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Mineral Composition of Leaves and Fruits of Some Promising Jujube (*Zizyphus jujuba* Miller) Genotypes

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The mineral compositions of leaves and fruits of the 4 selected promising jujube genotypes were investigated. Nitrogen, potassium, calcium and magnesium for leaves and nitrogen, potassium and calcium for fruit were major macroelements in promising jujube genotypes and represented about 98 and 93 % of the total mineral content, respectively. Other minerals were also detected in appreciable amount in leaves and fruits. Significant differences were observed for each individual mineral between genotypes except for the sodium content in leaves and manganese content in fruits. Generally, it was determined that jujube genotypes have high content of the minerals. Jujube genotypes are rich based on calcium, potassium, magnesium, sodium and phosphorus.

Key Words: *Zizyphus jujuba* Miller, Fruit, Leaf, Minerals.

INTRODUCTION

Jujube (*Zizyphus spp*), also known as ber, belongs to the family *Rhamnaceae* that consists of 45 genera and 550 species. Jujube is mainly distributed in tropical and subtropical climates in the world[1]. The fruits of *Z. mauritania* and *Z. jujuba* are of economical importance and cultivated in several countries. Jujube fruits have been consumed in fresh, dried and processed (jams, loaf, cakes, jelly, *etc.*) forms in the world. The fruit of jujube is favoured and profitable and much appreciated for its high nutritional value. It has a good amount of vitamin A and C along with vitamin B complexes and minerals[2]. It has been commonly used as a crude drug in traditional medicine[3-6]. Its barks, fruits, seeds, leaves and juice of roots are used in traditional medicine for the treatment of some diseases in the world[1,5]. Alkaloids, flavonoids, sterols, tannins, saponin and fatty acids have been isolated from the different species of the genus *Zizyphus*[4,5,7,8]. Jujube fruit has significant levels of antioxidant activity and scavenging effect on free radicals[6].

The importance of minerals such as potassium, calcium, sodium *etc.* to human health is well known. Required amounts of these elements must be in human diet to pursue good healthy life[9]. There is little information on jujube's chemical composition which plays an important role in human health. Few studies were performed on mineral composition of fruit and leaves of jujube[10-13]. However more studies should perform on mineral content of jujube that has an essential effect on human health in many ways. In this study, the main objective is to determine the mineral composition in leaves and fruits of the 4 selected promising jujube genotypes.

EXPERIMENTAL

In this study, the fruit and leaves of 4 promising jujube genotypes (20-Ç-10, 20-Ç-22, 20-Ç-51 and 20-Ç-52), selected from Denizli region of Turkey based on the desired characteristics, were used. Some chemical characteristics of promising jujube genotypes were given in Table-1[14].

TABLE-1
SOME CHARACTERISTICS OF FRUITS OF THE PROMISING JUJUBE GENOTYPES

Properties	Promising Jujube genotypes			
	20-Ç-10	20-Ç-22	20-Ç-51	20-Ç-52
Total soluble solids (%)	29.93	29.80	29.44	28.10
Total solids (%)	32.63	33.00	33.63	31.43
Vitamin C (mg 100 g^{-1})	309.30	271.30	366.00	364.00
Ash (%)	2.17	2.20	2.70	2.75
Protein (%)	4.24	2.91	3.71	3.90

In the study, nitrogen, potassium, phosphorus, calcium, magnesium, manganese, iron, sodium, zinc, copper and boron contents of leaves and fruits of jujube genotypes were determined.

Mature leaves and fruits of jujube were collected from different parts of trees in September (harvest time). Leaves and fruits were washed with tap water and dipped in ultra pure water. After the leaf and fruits samples were dried in oven at 65 ºC during approximately 48 h, they were ground and placed in plastic bags.

Total nitrogen content of samples was determined based on Kjeldahl method[15]. For other mineral determinations, 0.5 g samples of leaves and fruit were dissolved with 5 mL of nitric acid (Merck, Suprapur) and 1 mL of hydrogen peroxide. After digestion in a closed polypropylene tube at 90 ºC in a microwave oven (Milestone-Ethos plus 900), the solutions were then completed with ultra-pure water until a final volume of 25 mL.

Potassium, phosphorus, calcium, magnesium, manganese, iron, sodium, zinc, copper and boron contents of the samples were determined with inductively coupled plasma-optic emission spectroscopy (Perkin-Elmer 5300 DV)[16].

Plasma conditions were as following; RF power: 1450 watts; nebulizer flow: 0.55 L/min; auxiliary flow: 0.2 L/min; plasma flow: 17 L/min and sample flow rate: 1.5 mL/min.

Data were subjected to analysis of variance (ANOVA) using Minitab software (MINITAB 15 Inc.,) and the means were separated by Duncan's multiple range test ($p < 0.05$).

RESULTS AND DISCUSSION

In this study, significant differences were observed for each individual mineral of leaves between genotypes except for the sodium content (Table-2). Nitrogen, potassium, calcium and magnesium were major macroelements of jujube leaves and represented about 98 % of the total content. Nitrogen, potassium, magnesium and copper contents of 20-Ç-10 were statistically higher than those of other jujube genotypes.

TABLE-2
MINERAL COMPOSITION OF LEAVES OF PROMISING JUJUBE GENOTYPES (mg/100 g DRY WEIGHT)

Minerals	Promising Jujube genotypes			
	20-Ç-10	20-Ç-22	20-Ç-51	20-Ç-52
Nitrogen	2353.30 a	2056.70 b	1511.70 d	1756.70 c
Potassium	1078.30 a	904.70 b	873.70 c	751.00 d
Phosphorus	83.17 b	119.03 a	126.10 a	74.50 b
Calcium	3612.70 c	4807.70 b	4746.00 b	4961.30 a
Magnesium	271.33 a	255.00 b	239.67 c	244.00 c
Iron	19.03 b	16.3 c	18.40 b	21.33 a
Sodium	8.50 a	10.33 a	11.27 a	8.47 a
Manganese	3.90 a	1.47 c	3.33 b	3.83 a
Zinc	2.53 a	2.30 ab	1.97 b	1.23 c
Boron	6.53 a	4.63 b	6.17 a	6.07 a
Copper	0.57 a	0.23 b	0.13 b	0.10 b

Means followed by different letters (a, b, c, d) in the same row are significantly different ($p < 0.05$).

The phosphorus content of leaves was found statistically high in 20-Ç-22 and 20-Ç-51 jujube genotypes. The maximum amount of calcium was found in 20-Ç-52 jujube genotype (4961.30 mg) and the minimum in 20-Ç-10 jujube genotype (3612.70 mg). 20-Ç-52 jujube genotype has statistically higher iron content compared to the other jujube genotypes. Manganese contents of leaves of genotypes ranged from 1.47 to 3.90 mg. Zinc content of leaves of genotypes was between 1.23 and 2.53 mg and boron content was between 4.63 and 6.53 mg. There was only one published study in literature describing mineral composition in jujube leaves until the present study. Sena *et al.*[10] investigated the mineral contents of *Zizyphus mauritiana* leaves and they found that phosphorus, potassium, calcium, copper, iron, magnesium, manganese, sodium and zinc contents were 178, 725, 440, 0.70, 4.31, 112, 1.21, 0.77, 1.50 mg/100 g dry weight, respectively. In the same study, molybdenum and selenium contents of leaves were also determined in detectable levels (> 0.5 mg/100 g dry weight). In present study, while calcium, iron, potassium, magnesium, manganese and sodium contents of jujube leaves were higher than those reported by Sena *et al.*[10], phosphorus, copper and zinc contents were found to be similar.

In this study, *ca.* 93 % of total mineral composition of jujube fruits was composed of nitrogen, potassium and calcium (Table-3). 20-Ç-10 jujube genotype had the highest nitrogen content. Magnesium in jujube fruits ranged from 15.77 to 20.87 mg. Among the jujube genotypes studied, 20-Ç-51 and 20-Ç-52 jujube genotypes had higher magnesium content. Phosphorus contents of jujube genotypes changed between 27.13 and 30.20 mg. Sodium concentration of jujube fruits ranged from 6.07 to 9.50 mg. Iron, manganese and zinc were also detected in appreciable amount in fruits of jujube genotypes. Boron was detected in only 20-Ç-10. There are very few numbers of reports examining mineral composition of jujube fruits. Potassium contents presented here were higher and magnesium and phosphorus contents were lower than those reported by Al-Kindy *et al.*[11]. Calcium, iron, potassium, sodium and zinc content of present jujube genotypes were lower than those of Montiel-Herrera *et al.*[12]. This difference was possibly due to the different species, *Z. sonorensis S. Wats* while in present studies was *Z. jujuba* Miller.

TABLE-3
MINERAL COMPOSITION OF FRUITS OF PROMISING JUJUBE GENOTYPES (mg/100g dry weight)

Minerals	Promising Jujube genotypes			
	20-Ç-10	20-Ç-22	20-Ç-51	20-Ç-52
Nitrogen	506.67 a	170.00 c	173.33 c	310.00 b
Potassium	314.67 c	348.00 b	420.00 a	405.67 a
Phosphorus	27.13 b	27.30 b	30.20 a	29.73 a
Calcium	106.33 a	79.33 b	121.33 a	117.50 a
Magnesium	18.10 b	15.77 c	20.57 a	20.87 a
Iron	1.43 a	0.67 b	0.80 ab	0.67 b
Sodium	9.50 a	8.53 a	6.07 b	8.50 a
Manganese	0.20 a	0.10 a	0.17 a	0.17 a
Zinc	1.27 a	0.83 b	1.00 b	0.53 c
Boron	0.80	nd	nd	nd

Means followed by different letters (a,b,c,d) in the same row are significantly different ($P<0.05$), nd= not detected

Potassium, phosphorus, calcium, sodium and zinc contents of fruits of the jujube genotypes were generally similar to those of Li *et al.*[13]. However manganese, iron and copper contents of fruits of jujube genotypes were lower than those of Li *et al.*[13]. This might have been the result of climate, soil nutrient content, harvest time and especially genotypes.

Generally, while mineral contents of leaves of jujube genotypes were remarkably higher than jujube fruits, sodium contents of jujube fruits and leaves were similar. Copper was only detected from leaves but not from fruits of jujube. Boron was detected from leaves of all jujube genotypes and fruits of only 20-Ç-10 jujube genotype.

As a result, it was determined that these jujube genotypes have high content of the minerals in the study. Jujube genotypes were rich based on calcium, potassium, magnesium, sodium and phosphorus. It is a fruit that might play an important role for human nutrition and should be included in human diet.

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