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Determination of Fruit Quality Properties of Loquat Genotypes Grown In Ordu Province of Turkey

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Abstract
This study was conducted to determine the quality attributes of loquat fruit grown in Ordu province of Turkey, in 2015. In the study, fruit weight, fruit sizes, color characteristics, seed and flesh weight, fruit firmness, pH, SSC and titratable acidity were investigated. The highest (35.52 g and 41.91 mm) and lowest (16.02 g and 31.13 mm) values in terms of fruit weight and fruit length were obtained from Ordu-1 and Ordu- 17 genotypes, respectively. The highest fruit width (41.05 mm) and fruit thickness (39.33 mm) were measured from Ordu-12 genotype. The b * value of the fruit ranged from 46.28 (Ordu-3) to 53.79 (Ordu-8). The seed number ranged from 1.40 (Ordu-24) to 4.80 (Ordu-19). The highest flesh weight (29.04 g) was measured from Ordu-1 genotype. The flesh weight/seed weight ratio varied from 5.04 (Ordu-25) to 2.70 (Ordu-14). Compared the other genotypes, Ordu-1 genotype was higher firmness values than other genotypes. Both the highest SSC value (14.50%) and the lowest acidity value (0.33%) were measured from Ordu-5 genotype. As a results, a wide variation was observed among examined genotypes in terms of quality characteristics.

Keywords: Acidity, color, *Eriobotrya japonica*, firmness, SSC

1. Introduction

Loquat naturally grows in coastal parts of the Mediterranean, Marmara and the Black Sea regions of Turkey. Loquat is consumed with pleasure by consumers due to its rich nutrient content. Loquat fruit is highly demanded and satisfy consumers fresh fruit needs because it is marketed during the spring and early summer when fresh fruits are limited on the market (Özçağıran et al., 2011).

Consumers prefer to high quality loquat fruits in the market. Therefore, it is tried to be obtained high quality varieties with plant breeding studies. The new genotypes with high fruit quality can be obtained from seed-propagated loquat plants called chance seedling. Therefore, to examine prominent loquat genetic resources in terms of fruit quality and selection of high quality genotypes for breeding programme from the existing genetic variation are important (Yarılgac et al., 2017). The plant breeding studies are greatly significant in order to preserve genetic resources and to use them as materials in researches (Özçağıran et al., 2011; Badanes et al., 2013). Breeding objectives, which are mainly fruit appearance and qualiy in the loquat have to contain consumer requirements as well as grower acceptability (Badanes et al., 2013).

The aim of the study is to determine the fruit quality characteristics of the loquat genotypes grown from seed in Ordu Province located in the east-northern of Turkey.

2. Material and methods

This research was carried out in the loquat fruits growing in Altınordu district of Ordu province (Black Sea Region of Turkey). In the study, totally 30 local loquat genotypes were determined. Codes were labeled to genotypes from Ordu-1 to Ordu-30. Fruits were hand-harvested at edible maturity stage. Harvested fruits were placed into polyethylene bags to reduce water loss and immediately transported to laboratory for analyses. Dimensional characteristics [length (L), width (W) and thickness (T)], fruit

weight, seed weight, seed number, flesh weight/seed weight ratio, color characteristics (L*, b*, chroma and hue angle) and flesh firmness values were determined over 50 fruits for each genotype.
Fruit and seed weights (g) were determined with a digital balance (±0.01 g) (Radvag PS, Poland). Dimensional characteristics were measured with a digital caliper (± 0.01 mm) (CD-6"CSX, Mitutoyo, Japan). By using fruit and seed weights, flesh weight /seed weight ratio was calculated with the following equation;

$$\text{Flesh weight / seed weight ratio} = \frac{W_f - W_s}{W_s}$$

W_f : fruit weight (g)
W_s : seed weight of the same loquat (g)

Color parameters of L*, b*, chroma and hue angle were determined using a colorimeter (Minolta, Japan). Measurements were performed over the opposite sides of each fruit. A three-dimensional color space was generated with the aid of *L**, *a** and *b** values in accordance with the CIE color system. The equation of $C^* = (a^{*2}+b^{*2})^{1/2}$ was used for chroma and the equation of $h^\circ = \tan^{-1} b^*/a^*$ was used for hue angle (McGuire, 1992).
Flesh firmness was measured with a press-mounted Effegi penetrometer (FT 327, Turkey) with 7.9 mm tip, expressed as Newton (N). Fruit seeds were removed and juice was extracted. In extract, SSC was determined with a refractometer (PAL 1, Atago, Japan). pH was measured by a pH meter (Hanna, Turkey). About 10 ml extract was diluted with 10 ml distilled water for titratable acidity and the amount of NaOH used to titrate the solution to a pH of 8.1 was expressed as titratable acidity (g malic acid 100 g^{-1}). Data were presented as the mean±standard deviation.

3. Results and discussion

According to results, a considerable variation was observed among genotypes for evaluated fruit characteristics. The highest and lowest values changed between 16.02 and 35.52 g for fruit weight, 41.8 and 30.86 mm for fruit width; 31.13 and 41.91 mm for fruit length and 32.16 and 39.33 mm for fruit thickness respectively. It was observed that Ordu-1 genotype has the highest fruit weight and length values, while Ordu-12 genotype has the highest fruit width and thickness values (Table 1).
In previous studies by Topuz (1998); Şenyurt (2006) and Xu and Chen (2011) reported that the fruit weight ranged from 19.74 g to 29.16 g; 26.66 to 60.24 g; and 19.2 g to 39.3 g respectively. Hussain et al. (2007), reported that fruit weight was 10.1 g and 39.7 g; the fruit width was 26.0 mm to 38.7 mm and the fruit length was 27.3 mm to 51.0 mm at Pakistan ecological conditions. Our results are compatible with the results of the studies conducted by Topuz (1998) and Hussain et al. (2007), but was found to be lower than the values determined by Şenyurt (2006).
In the study, the highest L * value (68.10) was obtained from Ordu-7 genotype, but the lowest L * value (62.96) was measured from Ordu-1 genotype. The lowest b * value (46.28) was obtained from Ordu-3 and the highest b * value (53.79) was obtained from Ordu-8 genotype. The lowest chroma (46.84) was obtained from Ordu-20 and the highest (54.19) was obtained from Ordu-10 genotype. The hue angle ranged from between 81.94 (Ordu-10) and 89.96 (Ordu-19) (Table 2).
While the color of the unripe loquat fruit is mainly green, but they are generally yellow during ripening. b * color value refers to the yellow fruit color. The increase in b * indicates that the yellow fruit color is increased. Topuz (1998) has determined that in his study, b* value is 40.49. Xu and Chen (2011) in his study in China, have found that the L * values were 60.3 to 67.8; chroma values were 40.9 to 47.5 and hue angle values were 63.0 to 75.3. Our results are in accordance with the results of the previous researchers.
The fresh fruit, which has the lowest seed number, is more preferred by consumers. In the study, Ordu-24 genotype has had the lowest seed number (1.40) while Ordu-19 genotype has had the highest seed number (4.80). Seed weight ranged from 3.82 g (Ordu-16) to 8.23 g (Ordu-13); from 12.04 g (Ordu-17) to 29.04 g (Ordu-1) for flesh weight; from 2.70 (Ordu-14) to 5.04 (Ordu-25) for flesh weight /seed weight ratio (Table 3).
In the similar studies seed number was determined as 1.76-6.58 (Yalçın and Paydaş, 1995); 1-6 (Özdemir and Topuz, 1997); 3.2-4.1 (Insero et al., 2003) and 2-6 (Şenyurt, 2006). In addition, Yalçın and Paydaş (1995); Topuz (1998) and Şenyurt (2006) reported that the flesh weight/seed weight ratio ranged from 3.50-5.56; 3.01-4.37; and 3.01-4.37 respectively. In the loquat fruit, which has lower number of seeds or has higher flesh / seed ratio, is more preferred by consumers. Our results were similar to those reported previously.

Table 1. Fruit weight, fruit width, fruit length and fruit thickness of loquat genotypes grown in Ordu province of Turkey

Genotypes	Fruit			
	Weight (g)	Width (mm)	Length (mm)	Thickness (mm)
Ordu-1	35.52±8.82*	38.58±2.70	41.91±2.54	36.01±3.39
Ordu-2	24.43±2.13	35.55±1.59	35.23±4.09	34.26±1.71
Ordu-3	26.94±6.71	34.01±2.97	35.26±2.91	32.67±3.52
Ordu-4	29.85±6.59	35.69±2.33	31.86±3.09	33.54±2.54
Ordu-5	26.69±4.46	35.76±1.68	33.95±2.00	34.39±2.04
Ordu-6	26.27±6.00	35.58±2.89	36.32±3.72	33.93±2.74
Ordu-7	32.77±7.00	39.47±2.24	34.60±2.01	37.86±2.01
Ordu-8	29.90±2.96	37.97±2.63	33.93±4.04	35.65±2.77
Ordu-9	30.87±2.03	39.95±2.79	33.75±1.21	36.75±2.85
Ordu-10	27.60±2.59	36.93±1.10	32.82±1.75	35.00±1.57
Ordu-11	35.41±6.19	40.10±2.12	39.77±2.01	38.31±2.03
Ordu-12	28.82±6.95	41.05±3.54	36.64±5.60	39.33±3.74
Ordu-13	35.23±4.77	39.57±2.18	37.96±2.56	38.44±2.15
Ordu-14	23.78±2.83	35.37±1.76	32.64±1.75	33.99±1.88
Ordu-15	19.52±1.35	35.75±1.88	33.55±2.02	33.63±2.20
Ordu-16	19.32±5.31	34.25±3.67	32.21±2.81	32.55±3.90
Ordu-17	16.02±2.32	30.86±2.16	31.13±2.53	29.26±2.37
Ordu-18	32.17±5.96	39.44±2.96	36.46±2.00	37.36±2.31
Ordu-19	29.37±1.75	37.91±1.25	36.12±1.24	36.39±1.25
Ordu-20	27.72±6.82	34.81±2.36	34.72±4.43	33.69±2.95
Ordu-21	26.01±3.53	33.93±1.90	37.82±2.52	32.16±2.81
Ordu-22	28.84±7.29	36.37±3.42	33.95±2.86	34.90±3.85
Ordu-23	25.48±2.89	35.17±1.42	37.24±3.52	32.47±1.83
Ordu-24	24.57±5.74	36.71±2.70	34.17±2.78	35.02±1.90
Ordu-25	26.26±4.50	35.07±2.67	34.05±3.48	33.41±1.94
Ordu-26	30.59±2.23	38.49±2.65	32.61±2.21	35.81±2.56
Ordu-27	27.75±2.47	36.72±2.10	33.11±2.18	35.37±2.47
Ordu-28	24.93±2.50	35.20±2.73	33.84±2.39	33.49±2.50
Ordu-29	23.50±2.85	34.56±1.88	35.02±2.67	32.83±1.75
Ordu-30	24.43±2.13	34.94±1.28	36.63±1.54	33.74±1.24

* standard deviation

Consumers desire that the firmness of ripened fruit is high. Moreover fruits with low seed number or seedlessness and higher soluble solids content are more preferred for higher flavor in the fruit consumed (Badanes et al., 2013). In the study, the highest firmness (16.09 N) was measured from Ordu-16 genotype while the lowest firmness values (9.42 N) were recorded from Ordu-7 and Ordu-19 genotypes. However, it has been determined that Ordu-5 genotype has the highest SSC (14.50%), and Ordu-17 genotype has the lowest SSC value (5.70%). It was determined that pH and acidity ranged from 3.18 (Ordu-12) to 6.00 (Ordu-3) and 0.33% (Ordu-5) to 2.27% (Ordu-10) respectively (Table 4).

In other studies, SSC was determined between 8.40-12.61% (Paydaş et al., 1992); 9.21-11.08% (Topuz, 1998); 9.00-15.00%; (Şenyurt, 2006) and 11.4-19.6% (Xu and Chen (2011). Topuz (1998) reported that

pH value was 3.74, but Şenyurt (2006) determined that pH values ranged from 2.95 to 4.67. Our results are compatible with the results of the researchers. Xu and Chen (2011), determined that acidity ranged from 0.15 to 0.72%. Our results about the acidity in the investigated loquat genotypes were partially differ from results of Xu and Chen (2011).

Table 2. L*, b*, chroma and hue angle value of loquat genotypes grown in Ordu province of Turkey

Genotypes	L*	b*	Chroma	Hue angle
Ordu-1	62.96±3.34*	47.93±2.99	48.37±2.66	83.05±3.35
Ordu-2	63.73±1.51	49.45±2.02	49.90±2.40	82.82±2.72
Ordu-3	63.97±3.77	46.28±4.60	46.43±3.79	88.47±1.75
Ordu-4	65.43±1.68	51.30±2.20	51.47±2.17	87.28±4.11
Ordu-5	63.70±2.83	48.37±4.96	48.47±5.01	88.38±3.25
Ordu-6	65.65±2.08	50.38±2.31	50.59±2.38	85.97±3.54
Ordu-7	68.10±1.49	51.58±2.42	51.65±2.39	88.97±3.16
Ordu-8	65.97±2.02	53.79±4.27	53.99±4.36	86.08±3.08
Ordu-9	65.25±3.71	51.35±2.52	51.57±2.41	86.23±4.14
Ordu-10	63.82±0.19	53.49±1.35	54.19±1.20	81.94±4.62
Ordu-11	65.07±2.19	49.84±2.53	50.18±2.60	85.12±4.79
Ordu-12	65.27±2.90	49.83±4.55	50.15±4.45	86.21±5.66
Ordu-13	64.29±3.23	51.34±2.85	51.55±2.92	87.77±4.97
Ordu-14	66.02±1.23	49.90±2.11	50.01±2.16	87.03±2.39
Ordu-15	63.29±3.56	48.50±3.24	48.80±3.25	87.14±6.05
Ordu-16	66.57±2.71	50.78±5.90	50.88±5.89	86.87±1.79
Ordu-17	65.27±2.90	49.83±4.55	50.15±4.45	86.21±5.66
Ordu-18	66.24±3.29	49.80±4.11	50.04±4.08	84.88±2.49
Ordu-19	66.24±2.65	48.48±2.92	48.53±2.92	89.96±2.81
Ordu-20	63.69±3.73	46.65±5.10	46.84±5.06	87.14±4.60
Ordu-21	66.34±1.37	51.30±4.45	51.47±4.62	87.98±4.17
Ordu-22	65.30±2.64	52.67±3.77	52.94±3.81	85.60±4.07
Ordu-23	65.79±1.89	50.50±2.15	50.62±2.11	87.50±3.13
Ordu-24	65.03±1.30	51.56±3.89	51.94±4.10	83.96±3.28
Ordu-25	65.84±3.61	49.20±1.42	49.49±1.22	89.24±6.57
Ordu-26	63.26±3.40	48.52±3.00	48.90±3.00	84.46±4.77
Ordu-27	64.44±4.11	48.94±4.40	49.05±4.31	89.25±4.16
Ordu-28	63.22±1.65	49.74±3.83	50.11±3.91	85.96±5.98
Ordu-29	65.60±1.95	53.26±4.52	53.79±4.65	83.08±4.35
Ordu-30	65.94±3.69	49.66±5.32	49.72±5.37	88.58±2.38

* standard deviation

4. Conclusion

Consumers preferences for loquat fruits are, bigger size, lower seed number, higher firmness, good flavor and aroma. In this sense, it may be said that Ordu-1 is a significant genotype in terms of fruit weight and firmness. However Ordu-24 genotype is promising in terms of low seed number, and Ordu-5 and Ordu-13 are a significant genotype in terms of higher SSC.

Table 3. Seed number, seed and flesh weight, and flesh/seed ratio of loquat genotypes grown in Ordu province of Turkey

Genotypes	Seed number	Seed weight (g)	Flesh weight (g)	Flesh/seed ratio
Ordu-1	3.60±1.52*	6.48±2.76	29.04±6.21	4.48±1.43
Ordu-2	3.60±0.55	5.41±1.06	19.02±2.00	3.51±0.92
Ordu-3	3.20±0.84	5.50±1.49	21.44±5.73	3.90±1.05
Ordu-4	3.20±1.71	5.26±2.53	24.59±4.51	4.67±3.97
Ordu-5	3.80±1.30	5.31±2.26	21.38±2.38	4.03±2.54
Ordu-6	3.80±0.84	6.11±2.04	20.16±4.14	3.30±0.60
Ordu-7	4.60±1.95	8.15±2.96	24.62±4.36	3.02±0.79
Ordu-8	3.20±0.84	5.82±1.29	24.08±3.64	4.14±1.44
Ordu-9	3.40±1.14	6.72±1.25	24.15±1.89	3.59±0.73
Ordu-10	3.40±1.14	6.13±0.84	21.47±4.90	3.50±0.72
Ordu-11	3.00±0.71	6.93±1.83	28.48±4.90	4.11±0.96
Ordu-12	2.80±0.45	5.75±1.58	23.07±5.42	4.01±0.41
Ordu-13	3.80±1.48	8.23±2.09	27.00±3.25	3.78±0.93
Ordu-14	4.60±0.55	6.42±1.00	17.36±2.31	2.70±0.49
Ordu-15	2.00±0.71	4.11±1.11	15.41±0.94	3.75±1.24
Ordu-16	2.40±1.14	3.82±1.77	15.50±4.17	4.06±2.09
Ordu-17	2.80±1.10	3.98±1.36	12.04±1.44	3.03±1.59
Ordu-18	4.00±1.41	7.05±1.55	25.12±4.54	3.56±0.34
Ordu-19	4.80±1.64	6.96±1.10	22.40±0.85	3.22±0.45
Ordu-20	3.80±0.84	6.36±1.56	21.35±5.73	3.36±0.61
Ordu-21	2.20±0.45	5.65±1.47	20.36±2.67	3.60±0.91
Ordu-22	4.00±1.00	5.37±1.23	23.47±6.55	4.37±1.15
Ordu-23	2.00±0.93	5.41±1.18	20.06±1.82	3.71±0.70
Ordu-24	1.40±0.55	4.27±1.43	20.30±4.45	4.75±0.58
Ordu-25	1.80±0.45	4.35±1.91	21.91±3.30	5.04±5.69
Ordu-26	2.60±0.55	5.48±0.93	25.11±2.25	4.58±1.04
Ordu-27	4.00±1.22	6.74±1.56	21.00±3.08	3.12±1.58
Ordu-28	3.00±0.71	4.23±0.72	20.70±2.11	4.89±0.76
Ordu-29	4.00±1.00	4.88±1.12	18.62±1.94	3.82±0.69
Ordu-30	3.60±0.55	5.41±1.06	19.02±2.00	3.52±0.92

* standard deviation

Table 4. Flesh firmness, pH, SSC and acidity of loquat genotypes grown in Ordu province of Turkey

Genotypes	Flesh firmness (N)	pH	SSC (%)	Acidity (%)
Ordu-1	13.44±0.25*	3.33	12.90	1.70
Ordu-2	12.16±0.29	3.93	13.50	0.45
Ordu-3	14.03±0.28	6.00	7.40	0.86
Ordu-4	10.40±0.22	3.38	11.10	1.04
Ordu-5	12.95±0.25	4.49	14.50	0.33
Ordu-6	15.21±0.30	3.55	7.50	1.24
Ordu-7	9.42±0.16	3.29	10.30	1.14
Ordu-8	13.15±0.29	3.99	11.40	1.98
Ordu-9	11.77±0.29	3.30	6.60	1.50
Ordu-10	14.13±0.16	3.33	12.90	2.27
Ordu-11	11.18±0.21	3.45	10.90	1.04
Ordu-12	12.56±0.34	3.18	9.10	1.58
Ordu-13	10.69±0.28	3.35	14.20	1.08
Ordu-14	12.16±0.34	3.91	6.90	0.80
Ordu-15	14.72±0.36	3.58	6.90	0.59
Ordu-16	16.09±0.24	3.55	8.80	1.06
Ordu-17	12.75±0.28	3.72	5.70	0.51
Ordu-18	11.58±0.15	3.72	11.20	0.58
Ordu-19	9.42±0.28	3.78	9.60	0.54
Ordu-20	11.18±0.23	3.88	7.30	0.85
Ordu-21	9.71±0.21	3.51	11.00	0.65
Ordu-22	12.46±0.42	3.23	10.60	1.25
Ordu-23	10.99±0.21	3.34	10.80	1.46
Ordu-24	13.05±0.36	3.71	8.00	0.70
Ordu-25	10.89±0.30	3.52	11.80	1.37
Ordu-26	10.89±0.30	3.40	10.10	0.89
Ordu-27	12.75±0.28	3.44	6.70	0.88
Ordu-28	14.13±0.28	3.56	6.60	0.82
Ordu-29	9.71±0.15	3.22	10.90	1.18
Ordu-30	10.40±0.22	3.52	11.70	0.74

* standard deviation

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