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Chemical Composition of Fruits of Some Important Chestnut Cultivars

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ABSTRACT

In this study, chemical compositions of the fruits of some important domestic chestnut types and cultivars were investigated. They contained (g/100g dry matter basis) total carbohydrates 75.32 - 86.31, total sugar 10.32 - 22.79, invert sugar 0.08 - 1.25, starch 54.45 - 69.70, sucrose 8.86 - 21.28, ash 1.02 - 3.22, crude cellulose 3.58 - 5.96, total fat 0.49 - 2.01, total protein 4.88 - 10.87. Ca, Mg, Fe, Mn, Cu, Zn, P, Na and K contents were (mg/100g) 43 - 230, 70 - 160, 0.4 - 5.7, 0.7 - 5.5, 0.6 - 3.8, 1.8 - 9.1, 107 - 191, 6 - 41, 761 - 1271, respectively.

Key words: *Castanea sativa*, Chestnut, Fruit Composition

INTRODUCTION

Anatolia in Turkey is the motherland and one of the oldest cultivation area of chestnut (*Castanea sativa* Mill.). Numerous genotypes and cultivars have been developed this during past. Turkey is one of the leading countries in the world with its annual production of 50 000 tons. However, chestnut production has been decreasing day by day because of ink disease (*Phytophthora cambivora*) and chestnut blight (*Cryphonectria parasitica*) in the natural growing areas.

The term “bread tree” has been used in some places for chestnuts, which has been one of the fundamental nutrients used in human nutrition (Bounous et al., 2000). The fruit is rich in carbohydrates and low in fat content. This characteristic increases its use in diets. Chestnut is widely used as a food by cooking as well as in cake and candy industry (Anonymous, 2000). However, differences could be detected among the species and the cultivars with respect to their nutritional value. This fact should especially be considered in selection studies. In this way, the genotypes with higher nutritional value as well as high yield and other quality characteristics could be improved.

This work was carried out with the aim of determining the chemical composition of some selected important domestic cultivars and two foreign hybrid cultivars.

MATERIALS AND METHODS

In this work, the fruits of cultivars and genotypes belonging to the species *Castanea sativa* Mill., (Ayfer et al., 1988) and the foreign hybrid cultivars Maraval 74 (*C. sativa x C. crenata*) and Marigoule 15 (*C. sativa x C. crenata*) (Solignat et al., 1975) were used as below. 51205 (Sarıaşlama Clone - 2), 52509 (Sarıaşlama Clone - 3), 52112 (Vakit Kestanesi), 51314, 51315, 51112 (Mahmut Molla), 52214 (Hacıömer), 51101 (Osmanoğlu), 63110 (Acemoğlu), 52104 (Sarı Kestane), 62309 (Firdola), 51301, 51209 (Osmanoğlu Clone - 2)

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and 51206. The trees from which the fruits were collected were 23 years old, except Marigoule 15 and Maraval 74, which were 13 years old. The orchard soil was alluvial, clayey - loam type, saltless, slightly acid, mineral content level was good, and organic matter level was poor (Ertan et al., 1992). The climate is fairly mild, and annual rainfall is about 750 - 800 mm. The trees were grown in a natural growing condition, and they were supported only by irrigation in drought seasons and sometimes mineral fertilizer. The fruits were harvested at the end of September through the middle of October. The samples of about 120-150 g fruit that were randomly sampled were squashed with a mortar after their outer shells and seed coat (testa) were removed and analysis were carried out. The dry matter contents of the samples were determined by drying them overnight in the hot-air oven at 105 °C. Ash analysis was carried out by burning the sample in muffle furnace at 525 °C for 8 h. Total protein quantity was calculated by multiplying the nitrogen content using Kjeldahl method by the coefficient 5.30 (AOAC, 1990). Crude cellulose quantity was determined according to the method reported in AOAC (1990). Total fat quantity was found after extraction with ether for 6 h in soxhelet device (AOAC, 1990). Dinitrophenol method was utilised in the analysis of total carbohydrates, total sugar and invert sugar (Ross, 1959) using the Beckman Du 530 model spectrophotometer. Starch quantity was calculated by multiplying the value obtained through subtracting the total sugars from total carbohydrates by the coefficient 0.94. Mineral quantities were determined as described by Kacar (1972); the concentrations of iron (Fe), magnesium (Mg), copper (Cu), zinc (Zn) and manganese (Mn) were determined by atomic absorption spectrophotometer; phosphorus (P) was determined by spectrophotometer; potassium (K), sodium (Na) and calcium (Ca) were determined by flame photometer. However, analysis of minerals, total fat, crude protein, ash and crude cellulose were done in the second year of experiment. The results were given on dry matter basis.

RESULTS AND DISCUSSION

Total carbohydrates

Total carbohydrate quantities changed between 75.32 and 86.31 g/100g depending on cultivars, with a mean value of 80.73 g/100g (Table 1). The chestnut fruits generally contained high rates of carbohydrates; this was 86.26 g/100g in American chestnuts (*C. dentata* Borkh.) (McCarthy and Meredith, 1988), 87.50 g/100g in the Chinese chestnuts (McCarthy and Meredith, 1988; Anonymous, 2003c) and 71.68 - 88.10 g/100g in European chestnuts (McCarthy and Meredith, 1988; Künsch et al., 1999; Bounous, 1999; Bounous et al., 2000; Anonymous, 2003a). This value changed nearly 16 % in the different materials of *C. sativa* species (Bounous et al., 2000; Anonymous, 2003a). In this study, 11 % difference was found among the cultivars and the hybrids of *C. sativa* species. Our findings are in accordance with those of the researchers.

Total sugar

Total sugar contents changed between 10.32 and 22.79 g/100g (Table 1). This range was similar to those obtained by Pinnavaia et al. (1993) and Bounous et al. (2000) which were 14.01 - 20.60 g/100g and 20.38 g/100g, respectively.

Invert sugar

The invert sugars of the cultivars were between 0.08 and 1.25 g/100g (Table 1). Pinnavaia et al. (1993) found the invert sugar quantity of the cultivars between 0.82 and 3.56 g/100g. The invert sugar contents of the cultivars examined were somewhat lower than these values. However, the share of invert sugar in total sugars was quite low, often below 5 %.

Starch

Starch quantities ranged from 54.45 to 69.70 g/100g with regard to the cultivars (Table 1). The values found by most researchers were close to these ones, generally ranging from 49.60 to 65.40 g/100g in different species (Pinnavaia et al., 1993; Liu, 1993; Ferreria - Cardoso et al., 1993; Bounous et al., 2000). However, some researchers found the value lower (29.80 g/100g) (Üstün et al., 1999) or higher (Demiate et al., 2001) (80 g/100g) than these. A part of starch changes into sugars during storage, thus the ratio of sugars increases and that of starch decreases (Soylu et al., 1987).

Sucrose

The sucrose quantities of the cultivars changed between 8.86 and 21.28 g/100g (Table 1). Pinnavaia et al. (1993) found this value between 10.45 and 19.74 g/100g; Künsch et al. (1999)

determined it as 12.40 g/100g. Our findings are in accordance with the results obtained from these studies carried out with the cultivars in the species *C. sativa* Mill.

Ash quantity

The ash content changed between 1.02 and 3.22 g/100g (Table 2). Many other researchers found this value between 0.83 and 4.92 g/100g in various species and genotypes (Brighenti et al., 1998; Üstün et al., 1999; Demiate et al., 2001; Anonymous, 2003a, 2003b, 2003c).

Crude cellulose

The crude cellulose quantities of the cultivars ranged from 3.58 to 5.96 g/100g (Table 2). Demiate et al. (2001) found the crude cellulose quantity in Brazilian cultivars (*C. sativa)* as 2.34 g/100g. McCarthy and Meredith (1988) determined the crude cellulose quantity in American, European and Chinese chestnuts between 1.00 and 2.00 g/100g. Notable differences have been detected among the genotypes with respect to crude cellulose quantity.

Table 1 - Total Carbohydrates, Total and Invert Sugar, Starch and Sucrose Contents of the Cultivars of Chestnut

Cultivars	Total Carbohydrates (g/100g)			Total Sugar (g/100g)			Invert Sugar (g/100g)		
	I.year	II.year	Mean	I. year	II.year	Mean	I. year	II.year	Mean
51205 S.A* Clone-2	86.15	75.07	**80.61**	17.15	16.36	**16.75**	1.92	0.09	**1.00**
52509 S.A*Clone- 3	79.42	77.09	**78.25**	26.98	12.50	**19.74**	0.62	0.30	**0.46**
52112	86.50	69.76	**78.13**	12.16	12.16	**12.16**	0.22	2.29	**1.25**
51314	82.27	79.82	**81.04**	21.43	13.43	**17.43**	0.11	0.22	**0.16**
51315	78.29	80.41	**79.35**	28.95	12.96	**20.95**	0.81	0.10	**0.45**
51112	82.58	78.40	**80.49**	23.80	9.93	**16.83**	0.79	0.20	**0.49**
52214	78.75	85.34	**82.04**	17.35	12.97	**15.16**	0.74	1.70	**1.22**
51101	86.42	79.94	**83.18**	11.09	9.56	**10.32**	1.08	0.80	**0.94**
63110	84.62	-	**84.62**	22.79	-	**22.79**	0.38	-	**0.38**
52104	-	77.14	**77.14**	-	12.91	**12.91**	-	0.09	**0.09**
62309	-	80.31	**86.31**	-	15.85	**15.85**	-	0.70	**0.70**
51301	-	81.35	**81.35**	-	11.84	**11.84**	-	0.30	**0.30**
51209	-	75.32	**75.32**	-	17.12	**17.12**	-	0.10	**0.10**
51206	-	75.72	**75.72**	-	15.05	**15.05**	-	0.08	**0.08**
Maraval 74	-	85.95	**85.95**	-	11.80	**11.80**	-	0.50	**0.50**
Marigoule 15	-	82.29	**82.29**	-	11.62	**11.62**	-	0.40	**0.40**

Cultivars	Starch (g/100g)			Sucrose (g/100g)		
	I.year	II.year	Mean	I.year	II.year	Mean
51205 S.A* Clone-2	63.05	55.10	**59.07**	14.46	15.45	**14.95**
52509 S.A*Clone- 3	48.71	60.43	**54.57**	25.04	11.59	**18.31**
52112	69.67	51.99	**60.83**	11.34	9.37	**10.34**
51314	57.08	62.19	**59.63**	20.25	12.41	**16.33**
51315	45.61	63.30	**54.45**	26.73	12.21	**19.47**
51112	54.51	64.17	**59.34**	21.85	9.24	**15.54**
52214	57.62	66.42	**62.02**	15.75	10.70	**13.22**
51101	69.79	65.40	**67.59**	9.50	8.23	**8.86**
63110	57.76	-	**57.76**	21.28	-	**21.28**
52104	-	60.37	**60.37**	-	12.05	**12.05**
62309	-	66.23	**66.23**	-	14.24	**14.24**
51301	-	65.33	**65.33**	-	10.84	**10.84**
51209	-	54.99	**54.99**	-	15.99	**15.99**
51206	-	57.02	**57.02**	-	14.07	**14.07**
Maraval 74	-	69.70	**69.70**	-	10.62	**10.62**
Marigoule 15	-	62.43	**62.43**	-	10.54	**10.54**

* S.A Sarıaşlama

Table 2 - Ash, Crude Cellulose, Total Fat and Total Protein Contents of the Cultivars of Chestnut

Cultivars	Ash (g/100g)	Crude Cellulose (g/100g)	Total Fat (g/100g)	Total Protein (g/100g)
51205 S.A*Clone- 2	2.29	5.43	1.52	7.99
52509 S.A*Clone- 3	2.68	4.65	0.92	8.43
52112	2.90	5.96	0.51	10.87
51314	2.27	4.65	0.60	6.07
51315	1.99	5.32	0.49	8.29
51112	2.59	3.94	1.30	4.88
52214	2.61	4.72	0.64	5.23
51101	2.01	4.47	2.01	5.39
52104	2.23	5.24	1.17	6.43
62309	2.92	4.92	0.73	8.73
51301	1.02	4.05	1.02	6.43
51209	2.56	4.80	1.44	6.71
51206	2.69	4.68	0.78	7.37
Maraval 74	2.44	3.58	1.61	5.88
Marigoule 15	3.22	4.15	1.60	5.61

* S.A: Sarıaşlama

Total fat

The total fat content of the samples ranged from 0.49 to 2.01 g/100g (Table 2). This value was found between 0.66 and 5.59 g/100g by some other researchers in the cultivars belonging to the species *C. sativa* Mill. (Ferreria - Cardoso et al., 1993; Brighenti et al., 1998; Üstün et al., 1999; Demiate et al., 2001; Sundriyal and Sundriyal, 2001; Anonymous, 2003a). Fat content was determined as 1.98 g/100g in the Chinese chestnuts (Anonymous, 2003c) and as 0.38 g/100g in some Australian cultivars (Anonymous, 2003b).

Total protein

Total protein quantity changed between 4.88 and 10.87 g/100g, but it was between 5.23 and 8.73 g/100g in most of the samples (Table 2). This was reported between 3.43 and 13.28 g/100g by different researchers in *C. sativa* Mill. (Pinnavaia et al., 1993; Ferreria - Cardoso et al., 1993; Brighenti et al., 1998; Bounous, 1999; Üstün et al., 1999; Anonymous, 2003a). This range was narrower in the Chinese chestnuts being between 2.12 and 7.49 g/100g (McCarthy and Meredith 1988; Anonymous, 2003c).

Mineral contents

The mineral contents of the cultivars are given in Table 3. The cultivars contained different amounts of Ca, Mg, Fe, Mn, Cu, Zn, P, Na and K. These values were found as 43 - 230 mg/100g, 70 - 160 mg/100g, 0.4 - 5.7 mg/100g, 0.7 - 5.5 mg/100g, 0.6 - 3.8 mg/100g, 1.8 - 9.1 mg/100g, 6.0 - 41.0 mg/100g and 761 - 1271 mg/100g, respectively. Ca, Mg, Zn, P and K contents of the cultivars were higher than the values reported by Ferreria Cardoso et al. (1993); Künsch et al. (1999); Bounous, (1999); Bounous et al. (2000); Anonymous, (2003a). Fe, Mn and P values of the cultivars were in good agreement with the data from Ferreria Cardoso et al. (1993); Künsch et al. (1999), Bounous, (1999); Üstün et al. 1999, Bounous et al. (2000); Anonymous, (2003a), Anonymous, (2003b).

From a general point of view, the chemical composition of chestnut may vary depending on the source from which the fruits were taken. However it can be stated that fruit of chestnut contained mainly carbohydrates, mostly in starch and sucrose form. In addition Ca, Mg, P and K contents of the fruits are fairly higher.

Table 3 - Mineral Composition of the Cultivars of Chestnut

Cultivars	Ca (mg/ 100g)	Mg (mg/ 100g)	Fe (mg/ 100g)	Mn (mg/ 100g)	Cu (mg/ 100g)	Zn (mg/ 100g)	P (mg/ 100g)	Na (mg/ 100g)	K (mg/ 100g)
51205 S.A*Clone- 2	72	90	2.4	3.4	3.7	5.5	162	9	1066
52509 S.A*Clone- 3	203	150	0.9	2.8	3.8	9.1	179	37	1271
52112	80	80	4.4	1.1	1.4	3.0	185	14	837
51314	230	140	1.0	4.5	3.2	8.7	133	36	897
51315	215	160	1.6	0.8	2.5	8.7	178	37	762
51112	43	80	0.8	3.2	0.6	1.8	185	6	934
52214	219	140	1.1	2.4	1.1	7.2	145	41	1105
51101	54	70	3.0	2.0	0.6	2.6	107	14	1059
52104	105	80	0.4	5.5	1.1	2.1	180	16	922
62309	92	110	5.7	1.8	2.1	3.3	191	16	900
51301	73	70	0.7	1.6	0.7	2.5	157	6	761
51209	207	100	0.9	2.3	1.2	7.6	183	40	886
51206	69	80	2.0	0.8	1.7	2.8	160	11	951
Maraval 74	101	70	4.0	0.7	0.6	1.8	169	13	917
Marigoule 15	66	80	2.4	2.3	0.6	2.8	174	11	871

*S.A: Sarıaşlama

RESUMO

Neste estudo, a composição química das frutas domésticas importadas tipo castanha e seus cultivares foram investigados. Seu conteúdo (base da matéria seca de g/100g com base em matéria seca) carboidratos totais 75,32 - 86,31, açúcares total 10,32 - 22,79, açúcar invertido 0,08 - 1,25, amido 54,45 - 69,70, sacarose 8,86 - 21,28, cinzas 1,02 - 3,22, celulose bruta 3,58 - 5,96, gordura total 0,49 - 2,01 do total, proteína total 4,88 - 10,87. Ca, Mg, Fe, Mn, Cu, Zn, P, Na e k índice foi (mg/100g) 43 - 230, 70 - 160, 0,4 - 5,7, 0,7 - 5,5, 0,6 - 3,8, 1,8 - 9,1, 107 - 191, 6 - 41, 761 - 1271, respectivamente.

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