılık (Akşehir Kasabası)	Golden- Starking	15
20	Köy içerisi-melizlik (Akşehir Kasabası)	Golden- Starking	20

Table 1. (continued)

Sample No	Locations	Varieties	Garden old
21	Kasaba (Akşehir Kasabası)	Golden- Starking	6
22	Köyiçi Fatih Cami yanı	Golden- Starking	20
23	Burunoba yolu Köy kenarı	Golden- Starking	35
24	Kızık Yolu	Golden- Starkrimson	1
25	Ağlarharmanı/Merkez	Golden- Starking	15
26	Ağlarharmanı/Merkez	Koleksiyon Bahç	4
27	Ağlarharmanı/Merkez	Red Chif	2
28	Şarözü	Golden- Starkirimson	14
29	Şarözü	Grany Smith	15
30	Kurtderesi Dereiçi mevki	Golden- Starking	20
31	Mut Yolu	Golden- Starking	25
32	Kılbasan Yolu	Grany Smith	8
33	Konya Yolu Mesudiye köprüsü Üzeri	Golden	10
34	Bölük yazı Köy Girişi	Starkrimson	15
35	Kamısağıl (Akçaşehir Kasabası)	Starking- Golden	25
36	Kamısağıl (Akşehir Kasabası)	Starking- Golden	30
37	Zahran (Akçaşehir Kasabası)	Golden- Starking	20
38	Köyiçi Fatih Cami yanı	Golden- Starking	20
39	Burunoba yolu Köy kenarı	Golden- Starking	35
40	Şarözü	Golden- Starkirimson	14
41	Şarözü	Grany Smith	15
42	Okçu 1	Golden	5
43	Okçu 2	Golden	5

Total phenolics

The total phenolics of apple pomaces were measured using the Folin-Ciocalteu's colorimetric assay (Singleton et al. 1999). In reaction mixture, methanolic solution, extract, distilled water, sodium carbonate and Folin-Ciocalteu reagent were used. Certain amounts of these reagents were mixed, and allowed to stand for 2 h in the dark. The sample was measured at 750 nm absorbance (Spectrofotometer, Shimadzu, Japan). The total phenolic contents were determined as chlorogenic acid equivalents against the fresh weight of the samples.

The total soluble solids

The total soluble solid contents of apple samples were determined in the juice of each sample using a refractometer at 21 °C (Wu et al. 2007). Dry matter was

determined at 105 ± 2 °C. pH, total acid and ascorbic acid were established according to Cemeroğlu (1992).

Determination of ascorbic acid

Approximately 500 g of each frozen sample were used. Homogenized material (about 1 g) was weighed and powdered with liquid nitrogen in a mortar and mixed with 20 ml of aqueous meta-phosphoric acid (3%) at room temperature for 30 min using a shaker. This mixture was filtered and made up to 25 ml with the same solvent, then used for HPLC analysis. The high-performance liquid chromatographic apparatus (Shimadzu LC 10A vp, Kyoto, Japan) consisted of an in-line degasser (DGU-20A5), pump and controller coupled to a photodiode array detector (Shimadzu SPD-M20 A) equipped with an automatic injector (20 µL injection volume) interfaced to a PC running Class VP chromatography manager software (Shimadzu, Japan). Separations were performed on a 250 mm 4.6 mm i.d., 5 µm, reverse-phase Inertsil ODS3 analytical column (GL Sciences, Japan) operating at 30°C (column oven CTO-10AS vp) with a flow rate of 0.5 ml/min. Detection was carried out with a sensitivity of 0.1 a.u.f.s. between the wavelengths of 200 and 360 nm. Elution was isocratic with 0.5% aqueous meta-phosphoric acid (Kafkas et al. 2006).

Mineral contents of samples

About 0,5 g of apple fruits was put into burnig cup with 15 ml of pure NHO_3 . The sample was incinerated in a MARS 5 microwave oven at 200 °C. Distilled deionized water and ultrahigh-purity commercial acids were used to prepare all reagents, standards, and apple samples. After digestion treatment, samples were filtrated through whatman No 42. The filtrates were collected in 50 ml Erlenmayer flasks, and analysed by ICP-AES. The mineral contents of the samples were quantified against standard solutions of known— concentrations which were analyzed concurrently (Skujins 1998).

Working conditions of ICP-AES:

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)
Auxiliary 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 analysis

All analysis were carried out three times and the results are mean (Püskülcü and İköz, 1989).

RESULTS AND DISCUSSION

The results of some chemical analysis of apple pomace are submitted in Table 2. The total phenolic content of samples was established with the Folin-Ciocalteu method. The amounts of total polyphenols of apple fruits are determined as chlorogenic acid equivalent and ranged from 95 mg/kg to 245 mg/kg. Cetkovic et al. (2008) reported 4.22 mg/g to 8.67 mg/g in different apple pomaces. The total phenolic content measured by the Folin-Ciocalteu method was found between 26 mg GAE/100 g to 2167 mg GAE/100g in major fruits from Ecuador (Vasco et al. 2008). Sudha et al. (2007) determined a total phenolic content of 10.16 mg/g in different apple pomaces. As seen in Table 1, total acid values of apples varied between 4.3 g/kg and 20.3 g/kg. Total acid values of about 23 apple samples were found below 10g/kg. pH values of our samples varied between 3.5 and 4.9.

Table 2.
Some chemical properties of apple pomaces

Sample No	Total soluble solids (%)	pH	Total acid (g/kg)	Total phenolic mg/kg	Ascorbic acid mg/100gr	Dry matter (%)
1	16.7	4.9	7.5	144.0	11.0	22.1
2	15.5	4.2	5.6	134.0	8.9	21.0
3	15.2	4.4	5.6	125.0	7.3	19.7
4	14.4	4.7	4.9	164.0	10.9	20.3
5	16.2	4.3	6.2	153.0	12.2	20.6
6	17.2	3.5	17.2	245.0	12.0	22.7
7	13.4	4.1	15.2	166.0	10.9	24.5
8	23.6	3.6	20.3	245.0	12.0	27.4
9	20.0	4.2	6.4	150.0	7.3	22.6
10	18.5	4.2	7.4	176.0	14.6	22.2
11	20.0	4.0	10.0	186.0	12.0	24.0
12	17.0	4.4	5.1	178.0	12.2	21.9
13	20.0	4.2	11.0	180.0	11.0	24.0
14	19.5	4.5	5.9	176.0	9.6	24.7
15	13.3	3.7	12.6	159.0	12.0	13.8
16	16.8	4.8	14.0	188.0	10.5	19.0
17	17.0	4.5	17.0	132.0	11.2	16.7
18	15.0	4.3	4.3	122.0	14.6	15.8
19	16.2	4.4	7.9	112.0	9.8	18.0

Table 2. (continued)

Sample No	Total soluble solids (%)	pH	Total acid (g/kg)	Total phenolic mg/kg	Ascorbic acid mg/100gr	Dry matter (%)
20	15.2	4.3	5.9	95.0	7.2	17.4
21	15.0	4.3	10.4	109.0	12.2	18.7
22	12.6	4.2	9.7	173.0	14.5	11.1
23	14.5	4.0	12.0	176.0	13.2	16.8
24	15.8	4.3	11.2	220.0	14.5	16.0
25	14.2	3.7	13.7	238.0	7.2	17.1
26	16.4	4.1	9.6	145.0	9.6	20.0
27	16.0	4.3	8.8	145.0	10.4	18.0
28	15.0	4.4	6.2	117.0	12.2	17.4
29	17.2	4.1	7.1	161.0	19.5	19.4
30	15.2	4.1	7.0	132.0	9.6	16.6
31	14.0	4.1	6.6	113.0	4.8	17.8
32	16.2	4.7	8.8	196.0	6.7	22.1
33	15.0	4.2	9.0	176.0	9.9	19.0
34	15.6	4.6	14.5	188.0	12.8	22.0
35	16.2	4.6	12.2	176.0	11.0	19.0
36	16.0	4.9	11.0	165.0	8.0	17.0
37	13.3	3.5	4.3	95.0	4.8	11.1
38	15.0	3.8	6.8	112.0	6.4	14.7
39	14.8	3.7	12.0	185.0	8.9	16.0
40	23.6	4.7	20.3	245.0	19.5	27.4
41	18.0	4.2	13.6	143.0	14.0	24.0
42	17.3	4.2	15.0	156.0	12.0	25.0
43	16.6	4.8	12.0	178.0	13.8	26.0
Mean	16.4±2.4	4.2±0.4	10.0±4.2	162.2±38.9	11.0±3.2	19.8±3.9

In addition, water-soluble dry matter contents ranged between 13.3 % and 23.6%. Ascorbic acid contents of apple pomace were found 4.8 mg/100g to 19.5 mg/100g. Generally, ascorbic acid values of 15 apples were found below 10 mg/g. Dry matter values of apple samples varied between 11.1% and 27.4%. Ascorbic acid contents in commercial fruit juices (orange, lemon, cocktail) according to Kabasakalis et al. (2000) ranged from 2.4 to

Table 3.

Mineral contents of different apple pomaces (mg/Kg)

Sample No	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	Se	Zn
1	62.20	9301.94	0.06	0.32	2.00	36.46	1027.24	5595.71	20.50	696.51	4.44	60.26	0.86	0.36	27.86
2	56.71	8121.89	0.12	0.00	1.56	16.84	1159.56	5123.11	15.95	812.26	3.30	79.56	2.47	1.75	32.86
3	58.84	8616.30	0.01	0.43	0.01	15.10	1070.92	4792.25	20.98	685.62	5.36	37.89	1.64	7.13	24.37
4	52.71	7215.25	0.35	0.34	1.55	14.85	1102.56	3816.51	17.17	430.89	3.21	69.71	2.53	10.87	25.56
5	48.82	8765.22	0.04	0.17	1.69	32.34	657.81	4315.89	22.63	1060.54	2.70	30.41	0.00	6.39	27.67
6	46.83	7989.73	0.11	0.74	0.04	14.48	603.40	4010.86	26.04	1131.02	3.16	24.08	3.52	0.23	18.15
7	54.64	8411.55	0.31	0.48	1.83	31.57	944.11	4023.42	30.84	692.31	5.00	65.71	2.11	3.55	35.59
8	58.83	10080.62	0.21	0.15	1.52	48.42	1066.84	5129.36	26.58	837.55	4.37	42.43	2.22	3.15	27.92
9	40.88	7397.04	0.00	0.89	0.17	6.06	987.12	3708.87	20.06	450.37	2.67	52.17	0.00	2.05	25.26
10	51.09	7947.93	0.13	0.47	2.09	17.81	931.08	5025.43	18.59	1037.34	2.65	58.32	0.72	2.64	36.80
11	59.86	9649.59	0.41	0.33	2.17	27.80	1018.02	5202.68	30.16	792.85	3.49	72.65	2.02	6.44	49.01
12	56.95	8508.58	0.13	0.50	0.88	12.31	988.16	4589.96	17.06	848.20	3.29	69.74	3.53	0.00	37.91
13	51.84	7846.27	0.02	0.15	1.57	23.05	851.40	4906.74	19.39	750.82	2.08	60.03	1.70	1.69	25.89
14	58.61	8113.79	0.00	0.68	1.70	30.80	822.88	3647.92	22.43	1483.53	4.24	55.51	0.00	2.49	35.21
15	65.79	7495.83	0.10	0.22	1.11	13.99	880.64	5415.35	16.34	716.72	4.36	34.40	0.00	15.16	18.78
16	57.57	7537.63	0.24	2.18	1.86	25.18	868.06	5807.17	53.62	1065.52	5.12	52.81	2.10	3.96	25.51
17	44.15	7887.75	0.31	0.23	2.33	42.62	724.70	2945.92	28.59	1112.32	4.49	39.76	3.82	8.05	29.54
18	43.52	8214.99	0.11	0.44	0.96	28.25	1038.40	3997.95	23.20	464.02	5.46	60.36	4.43	3.03	40.78
19	49.97	9021.40	0.00	0.53	1.66	26.52	854.41	5334.71	12.48	464.46	3.34	54.15	0.00	0.00	28.68
20	53.76	8467.14	0.12	0.73	2.14	25.64	939.02	5186.85	29.26	558.00	5.74	43.12	2.62	5.32	24.05
21	56.95	8923.77	0.18	0.15	1.17	16.36	621.87	4972.01	13.20	644.92	3.75	38.24	0.68	0.00	22.15
22	55.53	10116.18	0.00	0.16	3.95	36.03	1000.16	5512.10	21.67	629.31	4.03	59.23	2.15	4.76	29.19
23	74.37	7703.73	0.19	0.36	3.54	17.44	1278.77	5636.07	20.88	1467.99	2.83	86.82	2.88	3.01	28.48

Table 3. (continued)

Sample No	B	Ca	Cd	Co	Cu	Fe	K	Mg	Mn	Na	Ni	P	Pb	Se	Zn
24	54.45	7787.43	0.00	0.72	1.57	16.36	1126.50	5045.24	15.31	660.75	1.60	71.63	0.06	11.63	28.00
25	55.08	8060.42	0.04	0.61	1.61	17.83	1080.34	4715.96	19.21	693.42	5.99	34.03	1.33	0.18	24.68
26	46.49	7438.38	0.21	0.89	1.31	16.31	1081.60	3852.86	22.86	438.94	5.40	68.69	3.65	0.50	25.71
27	43.35	8690.83	0.08	0.00	2.60	40.22	639.29	4467.83	23.01	1013.52	3.72	33.76	6.11	0.00	29.99
28	52.17	8751.01	0.22	1.05	0.10	19.35	695.51	4303.93	25.34	926.06	3.33	27.42	0.00	1.43	21.04
29	53.83	8592.69	0.00	1.49	1.88	36.67	959.58	4148.26	36.45	585.31	4.29	55.95	7.35	3.18	37.00
30	53.09	9125.10	0.00	0.10	1.71	44.83	990.04	4933.21	23.48	782.22	6.40	45.69	2.43	7.86	28.56
31	38.09	7328.11	0.16	0.81	1.32	11.91	991.01	3622.74	19.15	371.60	2.40	57.02	5.51	4.15	27.51
32	51.34	8244.15	0.23	0.71	2.77	18.05	970.45	4463.86	19.46	1036.50	5.27	64.02	0.48	0.00	38.31
33	63.53	9370.91	0.21	1.05	2.19	36.52	949.06	5381.23	29.35	748.42	4.49	62.34	1.35	3.03	43.62
34	56.22	8384.74	0.00	1.08	0.57	9.22	1036.56	4478.53	15.80	804.09	2.85	69.36	1.36	4.35	36.25
35	42.28	7965.29	0.09	0.36	2.44	20.81	837.02	4312.66	20.29	590.89	2.85	47.00	1.38	6.86	26.47
36	55.57	8266.84	0.16	0.49	1.86	34.22	856.05	3907.08	23.37	1412.30	4.50	51.18	4.76	0.75	36.85
37	69.78	8332.29	0.04	0.23	1.48	15.18	960.02	6188.16	19.22	667.74	2.24	30.54	1.46	1.84	19.10
38	55.91	7585.18	0.29	0.51	1.99	25.99	905.23	6186.03	31.37	1143.66	6.34	55.72	2.93	0.71	26.32
39	45.11	8017.78	0.00	0.00	2.29	50.90	694.99	3412.29	31.17	1011.38	3.37	35.13	0.50	6.84	29.75
40	47.57	9117.04	0.18	0.00	1.36	32.47	1134.29	4222.19	23.84	464.47	4.94	58.58	1.94	0.64	35.56
41	51.90	9733.57	0.26	0.51	1.62	30.99	924.11	5828.98	13.31	504.11	4.26	55.17	3.98	0.99	31.89
42	49.88	8730.18	0.00	0.00	1.68	26.59	1017.21	5187.41	22.42	529.68	4.65	42.71	0.00	0.00	23.43
43	61.17	9225.51	0.06	0.41	1.01	17.78	697.65	5081.30	112.73	603.82	6.88	48.85	0.25	1.72	25.86
Mean	53.66±	8420.50±	0.13±	0.50±	1.65±	25.17±	929.85±	4707.83±	24.99±	786.56±	4.07±	52.61±	2.07±	3.46±	29.61±
	7.50	736.71	0.11	0.43	0.81	11.00	158.15	771.11	15.50	283.41	1.27	14.85	1.79	3.52	6.74

43 mg/100 mL. Wu et al. (2007) established 2.8 to 7.3 g/L total acids in eight apple cultivars. Some researchers (Cemeroğlu & Acar1986, Wu et al. 2007) measured pH between 3.40 to 4.16 and total soluble solid between 10.48% and 14.68 % in apple fruits of eight cultivars. Ascorbic acid contents of samples were found low compared with literature. This decrease is due to differences of fruits. In addition, pH values of our samples were found similar compared with literature values. However, the total soluble solids were established high than the results of Wu et al. (2007).

The mineral contents of 43 samples of apple pomace from different locations in Konya varied in a relatively range. The mineral compositions of apple fruits are given in Table 3.

According to results, Ca, K, Mg, Na, P and Zn contents were established very high in all the apple samples. Also, Cd, Co, Cu, Pb and Se contents of fruits were found very low. The Ca levels of apple fruits ranged between 7328.1 mg/kg to 10116.2 mg/kg. While K content was high (1278.77 mg/kg) in sample no 23, it was found low (621.9 mg/kg) in sample no.6. The level of Mg of in this study was found higher (6188.2 mg/kg) than those of other samples. In addition, the lowest level of K was found in (2945.9 mg/kg). Generally, P contents of all samples were found low compared with Ca, K, Mg and Na minerals. The levels of P contents were varied between 24.08 mg/kg to 86.82 mg/kg. Among minerals, Ca had the highest content, followed by K, Mg, Na, P, B and Fe.

Ferreira et al. (2005) determined a copper content between 0.02 mg/100g (Argentianan apple) and 0.20 mg/kg (Avocado) in commonly consumed food (avocado, pineapple, prunes, banana, gold banana, banana prata, kaki, red guava, kiwi, orange, etc.). Leterme et al. (2006) established 36.0 to 1782 mg K/100 g edible portion; 280.0 to 1242 mg Ca /100 g; 0.7 to 8.4 mg Fe/100 g edible portion. In addition, mineral composition of different pear cultivars ranged between 2.5 to 19.5 mg Na /100 g, 897 to 1688 mg K /100 g, 11.5 to 46.5 mg Ca/100 g, 35.5 to 117.0 mg Mg/100 g of fresh pears (Chen et al. 2007).

The results showed that different apple varieties have different mineral contents. These differences of the mineral content of apple cultivars may be due to growth conditions, varieties, genetic factors, harvesting times, soil properties, geographical variations (Guil et al. 1998, Chen et al. 2007, Özcan et al. 2008).

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