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Selection of Superior Ber (*Ziziphus jujuba* L.) Genotypes in Çivril Region

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Abstract: The objective of this research performed between 1999 and 2001 was the selection of promising ber genotypes in ber population in Çivril, Denizli region and then the preservation as genetic resources. For this purpose, 52 genotypes were selected and evaluated for their superior fruit characteristics and productivity. Promising genotypes were selected using the 'Weighted-Ranged' method. 7 genotypes were selected based on fruit volume, yield, flesh/stone ratio, total soluble solids and vitamin C. The yield of selected genotypes changed between 6.34 and 17.28 g per annual shoot. The fruit characteristics for the selected genotypes were ranged from 4.52 to 6.12 g for fruit weights, 0.34-0.41 g for stone weights, 11.02-16.15 for flesh/stone ratio, 28.10-30.03 % for total soluble solids, 31.43-33.63% for total solid, 225.3-366.0 mg $100g^{-1}$ for vitamin C, 2.17-3.0 % for ash, 0.47-0.68 % for total nitrogen and 2.91-4.24 % for total protein.

Key Words: Ber, *Ziziphus vulgaris* L., selection

Çivril Bölgesinde Yetişen Üstün Özellikli Ünnap (*Ziziphus jujuba* L.) Genotiplerinin Seleksiyonu

Öz: 1999-2001 yılları arasında yapılan bu çalışmada Denizli'nin Çivril ilçesinde doğal olarak yetişmekte olan üstün özellikli ünnap tiplerinin seleksiyonu amaçlanmıştır. Yapılan ön seleksiyon sonucunda değerlendirmeye alınan 52 ünnap tipi tartılı derecelendirmeye tabi tutulmuş ve üstün özellikli bulunan 7 ünnap tipi seçilmiştir. Seçilen tiplerin verimleri 6.34-17.28 g/yıllık sürgün arasında değişmiştir. Seçilen tiplerin meyve ağırlığı, çekirdek ağırlığı, meyve eti çekirdek oranı, suda çözünebilir toplam kuru madde miktarı, toplam kuru madde miktarı, vitamin C, kül, azot ve protein içerikleri sırasıyla 4.52-6.12 g, 0.34-0.41g, 11.02-16.15, %28.10-30.03, %31.43-33.63, 225.3-366.0 mg/100g, %2.17-3.0, %0.47-0.68 and %2.91-4.24 olarak belirlenmiştir.

Anahtar Kelimeler: Ünnap, *Ziziphus vulgaris* L., seleksiyon

Introduction

Ber (*Ziziphus spp*), belonged to the family *Rhamnaceae* that consists of 45 genera and 550 species, is widely distributed in tropical and subtropical climates in the world (Mukhtar et al. 2004). These trees grow up to 12 m in height. Ber is a hardy tree of arid region which can be grown succesfully in saline soil under hot, arid environment (Meena et al. 2003). Its fruits are palatable and delicious with a good amount of vitamin A, C and B complexes and minerals (Pareek, 2002). On the other hand, alkaloids, flavonoids, sterols, tannins, saponin, and fatty acids have been isolated and chemically idendified from the different species of the genus *Ziziphus* (Croueour et al. 2002; Abdel-Zaher et al. 2005; Bhargava et al. 2005; Zhao et al. 2006). Besides, ber has significant levels of antioxidant activity, reducing power, scavenging effect on free radicals (Li et al. 2005). Because of these properties, *Ziziphus* species are used in folk medicine for the treatment of some diseases in the world (Belford, 1994; Crouėour et al. 2002; Abdel-Zaher et al. 2005; Li et al. 2005). Its barks is used to heal ulcer, wounds, scabies, throat problems and burning sensation of the body. Its fruit purify and enrich blood, treat chronic bronchitis, fever and enlargement of the liver. Ber seeds are used to treat dry cough and skin eruptions. The juice of ber root is used as a purgative and externally in gout and rheumatism (Mukhtar et al. 2004). Its leaves are used for the treatment of diabetes mellitus (Abdel-Zaher et al. 2005).

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Ber demonstrates a rich genetic diversity mostly resulting from natural cross pollination and self incompatibility (Bhargava et al. 2005). Turkey has a genetic variation for this species in some of its regions due to croos-pollinations. There is a genetic variation in native ber population in forms of fruit volume, yield and other characteristics. Standard cultivar production is a very significant process in the fruitculture. There has not been any a study regarding the selection of ber in Turkey.

Thus, it is necessary to select desired genotypes for superior fruit characteristics and to develop standart cultivars from a wide variety of natural population.

The objective of this study was to select fruitful and high quality ber genotypes grown naturally in Civril, Denizli, Turkey.

Material and Methods

The study was performed on naturally grown ber population in Civril, Denizli, Turkey. Fifty two genotypes from this ber population were selected as a research material based on their high yield and attractive appearance of fruits in the first year, 1999. The trees were approximately 15-50 years old. The following characteristics were evaluated for the harvested fruit: Morphological characteristics: Fruit weight (g), fruit volume (ml), stone weight (g), fruit length (mm), fruit width (mm) and fruit flesh/stone ratio. Chemical analyses: total soluble solids (%), total solids (%), vitamin C (mg 100 g^{-1}), ash (%), total nitrogen (%) and protein (%) contents.

In order to chose the promising genotypes, the selection criteria used at the end of 3 years study were yield, fruit volume, flesh/stone ratio, total soluble solids and vitamin C. Then based on the 'Weighted-Ranged' (WR) results, 7 genotypes with a minimum score of 670 were selected.

Yield of genotypes were evaluated according to total fruit weight per annual shoot. Average fruit volume, fruit weight, stone weight, fruit width and fruit length were determined on 100 randomly-choosen fruit, and flesh/stone ratio was calculated using the formula the weight of fruit with stone/stone weight.

Total soluble solids of the fruit were determined by a hand refractometer. Vitamin C content of fruit was determined as described (Anonymous, 1983). Total nitrogen and total protein contents of fruit were determined according to Kacar (1984).

Table 1. Characteristics, relative scores, classes and scores of the characteristics for 'Weighted-Ranged' method of ber genotypes

Characteristics	Relative Scores	Classes and Scores of the Charasteristics	
		Average fruit Volume (ml)	
Fruit Volume	30	3.17-4.09	1
		4.10-5.01	4
		5.02-5.93	7
		5.94-6.87	10
Yield	30	Total fruit weight per annual shoot (g)	
		3.07-6.67	1
		6.68-10.27	4
		10.28-13.87	7
		13.88-17.47	10
Flesh/Stone Ratio	20	Fruit weight with Stone/Stone weight	
		8.94-10.85	1
		10.86-12.76	4
		12.77-14.68	7
		14.69-16.60	10
Total Soluble Solids	12	Refractometric Value (%)	
		25.36-27.12	1
		27.13-28.89	4
		28.90-30.65	7
		30.66-32.40	10
Vitamin C	8	Ascorbic acid (mg 100 g^{-1})	
		212-250	1
		251-289	4
		290-327	7
		328-366	10

Evaluation of the total 'Weighted-Ranged' Scores: The modified 'Weighted-Ranged' (WR) method was used to determine the promising ber genotypes (Şen, 1986; Güleryüz et al. 1998; Serdar and Soylu, 1999; Demir and Beyhan, 2000). The characteristics evaluated with the WR method and their relative scores were shown in Table 1. The relative scores were multiplied by the each characteristics score and summed to obtain WR scores for the each ber type.

Results

Fruit characteristics of 52 ber genotypes were evaluated (Tables 2). There were differences among the genotypes in terms of morphological, physical and chemical characteristics. Average data of the 3 years

Table 2. Some characteristics and 'Weighted-Ranged' scores of the genotypes studied

Types No	Yield per annual shoot (g)	Fruit Volume (ml)	Flesh/Stone ratio	TSS (%)	Vitamin C (mg 100 g^{-1})	WR Score
20-Ç-1	3.07	6.55	13.02	25.37	251.7	514
20-Ç-2	4.57	6.54	14.81	30.07	236.7	622
20-Ç-3	3.24	6.79	12.69	31.03	327.7	646
20-Ç-4	7.39	6.87	15.02	30.03	225.3	712
20-Ç-5	5.45	6.54	14.62	27.80	278.0	610
20-Ç-6	4.34	6.29	11.37	29.67	317.3	550
20-Ç-7	5.21	6.62	13.28	28.40	278.3	550
20-Ç-8	5.92	6.75	14.48	28.17	255.7	610
20-Ç-9	4.09	6.47	15.14	28.70	218.0	586
20-Ç-10	6.34	6.95	15.69	29.93	309.3	670
20-Ç-11	6.56	5.94	13.17	27.27	262.0	550
20-Ç-12	7.06	6.27	13.97	29.07	257.3	676
20-Ç-13	8.43	6.00	13.02	26.70	250.7	580
20-Ç-14	5.69	6.74	16.60	27.67	212.0	586
20-Ç-15	5.87	6.70	14.32	27.50	251.3	610
20-Ç-16	7.13	6.74	14.28	28.60	291.3	724
20-Ç-17	7.29	5.97	13.44	28.33	265.0	640
20-Ç-18	5.68	6.17	12.46	28.87	313.3	574
20-Ç-19	10.97	3.67	10.90	29.80	274.0	436
20-Ç-20	7.47	5.90	12.83	27.53	290.0	574
20-Ç-21	7.61	3.24	12.29	30.33	284.0	406
20-Ç-22	9.33	6.52	16.15	29.80	271.3	676
20-Ç-23	8.26	4.95	11.67	29.93	330.0	484
20-Ç-24	7.03	5.54	11.59	27.27	327.3	514
20-Ç-25	7.73	4.19	11.60	29.47	284.7	436
20-Ç-26	6.13	4.59	11.27	28.60	282.0	310
20-Ç-27	10.25	5.19	12.36	25.80	268.0	514
20-Ç-28	10.11	3.74	13.49	29.03	330.0	454
20-Ç-29	5.34	3.60	13.78	28.30	264.7	280
20-Ç-30	8.55	3.26	15.04	28.03	254.0	430
20-Ç-31	8.20	4.70	9.69	30.57	250.7	436
20-Ç-32	9.45	5.59	12.15	26.70	213.3	490
20-Ç-33	7.64	3.90	12.42	26.53	245.3	310
20-Ç-34	4.16	3.65	10.77	30.78	275.3	292
20-Ç-35	3.08	3.17	9.91	30.50	221.0	232
20-Ç-36	8.60	5.77	11.48	29.40	248.0	502
20-Ç-37	4.09	3.79	12.48	30.17	234.7	292
20-Ç-38	5.17	4.02	10.93	29.53	250.0	232
20-Ç-39	3.21	4.00	11.97	30.70	228.0	328
20-Ç-40	5.55	5.36	13.43	30.40	285.3	496
20-Ç-41	11.54	5.37	12.48	29.93	246.0	652
20-Ç-42	7.83	4.58	8.94	29.07	244.0	352
20-Ç-43	8.44	5.27	12.47	30.60	242.7	562
20-Ç-44	11.79	3.46	11.50	29.07	257.3	466
20-Ç-45	17.47	3.91	11.93	30.47	234.7	502
20-Ç-46	9.04	4.40	12.41	29.40	235.3	472
20-Ç-47	6.31	5.09	9.29	28.63	234.7	316
20-Ç-48	11.73	3.51	10.17	32.40	309.3	496
20-Ç-49	11.99	4.78	11.09	30.40	246.7	502
20-Ç-50	10.38	5.38	9.84	29.53	245.3	592
20-Ç-51	17.28	5.37	11.02	29.44	366.0	694
20-Ç-52	15.51	5.89	12.41	28.10	364.0	778
Minimum	3.07	3.17	8.94	25.36	212.0	232
Maximum	17.47	6.95	16.60	32.40	366.0	778
Average	7.70	5.23	12.42	29.01	268,05	509,96

were used for the evaluation of the 52 genotypes. The characteristics evaluated with WR method for 52 ber genotypes were presented in Table 2. The yield of the 52 genotypes ranged from 3.07 to 17.47 g per annual shoot. Fruit volumes of these genotypes were between 3.17 and 6.95 ml while the flesh/stone ratio ranged from 8.94 to 16.60. The contents of TSS and vitamin C of the 52 genotypes were between 25.37-32.40 % and 221.0-366.0 mg 100 g^{-1} flesh fruit, respectively. After determination of the fruit characteristics, their scores for each ber genotypes were evaluated and given in Table 2. While the highest WR score was recorded for 20-Ç-52 genotype (778), the lowest WR score was for 20-Ç-35 and 20-Ç-38 genotypes (232).

As a result, seven genotypes with 670 or higher WR score were selected based on the desired characteristics (Table 3). Of the selected genotypes, while 20-Ç-51 had highest yield (17.28 g per annual shoot), highest TS (33.63%) and highest vitamin C (366.0 mg 100 g^{-1}), 20-Ç-10 had largest fruit (6.12 g or 6.95 ml), highest fruit width (23.65mm), fruit length (25.23mm), total N (0.68 %) and protein (4.24 %). 20-Ç-22 had smallest stone weight (0.34 g) and highest flesh/stone ratio (16.15).

Discussion

Yield, fruit volume and flesh/stone ratio are some of the principal objectives for breeding. Yields of the selected genotypes ranged from 6.34 to 17.28 g per annual shoot (about 50-80 kg per tree). Prasad (2005) reported that the greatest mean fruit yields were between 50.51 and 54.45 kg per tree. These results are in agreement with our results. However Kundi et al. (1989a) and Kundu et al. (1995) reported that the highest yield was 111.8 kg per tree and 88.33 kg per tree, respectively. This might result from different environmental conditions and genotypes.

Average fruit volumes of selected genotypes ranged between 4.52 g and 6.12 g or 5.37ml and 6.95ml based on three years evaluation. Sivakov et al. (1988) reported that fruit weight was between 5.72 and 10.45 g. These results agree with our result. However the average fruit weight reported by some researches was between 10.0 g and 29.34 g (Kundi et al. 1989b; Gao et al. 2003; Liu et al. 2004; Prasad, 2005; jiang et al. 2006). The ber cultivars with larger volumes may possibly be triploid. On the other hand, it was shown that ber cultivars with smaller fruit had higher ascorbic acid, total sugar and total soluble solids than the ones with larger fruit (Sivakov et al. 1988; Kundi et al. 1989b; Gao et al. 2003; Chen et al. 2006). Besides, the cultivars with smaller fruit are more suitable for drying (Gao et al. 2003). For this raison, selected genotypes are suitable for drying and as a breeding material.

Stone weights of selected genotypes were between 0.34 and 0.41g. The average stone weight was determined between 0.28 and 0.65 g in 6 ber varieties (Sivakov et al. 1988) and between 0.6 and 1.9 g in 9 cultivars (Ghosh and Mathew, 2002). As seen here, the stone weights of the selected genotypes are smaller than in many ber cultivars.

Average flesh/stone ratios were between 11.02 and 16.15 for selected genotypes. Kundi et al. (1989b) investigated the fruit characteristics of 7 ber cultivars and reported that the highest pulp/seed ratio was 16.22. The present results are in agreement with the finding of Kundi et al. (1989b).

Total soluble solids and total solids of selected genotypes were 28.10-30.03 and 31.43-33.63, respectively. Pan et al. (2003) reported that the content of total solids and total soluble solids of ber variety 'Jingzao' were 21.7% and 25.4%, respectively. Some researches reported that total soluble solids content of ber cultivars changed between 15% and 45% (Ma et al. 2000; Ghosh and Mathew, 2002; Gao et al. 2003; Chen et al. 2006; Jiang et al. 2006). This large differentiation might be due to genotypic differences.

In the present study, vitamin C content of selected genotypes changed between 225.3 and 366.0 mg 100 g^{-1} pulp. Similar results were obtained for vitamin C content. The highest vitamin C content was determined to be 101.47 mg 100 g^{-1} pulp for 'Haq Nawaz' cultivar (Kundi et al. 1989b) and 235.5 mg 100 g^{-1} pulp for 'Ilayachi' cultivar (Ghosh and Mathew, 2002). Sivakov et al. (1988) reported that vitamin C contents of 6 ber cultivars changed between 180.11 and 367.3 mg 100g^{-1} pulp.

Table 3. Some characteristics of the promising ber genotypes

Properties	Promising ber genotypes						
	20-Ç-4	20-Ç-10	20-Ç-12	20-Ç-16	20-Ç-22	20-Ç-51	20-Ç-52
Yield per annual shoot (g)	7.39	6.34	7.06	7.13	9.33	17.28	15.51
Fruit Volume (ml)	6.87	6.95	6.27	6.74	6.52	5.37	5.89
Fruit weight (g)	6.01	6.12	5.31	5.57	5.49	4.52	4.84
Stone weight (g)	0.40	0.39	0.38	0.39	0.34	0.41	0.39
Flesh/Stone ratio	15.02	15.69	13.97	14.28	16.15	11.02	12.41
Fruit width (mm)	22.16	23.65	20.94	21.57	21.55	17.27	19.56
Fruit length (mm)	23.76	25.23	22.24	23.38	22.69	16.86	21.58
TSS (%)	30.03	29.93	29.07	28.60	29.80	29.44	28.10
TS (%)	32.90	32.63	31.53	31.70	33.00	33.63	31.43
Vitamin C (mg 100 g^{-1})	225.3	309.3	257.3	291.3	271.3	366.0	364.0
Ash (%)	3.00	2.17	2.38	2.31	2.20	2.70	2.75
Total N (%)	0.61	0.68	0.53	0.56	0.47	0.59	0.60
Protein (%)	3.83	4.24	3.28	3.49	2.91	3.71	3.90

Ash content of selected ber genotypes changed between 2.17 and 3.0 %. In contrast to our results, Montiel-Herrera et al. (2005) reported that ash content of ber was 3.4 %.

While total N contents of selected genotypes were between 0.47 and 0.68 %, protein contents ranged from 2.91% to 4.24 %. Kundi et al. (1989b) reported that the protein content of 7 ber cultivars were between 1.24% and 2.96%. The protein contents of our selected genotypes are higher than those in literature cited.

We selected the number of 20-Ç-4, 20-Ç-10, 20-Ç-12, 20-Ç-16, 20-Ç-22, 20-Ç-51 and 20-Ç-52 genotypes as superior among the evaluated ber genotypes. These genotypes will be propagated and a replicated trial will be established and yield and fruit characteristics will be evaluated when trees reach maturity.

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